Environmental Investigation Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

June 25, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 11, 2016
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
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ENVIRONMENTAL INVESTIGATION PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND APPROVAL PAGE

Title of Plan: Environmental Investigation Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Tennessee Valley Authority

Effective Date: June 25, 2018 Revision 3 Final

TVA Compliance Point of Contact — Date 6/25/18

TVA Technical Point of Contact — Date 6/21/2018

Investigation Consultant Project Manager — 6/12/18 Date

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LIST OF APPENDICES

Abbreviations

BTV	Background Threshold Value
CARA	Corrective Action/Risk Assessment
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CPT	Cone Penetration Test
CUF	Cumberland Fossil Plant
CuRM	Cumberland River Mile
DPT	Direct Push Technology
EAR	Environmental Assessment Report (Report)
EIP	Environmental Investigation Plan
EPA	Environmental Protection Agency
ERI	Electrical Resistivity Imaging
EVS	Environmental Visualization Software
FEMA	Federal Emergency Management Agency
GPS	Global Positioning System
NEPA	National Environmental Policy Act
PLM	Polarized Light Microscopy
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan (CUF QAPP)
RSL	Regional Screening Level
RQD	Rock Quality Designation
SAP	Sampling and Analysis Plan
SPLP	Synthetic Precipitation Leaching Procedure
SPP	Standard Programs and Processes
TDEC	Tennessee Department of Environment and Conservation
TDEC Order	Commissioner's Order OGC15-0177

TOC	Total Organic Carbon
TI	Technical Instruction
TVA	Tennessee Valley Authority
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey

1.0 INTRODUCTION

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in Section 1.2 below. This CUF EIP Revision 3 addresses TDEC's EIP Revision 2 review comments provided in a letter dated December 11, 2017.

1.1 PURPOSE

The purpose of this EIP is to comply with Section VII.A.d. of the TDEC Order, which requires TVA, upon receiving requests for information from TDEC, to develop an EIP for each site that, when implemented, shall provide the information necessary to "fully identify the extent of soil, surface water, and ground water contamination by CCR." The responses and schedule set forth in this EIP correspond to each individual task in TDEC's information request letters for CUF dated April 11, 2016, January 13, 2017, and August 31, 2017. The Environmental Assessment Report (EAR), to be submitted at a later date following completion of the environmental investigation identified in the EIP, shall provide "an analysis of the extent of soil, surface water, and groundwater contamination by CCR at the site" and thus shall provide the information, analyses, and/or evaluations responsive to TDEC's information requests and the TDEC Order.

1.2 MULTI-SITE ORDER TIMELINE

By way of background, a summary of events related to the TDEC Order is provided below:

- TDEC issued Commissioner's Order OGC15-0177 to TVA on August 6, 2015.
- On September 22, 2015, TDEC and TVA met to discuss the Order. During the meeting, TDEC submitted a list of questions to be addressed at each Investigation Conference.
- On February 26, 2016, TVA provided TDEC with an Investigation Conference Data Transmittal for CUF. This transmittal included electronic and hard copies of supporting information files (and a file directory).

- TVA held the Investigation Conference at CUF on March 9-10, 2016. The Investigation Conference included a site reconnaissance and presentation that addressed the questions provided by TDEC on September 22, 2015.
- On April 11, 2016, TDEC provided an Investigation Conference Response Letter. The letter requested additional data, and the EIP. The list of questions and environmental investigative tasks to be addressed in the EIP is included in the letter. The deadline for submittal of the EIP was established as May 31, 2016.
- On April 27, 2016, TVA issued a response letter to TDEC requesting the EIP submittal deadline be extended to July 11, 2016. TDEC granted the request on May 3, 2016.
- On June 14, 2016, TDEC provided its General Guidelines for Environmental Investigation Plans (General Guidelines), and requested that TVA include responses to them in the CUF EIP. The General Guidelines are addressed in Section 4 of the EIP.
- TVA submitted CUF EIP Revision 0 to TDEC on July 11, 2016.
- TDEC provided CUF EIP Revision 0 review comments to TVA in a letter dated January 13, 2017. The deadline for submittal of CUF EIP Revision 1 was set for March 31, 2017.
- On January 30, 2017, TVA issued a response letter to TDEC requesting the EIP submittal deadline be extended to May 12, 2017. TDEC granted the request on February 22, 2017.
- As part of the response to TDEC's January 13, 2017 review comments, TVA submitted CUF EIP Revision 1 to TDEC on May 12, 2017.
- TDEC provided CUF EIP Revision 1 review comments to TVA in a letter dated August 31, 2017.
- TVA submitted CUF EIP Revision 2 to TDEC including responses to TDEC's review comments on November 9, 2017.
- TDEC provided CUF EIP Revision 2 review comments to TVA in a letter dated December 11, 2017.

1.3 EIP IMPLEMENTATION (INVESTIGATION)

A summary of the proposed EIP process for CUF is provided below and is included in the proposed EIP implementation schedule in Appendix A:

- TVA will address TDEC's CUF EIP Revision 2 comments and develop and submit CUF EIP Revision 3 and its implementation schedule to TDEC on January 26, 2017.
- TDEC will review and approve CUF EIP Revision 3, or will provide TVA a list of comments to be addressed in a subsequent future EIP revision.
- TVA will address additional comments TDEC may have, submitting additional revisions, and repeating the process until TDEC approves the EIP and schedule.

- In a letter dated September 28, 2015 from TDEC to the Southern Alliance for Clean Energy, TDEC added an opportunity for public involvement. TDEC committed to host a meeting with interested parties to discuss the proposed EIP before the public comment period stated in the Order.
- TVA will provide public notice of the EIP published in a manner specified by TDEC and allow a minimum of 30 days for public comment.
- TVA will provide responses to public comments to TDEC within 30 days after the end of the public comment period.
- TVA will work with TDEC to revise the EIP and schedule accordingly.
- TVA will implement the EIP by conducting the investigation in accordance with the approved plan and schedule.
- Within 60 days of completion of EIP activities, TVA will submit an EAR to TDEC. The EAR is described in Section 5.0.

Refer to Appendix A for additional details regarding the implementation schedule.

2.0 APPROACH

The following describes TVA's overall approach for planning and conducting the EIP.

2.1 EIP DEVELOPMENT AND STRUCTURE

Responses to each TDEC information request will be developed by:

1. **Stating clear objectives and goals of the EIP Response.**
   This will be accomplished by re-stating each original information request from TDEC and identifying specific objectives for developing the information necessary to satisfy that request.

2. **Focusing on the objectives and desired outcomes of the EIP.**
   Each response will identify specific deliverables or information to respond to the request.

3. **Leveraging existing and ongoing data collection efforts, where available.**
   TVA has conducted numerous studies at CUF and has programs underway for the Environmental Protection Agency (EPA) Final CCR Rule (CCR Rule), TDEC permitting requirements, Federal permitting and program commitments, Capital Projects, normal site operations, inspections, and maintenance that can help address TDEC's information requests. TVA will describe how, to the extent possible, data from work already completed, ongoing, or planned will be used to meet the objectives of the information requests.

4. **Conducting on-site and/or off-site studies, activities, plans and analyses in support of the EIP tasks as needed.**
   TVA will work with TDEC to develop and execute Sampling and Analysis Plans (SAPs) to develop new data where needed to respond to TDEC's information requests. The SAPs will provide detailed plans for conducting those studies to obtain new data and will describe how it will be used to respond to specific information requests. The SAPs will be structured as independent documents that guide the work of the Sampling and Analysis Plan (SAP) execution teams. The SAPs will document and communicate:

   - Background information
   - Objectives
   - Health and safety program
   - Field investigation approaches and procedures
   - Data analysis approaches and procedures
   - Reporting approaches and deliverables
   - Quality assurance/quality control (QA/QC) objectives and program

- Schedules
- Assumptions and limitations

A brief summary of each SAP will be provided in the response to corresponding information requests. The SAPs are included as appendices to the EIP; therefore, a list of proposed SAPs can be found in the Table of Contents. Field implementation may result in minor modifications of approaches. If this occurs, changes from the procedures specified in SAPs will be communicated to TDEC and documented in the EAR. TVA will notify TDEC of problems that impede the successful completion of the field activities described in the EIP and SAPs.

Where appropriate, a phased approach will be used to execute the EIP and SAP activities. For this approach, existing and ongoing studies will be used to develop additional plans; a broad study or test will then be used to pinpoint the location of a targeted study or test when needed.

5. **Revising the EIP to address TDEC and public comments.**
   TDEC and public comments will be addressed in each EIP revision, as appropriate; however, to maintain clarity, these comments will not be listed in the EIP document. Regulatory correspondence is provided as Appendix B. Public comments will be included in Appendix W. TVA will work with TDEC and revise the EIP until a final version is approved.

Section 3, TDEC Site Specific Environmental Investigation Requests, addresses 44 site-specific questions from TDEC's Investigation Conference Response Letter. TDEC's information requests are shown in italics. The numbering sequence and format for the requested information provided in TDEC's Letter is provided in its original form. Section 4, TDEC General Guidelines for EIP, was formatted to correlate with TDEC's General Guidelines which correspond to 36 general information requests. Similar to Section 3, these TDEC information requests are shown in italics. This format will enhance clarity and cross-referencing between the two documents.

During the Investigation and EAR process, TVA will provide monthly progress reports to TDEC. The progress reports will include schedule updates, percent completion on various tasks, and tasks that have been completed. The progress reports will include schedule updates, percent completion on various tasks, and tasks that have been completed. The periodic submittal of schedule and status updates to TDEC is intended to help communication between TVA and TDEC throughout the Investigation.

2.2 PROPOSED SCHEDULE

A proposed EIP schedule is provided in Appendix A, and assumes work will begin when TDEC approves the EIP, which will occur after the public comment and resolution period. The schedule numbering matches each information request in the sequence presented in TDEC's April 11, 2016 and June 14, 2016 letters and provides the following:

- A timetable for the investigation and EAR submittal
- An outline of the activities required to respond to each information request
- Planned start and finish dates for each activity

Since, in most cases, TVA will use information from ongoing and planned studies for other programs to help respond to TDEC's requests, the EIP schedule incorporates TVA's milestone dates for those studies. Consequently, should postponement of a key milestone date occur for such a study that also is on the EIP critical path, it will impact EIP and EAR schedules. Should that occur, TVA may request a time extension for impacted deadlines. Requests for a time extension will include supporting information to demonstrate appropriate cause if applicable. Any plans for construction will be subject to the completion of all necessary National Environmental Policy Act (NEPA) reviews.

2.3 QUALITY ASSURANCE PROJECT PLAN

The CUF environmental investigation Quality Assurance Project Plan (CUF QAPP) in Appendix C has been developed to ensure that the CUF investigation objectives are met by TVA and its contractors through the generation of documented, high-quality, and reliable investigative/analytical data. The CUF QAPP describes quality assurance (QA) procedures and quality control (QC) measures to be applied to investigation activities. The CUF QAPP also governs the investigation-specific SAPs and TVA Technical Instructions (TIs).

The CUF QAPP describes the QA implementation for the investigation and identifies the obligations of the various entities responsible for generating environmental data. The CUF QAPP describes the generation and use of environmental data associated with the investigation and is applicable to sampling and monitoring programs associated with the project.

The CUF QAPP establishes an overall environmental QA framework for the investigation and provides quantitative objectives for analytical data generated under the investigation. Requirements associated with various analyses; data generation, data reduction, and data management; and results reporting are stipulated therein.

The CUF QAPP addresses the following items:

- Project organizational structure, roles, and responsibilities
- QA objectives
- Training requirements
- Field and laboratory documentation requirements
- Sample collection, handling, and preservation
- Chain-of-Custody procedures
- Field and laboratory instrumentation and equipment calibration and maintenance
- Preventive maintenance procedures and schedules
- Laboratory procedures
- Analytical methods requirements
- Sample analysis, data reduction, validation, and reporting
- QC sample types and frequency
- QA performance and system audits
- Data assessment procedures, including processing, interpretation, and presentation
- Corrective actions
- QA reports to management

Additional investigation-specific QC requirements are presented in the associated SAPs. The CUF QAPP appendices present requirements and quantitative objectives for analytical data for each investigation. Analytical data intended for use under the CUF investigation will be managed in a database in accordance with the Data Management Plan for the TVA Multi-Site Order.

3.0 TDEC SITE SPECIFIC ENVIRONMENTAL INVESTIGATION REQUESTS

TDEC requested that TVA provide responses to the following information requests presented below following the numbering sequence format of the Investigation Conference Response Letter. The information requests from TDEC are printed in italics to distinguish them from TVA's responses.

3.1 A. SITE INFORMATION

TVA shall provide information about CCR storage and disposal sites at the TVA Cumberland Fossil Plant (TVA Cumberland). TVA shall:

3.1.1 A.1 TDEC Site Information Request No. 1

Review the natural chemistry of the soils in the area of the TVA Cumberland including the naturally occurring levels of metals and other CCR constituents present in the soil. TVA shall collect soil samples within a one-mile radius of the Cumberland Fossil Plant to supplement the information gained from local soil studies, reports, or soil profiles. Of particular interest are the concentrations of Boron, Chromium, and Hexavalent Chromium. TVA shall report the levels of naturally occurring CCR constituents found during the investigation of the naturally occurring soils.

TVA Response

TDEC has requested the characterization of the local soils within a one-mile radius of CUF to evaluate the background levels of constituents of concern, which includes those listed in Appendices III and IV of 40 Code of Federal Regulations (CFR) Part 257. In addition, five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04, and not included in CCR Appendices III and IV, have been added to maintain continuity with other TDEC environmental programs. Those constituents include the following metals: copper, nickel, silver, vanadium, and zinc. These constituents will hereafter be referred to as "CCR parameters." TDEC's comments on the CUF EIP Rev 2, dated December 8, 2017, removed the requirement for hexavalent chromium (Cr(VI)) analysis.

TDEC's request also includes development of a Background Soil SAP and sampling location map, and TVA has provided both documents in the EIP submittal (see Appendix E).

TVA has prepared the CUF Background Soil SAP to characterize background soils on TVA property in the vicinity of the TVA CUF Plant. The approach in characterizing the background soils is to identify locations where naturally occurring, insitu, native soils are present, yet unaffected by CCR material. Soil samples will be analyzed for the CCR Parameters to determine the naturally occurring levels.

The surficial soil at each location will additionally be analyzed for percent ash, to determine the presence or absence of CCR.

Activities constituting the background soil characterization study include:

- Determine sampling locations for representative background soils;
- Sample background soils; and
- Review and evaluate background soils analytical data (i.e., CCR constituent levels) for the EAR.

Steps required to conduct this investigation include:

1. Research and review existing background soil documentation;
2. Review available information on beneficial uses of CCR materials within one mile of CUF;
3. Identify and map background soil sampling locations;
4. Finalize Background Soil SAP;
5. Collect background soil samples, using appropriate sampling equipment and protocols;
6. Analyze soil samples for CCR parameters in accordance with the CUF QAPP; and
7. Review and evaluate existing and new analytical data to identify background concentrations of CCR parameters.

In 2016, TVA completed a subsurface investigation in support of an ongoing hydrogeologic characterization study. Soils were collected from the screened intervals of saturated soil samples for two potential background groundwater monitoring wells installed in overburden (CUF-201 and CUF-202; Figure 1, Appendix D). A composite sample was collected from each well, and submitted for analysis of naturally-occurring metals and other elements per TVA's background soil sampling protocols under the CCR Rule Groundwater Program. The analyses included most CCR parameters; however, sulfate, boron and radium were not analyzed for one or both of the wells. The results for these soil samples will be evaluated against the specifications of the CUF QAPP. If data meets quality standards, it will be included as part of the environmental investigation and presented in the EAR.

In identifying locations for representative background soil samples, TVA will meet the location criteria set forth by TDEC, namely:

- A minimum of twelve sample locations; and
- Within a one-mile radius of the center of the CUF site, excluding points in Lake Barkley or other water bodies.

Additional criteria TVA will consider in determining representative background soil sample locations include:

- Relative elevation to CUF ground surface;
- Similarity to geologic units present at CUF;
- Similar depositional environment (i.e., alluvial, or non-alluvial);
- Proximity to existing background groundwater monitoring wells, when feasible; however, proximity to existing monitoring wells will not be used to exclude a sample location;
- Accessibility if on private property (all currently proposed locations are on TVA owned properties);
- Exclusion of areas of known CCR beneficial reuse; and
- Exclusion of areas known or expected to be in contact with CCR constituents during rain events, flood events, or currently being influenced by groundwater flow from CUF.

The twelve-proposed background soil sampling locations are shown on Figure 2 and are located on property owned by TVA. Figure 3 shows the locations of the proposed background soil sampling locations overlain by a United States Department of Agriculture soil map, which depicts surficial soil types. Proposed sampling locations were evaluated for past placement of CCR material and to our knowledge, no CCR materials have been placed in these areas. Based on beneficial use receipt records, the closest location where CCR materials were shipped for beneficial use is a location in Clarksville, Tennessee, over 10 miles away.

Prior to mobilization for sample collection, the twelve sampling locations will be verified using the Global Positioning System (GPS). If necessary, sampling points will be changed to the closest possible location that can be safely accessed.

An initial grab sample representing the surficial soils (i.e., top six inches) will be collected by hand auger and submitted for laboratory analysis of percent ash by polarized light microscopy (PLM) in addition to CCR Parameters. Borings will then be advanced using a direct push technology (DPT) drill rig equipped with 5-foot, 3.25 inch outside diameter probe rods, or equivalent technology.

In collecting soil samples, borings will be extended until refusal or a depth of 20 feet below encountered groundwater surface, whichever is shallower. Grab samples will be collected from the mid-point of each 5-foot boring interval. The mid-point for grab samples will be the mid-point based on recovery.

If soils are expected to be hard to recover during core retrieval core catchers will be used to prevent loss of sample material. No composite samples are proposed.

If a change in lithology, such as a change in residuum, colluvium, alluvium, etc., occurs within a core interval separate grab samples will be collected from the mid-point of both lithologies in the core. Samples collected by DPT will be sent to the laboratory for analysis of CCR parameters. A complete description of the sampling methods and protocols is provided in the Background Soil SAP (Appendix E).

In addition to the soil data that will be collected from the twelve proposed sampling locations, TVA will collect soil samples through the well screen interval at locations of proposed background groundwater monitoring wells.

Once sampling has been completed and analytical results have been received, the analytical data for background soil will be evaluated and addressed in the EAR. In doing so, TVA proposes to utilize Background Threshold Values (BTVs) as the method to statistically evaluate and quantify site specific background concentrations for CCR parameters.

BTVs are calculated using sampling data collected from un-impacted site-specific reference areas and represent an upper threshold of background concentration(s).

The choice of BTV (Upper Confidence Limit, Upper Threshold Limit, Upper Prediction Limits) will be determined based on characteristics of the data (e.g. sample size, statistical distribution). All statistical analyses will be conducted utilizing the latest version of EPA ProUCL software (currently version 5.1.0) and consistent with ProUCL Technical Guidance Document (EPA 2015b).

3.1.2 A.2 TDEC Site Information Request No. 2

Provide in its Environmental Investigation Plan geologic maps before Lake Barkley was created and topographic maps that identify surface water features such as springs, the original flow of Wells Creek, etc.

TVA Response

According to USACE (2017), construction of Barkley Dam began in June 1957 and was completed in July 1966. The Geologic Map of Wells Creek Basin (Tiedemann et al. 1968) is provided as Figure 4 and shown on Figure 5 with the approximate boundary of the CCR units added for clarity.

This geologic map was published in 1968; however, by inspection it shows topography prior to the impoundment of Lake Barkley and subsequent backwater conditions along Wells Creek.

A topographic map and an aerial image showing springs reported in Law (1992b) and the historic alignment of Wells Creek is provided as Figures 6 and 7. The historic alignment of Wells Creek is also shown on Figure 8. TVA will review these maps during the Investigation and discuss the springs and historic alignment of Wells Creek in the EAR.

3.1.3 A.3 TDEC Site Information Request No. 3

Provide the surface elevation and flow rate of the spring currently used as a background ground water monitoring point.

TVA Response

TVA has not been granted access by the property owner to sample Rye Spring. Historically, TVA sampled Rye Spring as a background groundwater monitoring site. The last date TVA was able to survey the spring and record the approximate elevation (398 feet) was April 15, 2016. After that time, the property owner has decided not to allow TVA access to the spring.

3.1.4 A.4 TDEC Site Information Request No. 4

Provide the construction design of the original CCR surface impoundments.

TVA Response

As part of the Investigation, TVA will review the following documents to summarize the design and materials used to construct the original Ash Pond. TVA will also use this information to estimate the original surface elevation at the location of the original Ash Pond. TVA will report this information in the EAR.

- **Record Construction Drawings:** TVA provided Record Drawings 10N212 (Revision 11), 10N213 (Revision 6) and 10N214 (Revision 2) to TDEC in the Investigation Conference (Slide 31) and Investigation Conference Data Transmittal. These drawings provide plan views and cross sections for the construction of the original Ash Pond as well as subsequent modifications. Additionally, TVA drawing 10N213 includes 15 notes that indicate specifications for the construction of the Ash Pond dikes including a minimum factor of safety with respect to slope stability analysis.
- **Historic Geologic and Geotechnical Reports:** The first known preliminary geologic investigation report for CUF was TVA (1958). Subsequent geotechnical reports, including a borrow study for the perimeter dike raising project (TVA 1981) and geotechnical explorations of the perimeter dike (TVA 1974; HBA 1986), were

summarized in the Investigation Conference (Slide 31) and provided to TDEC in the Investigation Conference Data Transmittal.

These reports also provide information regarding the design and materials used to construct the original Ash Pond.

- **Recent Geotechnical Reports:** As part of its Investigation Conference Data Transmittal, TVA provided TDEC more recent geotechnical reports for the Stilling Pond (including Retention Pond), Dry Ash Stack, and Gypsum Storage Area (Stantec 2010a, 2010b, 2010c, 2013). These geotechnical reports included stability cross sections that depict the configurations of the starter and raised dikes as well as material classification and consistency descriptions.

Based on the amount and context of data available to support a response, additional field work is not anticipated at this time to answer this information request.

As requested by TDEC's CUF EIP Revision 0 comments (see Appendix B), well locations overlaid on TVA Drawing 10N212 are shown on Figure 8 and water elevation data is discussed in Section 3.1.12.

In TDEC's CUF EIP Revision 1 comments (see Appendix B), additional information is requested regarding the potential for preferential seepage pathways through the foundation soils via stream channels that were present prior to development of the Dry Ash Stack and the Stilling Pond (including Retention Pond). Additional information is also requested regarding historical grouting of the foundation soils beneath the perimeter dike along the current alignment of Wells Creek. Figure 9 shows the pre-construction channel of Wells Creek crossing the CCR unit perimeters at two different locations, and shows the grouting alignment (based on TVA Drawing 10N212).

There is limited information available on how the foundation was prepared during original perimeter dike construction. It is unclear if more pervious stream deposits were present, and if so whether they were excavated or otherwise treated prior to placing fill. In addition, TVA Drawing 10N213 indicates a design section for the perimeter dike that included an option to place an initial layer of rockfill to begin the starter dike in areas where the existing ground was below water. However, no documentation is available to indicate if this option was ever employed. Finally, available documentation of the grouting program indicates that seepage was believed to be occurring along a pervious layer in the foundation soils beneath the perimeter dike. A more detailed review of the available information for these three potential seepage pathways is presented in Appendix F.

Additional field work is proposed to better characterize the uppermost foundation soils and base of the starter dike in the vicinity of the mapped, pre-construction Wells Creek channel, as well as in an adjacent area of historical grouting.

The use of various surface geophysical methods was considered, but because the location is known to a reasonable degree of certainty (based on historical drawings) a targeted subsurface exploration is proposed that should provide more definitive results.

At or near each stream crossing location along the perimeter dike system, a series of closely spaced Cone Penetration Test (CPT) soundings is proposed. The CPT data, correlated to existing nearby boring logs, can be used to differentiate relatively sandy (i.e., more pervious) foundation soils, if present. CPT refusals at specific elevations may indicate the presence of the rockfill layer. The proposed CPT layout is shown on Figure 10 and the detailed plan is presented in the Exploratory Drilling SAP (Appendix G).

The information gathered from historical and ongoing explorations, historical observations of seepage, grouting data, piezometer data, and changes in site operations (i.e., conversion from surface impoundments to landfills) will be used to develop an improved understanding of the seepage characteristics along the area of pressure grouting. Results will be presented in the EAR. If the results of these efforts identify remaining data gaps, additional field efforts will be designed and implemented in communication with TDEC.

3.1.5 A.5 TDEC Site Information Request No. 5

Provide the construction design of the surface impoundments as TVA began to divide the original surface impoundment into individual units.

TVA Response

The original Ash Pond was first divided to construct Ash Disposal Areas No. 1 and 2 in 1976. Ash Disposal Areas No. 1 and 2 were divided in 1977 to construct the Stilling Pond and 1996 to construct Dry Ash Stack, Gypsum Storage Area, and Bottom Ash Pond. During the Investigation, TVA will review the following documents to describe how the original Ash Pond was divided into individual units. TVA will report this information in the EAR.

- **Record Construction Drawings:** Drawings described in Section 3.1.4 document how the original Ash Pond was divided into individual units.
- **Companion Drawings:** Several companion drawings (specifically 10N224, 10N225, 10N227, 10W287-1, 10W287-2 and 10N218) provide cross-sections or details for the following dikes and structures:
    - 1976 divider dike which divided the original Ash Pond into two Ash Disposal Areas (No. 1 and No. 2);
    - 1977 divider dike constructed to establish the Stilling Pond at the north end of Ash Disposal Area 2; and

  - Spillways and drainage ditches that were constructed to improve impoundment safety and operations.

- **Permit Drawings:** TVA also provided permit drawings (10W302 series, United Engineers and Constructors dated 1992 and updated 2003) and the TVA 2003 Operations Manual (which included the 10W302 series drawings) to TDEC in the Investigation Conference (Slide 32) and Investigation Conference Data Transmittal. This documentation depicts the configuration and details the operation of the Dry Ash Stack, Gypsum Storage Area, and Bottom Ash Pond as the plant converted from wet to dry storage in the 1990s.
- **Geotechnical Reports:** Geotechnical reports described in Section 3.1.4 also provide information regarding the construction design of the surface impoundments as TVA began to divide the original surface impoundment into individual units.

Based on the amount and context of data available to support a response, additional field work is not anticipated at this time to answer this information request.

3.1.6 A.6 TDEC Site Information Request No. 6

Provide an as-built design of the interface between the gypsum stack and sluiced ash for the Gypsum Landfill.

TVA Response

The scope of work and supporting documentation to respond to A.6 and A.7 (Section 3.1.7) are similar. The difference is that A.6 is for the Gypsum Storage Area and A.7 is for the Dry Ash Stack; therefore, the scope to address A.7 is provided in this response to A.6.

During the Investigation, TVA will review the following documents to summarize the as-built designs of the Gypsum Storage Area and Dry Ash Stack. TVA will report this information in the EAR.

- **Inspection Reports:** TVA will review inspection reports for construction documentation (which may include photos) for the interface between the stacked CCR and sluiced ash in the Gypsum Storage Area and Dry Ash Stack. The 2015 Annual Inspection Report noted underdrain pipes in the Gypsum Storage Area that convey flow from the interface zone to the perimeter ditch; however, similar underdrain pipes have not been identified for the Dry Ash Stack.
- **Permit Drawings:** The permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 81-102-0086.

- **Geotechnical Reports:** Geotechnical reports for the Dry Ash Stack and Gypsum Storage Area (Stantec 2010b, 2010c) were summarized in the Investigation Conference (Slide 34) and provided to TDEC in the Investigation Conference Data Transmittal. This geotechnical work included drilling 15 soil test/sample borings and 10 cone penetration test (CPT) soundings through the stacked CCR/sluiced ash interface at locations shown on Figure 11. These reports included boring logs and stability sections which depicted the encountered interface between the stacked CCR material and sluiced ash within the Gypsum Storage Area and Dry Ash Stack. TVA will evaluate this existing data as described in the Evaluation of Existing Geotechnical Data (Appendix F).
- **Archived Documents and Interviews:** If additional information is discovered it will be incorporated into the Investigation. In an effort to obtain additional information regarding the interface between the stacked and sluiced ash, TVA will also interview existing plant and engineering personnel (if available) who supported initial construction of the Gypsum Storage Area and Dry Ash Stack in the 1990s.
- **Proposed Boring Data:** The existing information will be supplemented in the EAR with data from proposed borings and borings completed recently for other ongoing projects as outlined in the EIP.

TVA will use the referenced information, as well as information not previously transmitted to TDEC (if located) to summarize the as-built design of the interface between the stacked CCR and sluiced ash within the Gypsum Storage Area and Dry Ash Stack. TVA will provide a description of the as-built design along with supporting documentation in the EAR. The EAR will also provide explanation that a more accurate delineation of the stacked CCR/sluiced ash interface is not critical to the slope stability analysis of the units. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary.

This topic is closely related to identifying the drainage layer interface as discussed in Section 4.4.7. Discussion will be added to the EAR regarding how the findings of the geotechnical borings (existing and proposed) compares to the interface geometry shown on the referenced drawings.

3.1.7 A.7 TDEC Site Information Request No. 7

Provide an as-built design of the interface between the dry ash stack and sluiced ash for the Fly Ash and Bottom Ash Landfill.

TVA Response

See the response to A.6 (Section 3.1.6). The scope of work and supporting documentation to respond to A.6 and A.7 are similar. The difference is A.6 is for the Gypsum Storage Area and A.7 is for the Dry Ash Stack; therefore, the scope to address A.7 is provided in the response to A.6.

3.1.8 A.8 TDEC Site Information Request No. 8

Provide the anticipated final elevation of the Gypsum Landfill and the projected date that elevation will be reached.

TVA Response

The scope of work to respond to A.8 and A.9 (Section 3.1.9) are similar. The difference is A.8 is for the Gypsum Storage Area and A.9 is for the Dry Ash Stack; therefore, the scope to address A.9 is provided in this response to A.8.

The permit drawings (described in Section 3.1.5) show the build-out of the Gypsum Storage Area and Dry Ash Stack. The permit drawings are in accordance with Solid Waste Permit IDL 81-102-0082 and were provided in the Investigation Conference Data Transmittal.

As part of the investigation, TVA will review current and projected stacking plans and the most recent version of the permit drawings, and provide TDEC with the permitted elevation, proposed final elevation, and the projected date for completion of the final build-out of the Gypsum Storage Area and Dry Ash Stack. TVA will report this information along with required assumptions that lead to the conclusions in the EAR. If closure is mandated by the CCR Rule, the revised elevations and projected date for completion will be updated in the EAR.

3.1.9 A.9 TDEC Site Information Request No. 9

Provide the anticipated final elevation of the CCR Fly Ash and Bottom Ash Landfill and the projected date that elevation will be reached.

TVA Response

See the response to A.8 (Section 3.1.8). The scope of work and supporting documentation to respond to A.8 and A.9 are similar; therefore, the scope of work to address this information request is provided in the response to A.8.

3.1.10 A.10 TDEC Site Information Request No. 10

Provide a three-dimensional profile of the CCR materials from the final elevation of the landfills to the natural occurring surface below the landfills/gypsum ponds for the Gypsum and CCR Fly Ash and Bottom Ash Landfills. As a part of this effort, TVA shall provide an estimated amount of CCR material disposed at the TVA Cumberland Plant.

TVA Response

TVA prepared a Material Quantity SAP, provided as Appendix H, to describe the methods TVA will use during the Investigation to answer TDEC's information requests regarding CCR unit geometry, CCR material quantity, groundwater elevations, saturation levels, and subsurface conditions with respect to the Stilling Pond (including Retention Pond), Dry Ash Stack, Bottom Ash Pond, and Gypsum Storage Area. The objectives and approach for the Material Quantity SAP are summarized below.

Proposed TDEC Order Borings and Temporary Wells

TVA proposes installing CPTs, multi-purpose borings, and temporary wells at locations shown on Figures 10 and 12 to supplement existing data related to CCR thickness, piezometric saturation levels, clay foundation (and/or other materials) thickness, and top of bedrock elevations within the interior of the CCR units. A total of 26 CPTs and 19 borings are proposed. To evaluate water levels in saturated material, 10 of the borings will be completed as temporary wells screened in saturated material within the CCR units. Details regarding proposed drilling, sampling, and well installation activities are provided in the Exploratory Drilling SAP (Appendix G).

Water Level Monitoring

Monthly water level monitoring will be conducted for 6 months to establish and monitor levels in each CCR unit. TVA proposes using manual readings from temporary wells and open standpipe piezometers and automated readings from existing automated vibrating wire transducer piezometers shown on Figures 12 and 13 to estimate saturation levels in CCR. Details regarding water level monitoring field activities are provided in the CCR Material Characteristics SAP (Appendix I). Following characterization of the CUF site and in communication with TDEC, TVA may elect to remove the temporary wells.

Three-Dimensional Model

Three-dimensional models of the Stilling Pond (including Retention Pond), Dry Ash Stack, Bottom Ash Pond, and Gypsum Storage Area will be developed to depict subsurface conditions from the ground surface to bedrock using the data summarized below which includes data from the proposed exploratory borings and temporary wells discussed above.

1. The most recent permit drawings will be used to model the anticipated final elevations of the Dry Ash Stack and Gypsum Storage Area.
2. Ground and aerial survey data will be used with record drawings to model features such as a soil cap and riprap layers.
3. TVA surveyed slopes, embankments, and benches to develop stability cross-sections. TVA will use this topographic data with the most recent aerial survey data to model the geometry of the dikes and benches.
4. Contour data from the most recent aerial and hydrographic surveys will be used to model the upper CCR surface.
5. Pre-construction topographic information from TVA Drawing 10N212 (see Figure 8) and data from borings that penetrated the lower boundary of the CCR surface shown on Figures 10, 11, and 12 will be used to model the lower CCR surface.
6. Data from borings that encountered foundation soils shown on Figures 10, 12, and 14, will be used to model the foundation soils underlying the CCR units.
7. Borings that encountered top of bedrock shown on Figures 12 and 15 and Electrical Resistivity Imaging (ERI) transects shown on Figure 15 will be used to model the top of bedrock surface.
8. Estimated piezometric levels of saturation discussed above will be incorporated into the models.
9. Groundwater levels estimated as part of the hydrogeological investigation described in the Hydrogeological Investigation SAP (Appendix J) will be incorporated into the models.

The three-dimensional model will be generated using software capable of rendering three-dimensional surfaces and calculating volumes such as Autodesk's AutoCAD Civil 3D or ArcGIS. Environmental Visualization Software (EVS) may also be used to visualize the three-dimensional model of the CCR units.

Regarding the information request for the top of bedrock surface, the geologic setting at the CUF site is unique due to its location in the Wells Creek Structure, a meteor impact zone. The structural geology of this vicinity is well documented and high quality geologic mapping is available, including Wilson and Stearns (1968) and Ford, Orchiston and Clendening (2012), among others.

Figure 15 shows the existing borings with top of bedrock elevations, superimposed on the geologic map from Wilson and Stearns (1968). As expected, the bedrock beneath the CUF site is highly irregular, with many mapped faults/fractures and sharp changes in the bedrock elevation over short horizontal distances. Generating a detailed top of bedrock surface contour map based on borings and/or geophysics will have limitations. However, the available data can be compared with the existing geologic maps to look for unexpected trends. Therefore, the overall intent of characterizing the bedrock surface beneath the site will be satisfied.

Drawings

After the three-dimensional models are finalized, they will be used to produce drawings of the Stilling Pond (including Retention Pond), Dry Ash Stack, Bottom Ash Pond, and Gypsum Storage Area showing the following:

- Estimated final elevation of the Dry Ash Stack and Gypsum Storage Area
- Subsurface material types, properties, elevations, and thickness from the ground surface to top of bedrock
- Correlation of top of bedrock elevations (from borings, etc.) with site geologic mapping information
- Top of bedrock contours
- Estimated piezometric saturation levels, contours, and river stage
- Estimated groundwater elevations, contours, and river stage
- Plan view showing areas where CCR is saturated
- Normal/minimum pool elevation (lowest spillway rim elevation) and minimum embankment crest elevation (maximum pool elevation) in Stilling Pond (including Retention Pond)
- Estimated extent of clay foundation between CCR and bedrock and estimated groundwater elevation

Volumetric Estimates

The following volumetric estimates will be calculated for each CCR unit using three-dimensional modeling software such as Autodesk's AutoCAD Civil 3D or ArcGIS:

- Total volume of CCR in each CCR unit
- Volume of CCR below estimated piezometric saturation levels
- Volume of CCR below estimated groundwater elevations
- Volume of CCR above estimated piezometric saturation levels

- Volume of CCR above estimated groundwater elevations

The total volume of CCR at CUF will also be estimated. These volumetric estimates will be calculated using two methods to validate the model and results.

Reporting

The EAR will document the field activities from the Investigation. This will include deviations from those procedures, results, and geological and hydrogeological interpretations. The results of the CCR material quantity assessment, including three-dimensional models of the facilities, drawings, and volumetric estimates, will also be incorporated into the EAR.

3.1.11 A.11 TDEC Site Information Request No. 11

Provide a water balance analysis for the TVA Cumberland site. This consists of the water entering the impoundment from the plant and surface water runoff and the water discharged from the surface impoundment into the Cumberland River at the NPDES permitted discharge point.

<u>TVA Response</u>

A Wastewater Characterization report (HDR 2013) was previously prepared to provide a basis of design for a future wastewater treatment facility at CUF. The report included a wastewater flow evaluation of various inflows to the potential future treatment facility. The investigation did not specifically characterize inflows and outflows associated with the Stilling Pond/Retention pond impoundment system.

To address this information request, TVA will perform a water balance analysis for the CUF Stilling Pond/Retention Pond impoundment system. The objective of this water balance analysis is to compare hydrologic inputs and outputs of the impoundment system and evaluate if there is a net imbalance between them. The water balance will include the inflow parameters of process discharge water, precipitation, and surface water inflow and the outflow parameters of permitted discharge and evapotranspiration. The Water Balance SAP is provided as Appendix K.

- <u>Process Discharge Water:</u> This parameter includes water discharged from the Bottom Ash Pond and Gypsum processing area into the impoundment system via a rock lined channel and two 72" concrete pipes located along the northeast boundary of the Dry Ash Stack. The flow rate through these pipes has not been measured and is currently unknown. Details of the flow measurement to be completed for this parameter are included in the Water Balance SAP.

- Precipitation: This includes precipitation directly into the impoundment system. Precipitation data gathered from a currently installed on-site weather station will be used for this parameter.
- Surface Water Inflow: This includes surface water runoff from the Dry Ash Stack and Gypsum Storage Area. Runoff is accumulated in the perimeter ditch and enters the impoundment system via two pipes located near the northeast corner of the Dry Ash Stack. These are thought to be 36” reinforced concrete pipes but the dimensions and material will be verified for the EAR. The flow rate through these pipes has not been measured and is currently unknown. Details of the flow measurement to be completed for this parameter are included in the Water Balance SAP.
- Evaporation: This includes evaporation of water directly out of the impoundment system. No data exists for this parameter, but it will be evaluated by continually gathering water temperature data and using it in conjunction with data from the currently installed weather station to calculate evaporation.
- Transpiration: This includes transpiration of water from plants located within the impoundment system boundary. No direct measurements of this parameter have been made, but data exists to estimate transpiration via modeling techniques.
- Permitted Discharge: This includes surface water that is conveyed out of the impoundment system via four 36-inch reinforced concrete drop inlet spillway pipes which discharge to the Cumberland River via NPDES Outfall IMP001. Flow through these pipes will be monitored by installing flow meters in each pipe. Additionally, as detailed in the Water Balance SAP, flow through these pipes will be calculated using published rating curves and compared to direct flow measurements. Water level data that is currently gathered by pressure transducers within the impoundment will be used with the rating curves to calculate flows. NPDES sampling data is provided in Appendix L.

TVA will use currently installed equipment and historic data to measure precipitation and calculate transpiration and will perform additional fieldwork to measure or calculate the other parameters. An automated thermometer will be installed in the impoundment system and automated flow meters will be installed in the four inlet pipes discussed above to calculate inflows to the impoundment system. Evaporation will be calculated from impoundment system temperature and data gathered from the currently installed weather station. The accuracy of these automated measurements will determine the overall accuracy of the water balance and the ability to identify a statistically significant imbalance between inflows and outflows for the impoundment system.

The objectives, methods, and schedule for this fieldwork are detailed in the Water Balance SAP. Data collected during the implementation of the EIP will be analyzed and results will be summarized in the EAR.

If an imbalance between inflows and outflows is concluded from this evaluation, then the results of the water balance will be evaluated along with other current hydrologic and environmental studies.

3.1.12 A.12 TDEC Site Information Request No. 12

Present in table form all ground water sampling results from the TVA Cumberland site. This includes chemical, physical, ground water elevation, etc.

TVA Response

TVA has compiled current and available (at the time of the submittal of this EIP) groundwater sampling results into a database, including the following categories of parameters:

- Chemical
- Physical
- Groundwater elevation

The database includes monitored springs, as well as installed, abandoned, or closed groundwater monitoring wells at the site as clarified in Section C.1 of the General Guidelines. This information was provided as part of the Investigation Conference and is also provided in Appendix M in tabular form. This data has been collected for a variety of reasons since approximately 1990. TVA may use these historical data for qualitative purposes, but will use such data only after evaluating it in accordance with the CUF QAPP. In addition, a figure showing existing and abandoned monitoring wells is included as Figure 1. Well abandonment records for wells abandoned as part of CCR Rule activities are included in the Stantec Geotechnical Field Services for Well Installations and Closures report dated February 10, 2017 included in Appendix N.

The EAR will include a discussion of the monitored springs and existing, abandoned, or closed monitoring wells, and of the analytical results for samples collected from these sampling points. TVA will provide in the EAR available construction and location information for monitoring wells.

In addition to the sampling data, Section C.1 of the General Guidelines also sets out new requirements for including installed, abandoned, or closed groundwater monitoring well construction information and locations. This additional well construction information will be researched, collected, reviewed and provided in conjunction with and summarized in the EAR.

3.1.13 A.13 TDEC Site Information Request No. 13

Submit evidence that assures stability of the bedrock below fill areas and of the waste and of side-slope berms.

<u>TVA Response</u>

TVA understands the information request addresses two distinct topics:

1. Stability of bedrock below fill areas – evaluating the bedrock with respect to voids/cavities and faults/joints of significant lateral or vertical extent that could be large enough to lead to loss of structural support and potential release of the overlying CCR.
2. Stability of waste and side-slope berms – evaluating the slope stability (static and seismic) of the CCR unit perimeters, as it relates to potential release of CCR.

For each topic above, TVA will use existing data to respond to the information request. The adequacy of existing data to support these responses is presented below. TVA also presents a plan for additional field efforts, to be performed as part of the Investigation, to supplement existing data.

Stability of Bedrock Below Fill Areas

Evaluating the adequacy of existing data depends on the type of data, its quality, and its intended use. For evaluating the stability of bedrock below fill areas, existing data to be considered includes:

1. Geotechnical data from borings that included rock coring.
2. Geophysical surveys that included data below the top of bedrock.
3. Routine visual observations of CCR units, with respect to indicators of structural distress.
4. Geologic mapping and characterization of the site, including descriptions of the shallow rock formations.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Spatial coverage of borings, geophysical surveys, and visual observations.
2. Suitability of methods used to perform rock coring, geophysical surveys, and visual observations, and of the associated documentation. Suitability is evaluated qualitatively, based on how well the methods obtain the necessary data and how the methods compare to the current standard of practice.
3. Potential for relevant changes in subsurface conditions since borings, surveys, or observations were performed.

TVA plans to use data and evaluations from the following sources to demonstrate the stability of bedrock below fill areas. Refer to Appendix F for detailed evaluation of adequacy of information from each of these data sources:

- **Geotechnical Reports**: TVA provided geotechnical and slope stability evaluation reports for the Bottom Ash Pond, Stilling Pond (including Retention Pond), Dry Ash Stack, and Gypsum Storage Area (Stantec 2010a, 2010b, 2010c, 2013; United Engineers and Constructors 1993) to TDEC. This geotechnical work included performing rock coring in 23 borings. Rock Quality Designation (RQD) values, which provide a quantitative indication of rock competency, were estimated for each rock core run.
- **Hydrogeologic Report**: TVA provided a hydrogeologic evaluation report (Law 1992b) to TDEC. This scope of work included performing rock coring in four borings to a depth of up to 100 feet. This report included a general characterization of the bedrock based on the rock core data, including RQD. The report also includes packer test data for the rock core borings which was used to evaluate the hydraulic characteristics of the bedrock.
- **Visual Inspection Reports:** TVA provided a series of periodic, visual inspection reports to TDEC, dating back to 1972 when the first annual inspection was performed. TVA's current visual inspection program includes informal (quarterly), special (as needed, in response to an event such as significant rainfall), intermediate (annual), and formal (5-year) inspections. Visible signs of structural distress, if present, are documented. Such signs could include depressions, settlements, and sinkholes. The inspections are focused on the perimeter of each unit.
- **Geologic Mapping/Characterization:** Existing information sources for geologic mapping and/or characterization include, Wilson and Stearns (1968), Marcher (1962), TVA (1958, 1974, 1998), HBA (1986), Law (1992a, 1992b), Stantec (2010a, 2010b, 2010c, 2013), and Ford, Orchiston, and Clendening (2012). Some of these documents include detailed geologic mapping of the Wells Creek Structure, a meteor impact zone that includes the footprint of the CUF site. The documents also offer descriptions of each geologic formation present near the soil/rock interface, which contributes to the understanding of shallow rock formations that may be subject to voids/cavities and faults/joints.
- **Ongoing Hydrogeologic Characterization:** In 2016, TVA completed a subsurface investigation in support of an ongoing hydrogeologic characterization study. This investigation included a surface geophysical survey, using Electrical Resistivity Imaging (ERI) methods. Eight ERI transects were performed along the western and southern perimeter of the CCR units. The purpose of the survey was to evaluate subsurface conditions, including bedrock conditions that could potentially influence groundwater flow. The results were intended to aid in planning subsequent intrusive investigations.

Figure 15 shows the locations of existing borings with rock coring and alignment of surface geophysical surveys. After evaluating the adequacy of the data presented above and in Appendix F, the data is considered suitable for use in responding to this information request. However, TVA recognizes there is limited spatial coverage of the bedrock conditions on the CCR unit interiors and other specific locations. Therefore, TVA also proposes targeted borings to supplement the existing data.

Proposed boring locations are shown on Figure 12, and details of the proposed borings are in the Exploratory Drilling SAP (Appendix G). The proposed borings are not, by themselves, intended to assess bedrock stability. Instead, the proposed borings are intended to be used in conjunction with existing geotechnical and hydrogeologic data, surface geophysics, geologic mapping/characterization, and visual inspection reports. The proposed borings, when used as part of this broader data set, are sufficient to respond to the information request. A summary of the proposed borings is as follows:

- A total of thirteen borings are proposed, to address multiple data needs of the EAR. Ten of the thirteen proposed borings include rock coring. Three rock cores are in the Gypsum Storage Area, three in the Dry Fly Ash Stack, and four in the Stilling Pond (including Retention Pond).
- Eight of the ten rock cores are on the interior of the various units, to provide supplemental data in areas of limited spatial coverage. The remaining two borings are on the east perimeter of the Stilling Pond (including Retention Pond), to provide supplemental data.
- Each boring will include approximately 20 feet of rock coring, to characterize the shallow bedrock beneath the CCR units. Borings logs will include a detailed description of the recovered core, including the RQD for each core run. Each core run will also be photographed upon retrieval.

Stability of the Waste Fill and Side-Slope Berms

As described below, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix F (Evaluation of Existing Geotechnical Data) demonstrate that existing data is representative and suitable to support the stability analyses.

The load cases necessary for evaluation in the stability analyses are based on conventional practice and appropriate industry standards for landfills and surface impoundments, as applicable.

- Static, long-term (i.e., normal operation conditions) global stability
- Static, long-term veneer (i.e., final cover) stability (may not apply for certain surface impoundments)
- Seismic, pseudostatic global stability

- Seismic, pseudostatic veneer stability (may not apply for certain surface impoundments)
- Seismic, post-earthquake global stability (includes a preceding liquefaction triggering assessment)

Evaluating the adequacy of existing data depends on the type of data, its quality, and its intended use. For evaluating stability of the waste fill and side-slope berms, existing data to be considered includes:

1. Slope stability analyses of existing conditions;
2. Slope stability analyses of future (i.e., permitted, "build-out", or closed) conditions; and
3. Structural stability assessments performed for CCR Rule compliance.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Representative coverage with stability analysis cross sections;
2. Representative cross section geometry and subsurface characterization;
3. Representative material parameters and phreatic conditions;
4. Representative loads (static loads, seismic loads, etc.);
5. Appropriate stability analysis methods; and
6. Potential for relevant changes in conditions since analyses were performed.

TVA plans to use existing and upcoming slope stability analyses from the following sources to demonstrate the stability of waste fill and side-slope berms. Figure 16 is a plan view showing the locations of slope stability cross sections. Refer to Appendix F for detailed evaluation of adequacy of information from each of these data sources:

- **Static Slope Stability Assessments:** TVA has completed recent slope stability assessments for the Stilling Pond (including Retention Pond), Bottom Ash Pond, Dry Ash Stack, and Gypsum Storage Area. Typically, the scope of work included reviewing existing data, collecting new data (field and laboratory), selecting material parameters, updating surface and subsurface geometry (including phreatic surface), and performing slope stability analyses for various load cases. Several of these analyses were provided to TDEC as part of the Investigation Conference.

  TVA used existing and new boring data to complete slope stability analyses for the following load cases, for the noted CCR units (Stantec 2010a, 2010b, 2010c, 2013, 2016a, 2016b, 2016c; Geocomp 2013, 2016c):

- Long-term, maximum storage pool (Stilling Pond (including Retention Pond) and Bottom Ash Pond);
- Maximum surcharge pool (Stilling Pond (including Retention Pond) and Bottom Ash Pond);
- Rapid-drawdown analysis to evaluate the effects of sudden lowering of reservoir (pond levels) and/or exterior (e.g., tailwater) water levels (Stilling Pond (including Retention Pond));
- Long-term, normal operating condition (Dry Ash Stack and Gypsum Storage Area); and
- Rapid-drawdown analysis to evaluate the effects of sudden lowering of Wells Creek (Dry Ash Stack and Gypsum Storage Area).

- **Seismic Slope Stability Assessments:** TVA has performed recent seismic slope stability and liquefaction triggering assessments for the Stilling Pond (including Retention Pond) and Bottom Ash Pond (Geocomp 2016a, 2016b, 2016c). In support of these assessments, additional soil borings, field testing, seismic CPT soundings and laboratory testing were performed (Geocomp 2016c). The following seismic assessments have been completed:
  - Pseudostatic and post-earthquake slope stability; and
  - Liquefaction triggering.
- **Upcoming Seismic Slope Stability Assessments:** , As part of an ongoing seismic stability evaluation, TVA will be performing seismic slope stability assessments for the Dry Ash Stack and Gypsum Storage Area. In support of these assessments, TVA will perform additional soil borings, field testing, seismic CPT soundings and laboratory testing. The ongoing closure design includes veneer stability (static and seismic) analyses for the final cover. TVA plans to incorporate these assessments into the EAR. The following seismic assessments will be completed:
  - Pseudostatic and post-earthquake slope stability;
  - Liquefaction triggering; and
  - Veneer stability of final cover.
- **Structural Stability Assessments for CCR Rule Compliance:** As part of TVA's ongoing efforts to comply with the CCR Rule, structural stability assessments have been performed for the Bottom Ash Pond and Stilling Pond (including Retention Pond) (Stantec 2016d, 2016e). With respect to stability of the waste fill and side slope berms, this assessment considered the following aspects:
  - Foundation and abutment conditions (cracking, settlement, deformation, erosion, heave due to seepage);

- Slope protection;
- Embankment dike compaction;
- Vegetation of slopes;
- Spillway condition and capacity; and
- Sudden drawdown assessment (slope stability).

After evaluating the adequacy of the existing and upcoming analyses presented above and in Appendix F, the data is considered suitable for use in responding to both topics within this information request.

3.1.14 A.14 TDEC Site Information Request No. 14

Provide a map which identifies the current ground water surface elevation below the landfills and surface impoundment and indicate in that map where the ground water surface below the footprint of the landfills and an estimate of the amount of CCR material that is below the current ground water potentiometric surface.

TVA Response

The requested map will need to be created based on results from the EIP and other ongoing work. The water level measurements in the proposed temporary wells discussed in Section 3.1.10 will be used to evaluate the level of saturation within the CCR units. These water levels will be combined with data collected from other investigative activities to develop maps that illustrate the level of saturation below the CCR units. The maps will be provided in the EAR.

Additionally, as discussed in Section 3.4.5, analysis of correlations between groundwater and surface water elevations, seasonal variations, and effects on the saturation level in the CCR units will be included in the EAR.

Section 3.1.10 also provides a discussion of the Material Quantity SAP, which describes how existing and new data will be analyzed to develop a three-dimensional model of the CCR units and estimate the amount of CCR material below the level of saturation.

3.1.15 A.15 TDEC Site Information Request No. 15

Estimate the shear strength of the CCR materials in each landfill from borings into the Gypsum and CCR Fly Ash and Bottom Ash Landfills and the soils below the landfills.

TVA Response

TVA understands the information request is to comprehend the basis for CCR and soil shear strength parameters that are used in the Dry Ash Stack and Gypsum Storage Area slope stability analyses referenced in Section 3.1.13. Further, the request is to justify the use of historical data to derive these shear strengths.

TVA will use existing data to respond to the information request. The adequacy of existing data to support this response is presented below. Evaluating the adequacy of existing data depends on the type of data, its quality, and its intended use. Regarding CCR and soil shear strengths, existing data to be considered includes:

1. Shear strengths based on in-situ testing;
2. Shear strengths based on laboratory testing; and
3. Shear strengths based on published values for similar materials.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Locations of in-situ tests and/or samples for each material,
2. Suitability of methods used to perform in-situ testing, to collect samples, and to perform laboratory testing. Suitability is evaluated qualitatively, based on how well the methods obtain the necessary data and how the methods compare to the current standard of practice.
3. Potential for relevant changes in subsurface conditions since in-situ testing and/or sampling were performed.

TVA plans to use data and evaluations from the following sources for representative CCR and soil shear strengths. Refer to Appendix F for detailed evaluation of adequacy of information from each of these data sources:

- **Geotechnical Reports**: TVA provided geotechnical reports for the Dry Ash Stack and Gypsum Storage Area (Stantec 2010b; Geocomp 2013) to TDEC. These reports contain the most recent, relevant shear strength parameters and compile parameters from earlier evaluations of these CCR units. The Stantec (2010b) work included drilling 74 soil test/sample borings and advancing 17 CPT soundings at locations shown in Appendix F. The Geocomp (2013) work included drilling 14 soil test/sample borings and advancing 8 CPT soundings at locations shown in Appendix F. Both reports documented in-situ strength testing, laboratory shear strength testing, and selecting of material parameters for use in slope stability analyses.

- **Upcoming Geotechnical Reports:** As part of an ongoing seismic stability evaluation, TVA will be performing seismic slope stability assessments for the Dry Ash Stack and Gypsum Storage Area. In support of these assessments, additional soil borings, field testing, seismic CPT soundings and laboratory testing will be performed. Also, to support ongoing closure design, TVA is performing additional soil borings and installing additional piezometers. TVA plans to incorporate these assessments into the EAR.

In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR. Figure 12 shows the locations of planned (seismic stability evaluation, CCR Rule, and closure design) borings. Appendix F includes a figure showing locations of existing borings. After evaluating the adequacy of the data presented above and in Appendix F, the data is considered suitable for use in responding to this information request.

3.1.16 A.16 TDEC Site Information Request No. 16

Provide TDEC with all current information about the geologic lithology (formations, bedding planes, etc.) and their relevance to natural seeps, springs, and karst features in the area and below waste cells. Some beds of Ordovician and Mississippian limestones are very susceptible to solution channeling, especially when they have been disturbed as they have been in the Cumberland City area. TVA shall provide the process it will use to determine whether solution channeling has occurred at and near the soil/rock interface.

TVA Response

TVA understands the information request focuses on the potential for solution channeling, karst features, faults, fractures, etc. in the shallow rock formations beneath the CCR units.

TVA will use existing data, supplemented with new data from proposed borings and field reconnaissance, to respond to this information request. The adequacy of existing data to support this response is presented below. In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR. TVA also presents a plan for additional field efforts to be performed during the Investigation and documented in the EAR to supplement existing data.

Refer to the response in Section 3.1.17 regarding potential for groundwater flow through rock, including potential for natural seeps, springs, and flow through karst features, faults, and/or fractures.

The adequacy of existing data depends on the type and quality of data and its intended use. To evaluate the potential for solution channeling in the shallow rock formations beneath the CCR units, existing data to be considered are:

1. Geotechnical data from borings that included rock coring;
2. Geophysical surveys that included data at/below the top of bedrock; and
3. Geologic mapping/characterization of the site, including descriptions of the shallow rock formations.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Spatial coverage of borings, geophysical surveys, and geologic mapping;
2. Suitability of methods used to perform rock coring, geophysical surveys, and geologic mapping, and of the associated documentation; and
3. Potential for relevant changes in subsurface conditions since borings, surveys, or mapping was performed.

TVA plans to use data and evaluations from the following sources to demonstrate the potential for solution channeling, karst features, faults/fractures, etc. Refer to Appendix F for detailed evaluation of adequacy of information from each of these data sources:

- **Geotechnical Reports**: TVA provided geotechnical and slope stability evaluation reports for the Bottom Ash Pond, Stilling Pond (including Retention Pond), Dry Ash Stack, and Gypsum Storage Area (Stantec 2010a, 2010b, 2010c, 2013; United Engineers and Constructors 1993) to TDEC. This geotechnical work included performing rock coring in 23 borings. RQD values, which provide a quantitative indication of rock competency, were estimated for each rock core run.
- **Hydrogeologic Report**: TVA provided a hydrogeologic evaluation report (Law 1992b) to TDEC. This scope of work included performing rock coring in four borings to a depth of up to 100 feet. This report included a general characterization of the bedrock based on the rock core data, including RQD. The report also includes packer test data for the rock core borings which was used to evaluate the hydraulic characteristics of the bedrock.
- **Well Installations for Ongoing Hydrogeologic Characterization:** Additional boring data, including borings advanced into bedrock, is available for monitoring wells installed in support of an ongoing hydrogeologic characterization (Stantec 2017). Sonic drilling methods were used instead of rock coring. Although the data from sonic drilling is more limited compared to coring, the corresponding boring logs still offer another source of geologic information that will be reviewed for information related to solution channeling and karst features.

- **Geologic Mapping/Characterization:** Existing information sources for geologic mapping and/or characterization include Wilson and Stearns (1968), Marcher (1962), TVA (1958, 1974, 1998), HBA (1986), Law (1992a, 1992b), Stantec (2010a, 2010b, 2010c, 2013), and Ford, Orchiston, and Clendening (2012). Some of these documents include detailed geologic mapping of the Wells Creek Structure, a meteor impact zone that includes the footprint of the CUF site. The documents also offer descriptions of each geologic formation present near the soil/rock interface, which contributes to the understanding of shallow rock formations that may be subject to solution channeling and karst features.
- **Geophysical Testing for Ongoing Hydrogeologic Characterization:** In 2016, TVA completed a subsurface investigation in support of an ongoing hydrogeologic characterization study. This investigation included a surface geophysical survey, using ERI methods. Eight ERI transects were performed along the western and southern perimeter of the CCR units. The purpose of the survey was to evaluate subsurface conditions, including bedrock conditions that could potentially influence groundwater flow. The results were intended to aid in planning subsequent intrusive investigations.
- **Upcoming Fault Area Assessment:** As part of ongoing efforts to comply with the CCR Rule Location Restriction requirements, TVA plans to conduct a Fault Area assessment for the CUF CCR Units. TVA will assess available geologic data, to include a literature review to identify faults that have potentially experienced displacement during the Holocene period within a minimum radius of 2 miles of the CCR units. The assessment also will include an evaluation of identified local radial faults that are part of the Wells Creek meteor impact structure. A neotectonics analysis of the site will be performed to build on the findings from the literature review. The United States Geological Survey (USGS) archival earthquake map (online), USGS interactive fault map (online), and State geological survey information will be utilized. In addition, publicly available maps, reports, and scientific literature relevant to the terrain of the site will be reviewed. The neotectonics analysis likely will include a lineament analysis, drainage analysis and identification of fault scarps and other tectonic features. Results of the Fault Area assessment will be included in the EAR.

As mentioned previously in Item A.13 (Section 3.1.13), Figure 15 shows the locations of existing borings and alignment of surface geophysical surveys. Superimposed on this map is a geologic map of the Wells Creek Structure (Wilson and Stearns 1968).

After evaluating the adequacy of the data presented above and in Appendix F, the data is considered suitable for use in answering this information request. However, TVA also recognizes that there is limited spatial coverage of the bedrock conditions on the CCR unit interiors and other locations. Therefore, TVA also proposes targeted borings to supplement the existing data. Boring locations are shown on Figure 12, and details of the proposed borings are in Section 3.1.13 and the Exploratory Drilling SAP (Appendix G).

These planned borings are intended as an initial investigation; if data gaps still exist then additional investigations will be considered.

Downhole geophysical techniques, including acoustic televiewer, gamma logging, caliper logging, heat pulse flowmeter, and fluid resistivity will be used to characterize bedrock and groundwater flow within the rock coring portion of proposed borings. Other parameters, including conductivity, dissolved oxygen, pH, and temperature will be collected to evaluate the groundwater conditions beneath the site.

These data will allow TVA to evaluate the influence the fractures and bedding planes encountered in the borings have on groundwater flow. After the geophysical tests are complete, packer tests will be conducted to further characterize the bedrock hydrogeology. The Exploratory Drilling SAP (Appendix G) includes descriptions of procedures necessary to achieve the scope of the exploration.

To provide additional opportunity to characterize the near surface geology, TVA will conduct a field reconnaissance of accessible rock outcrops at a nearby quarry. The quarry is located just south of the Gypsum Storage Area and is mostly flooded by backwater from Wells Creek. The visible outcrops of the quarry rim (above the water line) are in the Knox Dolomite, which is a prevalent near surface formation within the CCR unit footprints (see Figure 4). Outcrops will be observed for possible solution channeling, voids/cavities, faults/fractures, etc.

3.1.17 A.17 TDEC Site Information Request No. 17

Discuss the geologic structure below the TVA Cumberland Plant. The overall condition of the faulting and fracturing shall be addressed through investigative borings to determine whether faulting and fracturing has impacted and/or controls groundwater movement. TVA shall determine if identified fractures and/or faults are filled with quartz or calcite to the point that they do not convey water using data collected from rock cores and other tests conducted during the site investigation.

TVA Response

TVA understands the information request addresses two distinct topics:

1. Geologic structure, including faulting and fracturing, at CUF. Refer to the response in Section 3.1.16 for this subject.
2. Potential for groundwater flow through rock, including flow through fractures and/or faults, as well as potential for natural seeps, springs, and flow through karst features.

TVA plans to use existing data (see the summary of available reports in Section 3.1.16) as well as ongoing studies and planned studies (see Section 3.1.16 for proposed investigations of bedrock) to respond to this information request. TVA has many investigative activities underway at CUF for the CCR Rule, TDEC permitting requirements and capital projects that will provide information which can be used to respond to TDEC's Information Requests related to characterization of the geologic structure below CUF, including evaluation of fracturing, the infilling of fractures, and the effect of fractures on groundwater flow. The schedules to complete these investigations are not driven by the TDEC Order. Some of this work has been conducted, but final reports have not been produced and the results of those investigations are not yet available to include in this EIP. However, TVA will incorporate pertinent data from these investigations that meet the QA/QC requirements of the CUF QAPP into the hydrogeological characterization of CUF. If, after completion of the above referenced investigations and others included in this EIP, data gaps exist, then TVA, in communication with TDEC, will perform additional investigations to fill those data gaps. The results of investigations will be reported in the EAR.

3.1.18 A.18 TDEC Site Information Request No. 18

As part of its Environmental Investigation Plan, TVA shall map top of bedrock using existing boring data and surface geophysics; installing additional borings/ground water monitoring wells as needed. TVA shall include the thickness and types of natural material overlying bedrock as well as the top of bedrock contours. This information shall be used to determine monitoring well locations. TVA and TDEC shall discuss the location and number of borings/ground water monitoring wells to be installed as a part of the EIP.

TVA Response

TVA's Material Quantity SAP, provided as Appendix H, describes the methods TVA will use to answer multiple information requests regarding CCR unit geometry, CCR material quantity, piezometric levels of saturation within the CCR units, top of bedrock contours, and other subsurface materials. The objectives and approach for the Material Quantity SAP are summarized in the response to A.10 (Section 3.1.10). The Material Quantity SAP describes how existing and new data will be used to model the foundation soils overlying bedrock and how top of bedrock elevations documented in borings will be used to correlate with site geologic mapping information. The scope to address this information request is provided in TVA's response to A.10 (Section 3.1.10).

3.2 B. HYDROGEOLOGICAL REPORT

The Hydrogeological Report for this site shall be revised as new core holes are completed and geologic data are generated at the proposed new landfill. TVA shall also provide:

TVA Response

TVA is completing a site-specific hydrogeological characterization of CUF which includes activities that are part of this EIP, other ongoing data collection and evaluation activities related to CCR management, and investigation of an area for a proposed new landfill. Data and information that are available at the time of writing the EAR will be incorporated into the EAR.

3.2.1 B.1 TDEC Hydrogeological Report Request No. 1

A site map showing bedrock contours at ponds, impoundments, and landfill.

TVA Response

TVA prepared a Material Quantity SAP, provided as Appendix H, to describe the methods TVA will use to answer multiple information requests regarding CCR unit geometry, CCR material quantity, piezometric levels of saturation within the CCR units, top of bedrock contours, and other subsurface materials. The objectives and approach for the Material Quantity SAP are summarized in the response to A.10 (Section 3.1.10). The Material Quantity SAP summary describes how existing and new top of bedrock data will be used to correlate top of bedrock elevations encountered in borings with site geologic mapping information; therefore, the scope to address this information request is provided in the response to A.10 (Section 3.1.10).

3.2.2 B.2 TDEC Hydrogeological Report Request No. 2

A three-dimensional map depicting the thickness of clay under impoundment / landfill.

TVA Response

The scope of work and supporting documentation to respond to B.2 and A.10 (Section 3.1.10) are similar. Both request a three-dimensional model of the CCR units; however, A.10 requires the thickness of the CCR materials to the natural ground surface and B.2 requires the thickness of the clay stratum. The response to A.10 summarizes the Material Quantity SAP and describes how existing and new data will be analyzed to develop a three-dimensional model of the CCR units including both CCR materials and clay stratum. Therefore, the scope of work to address this information request is provided in the response to A.10 (Section 3.1.10).

3.2.3 B.3 TDEC Hydrogeological Report Request No. 3

An explanation describing how the springs in the impoundment area identified in the 1992 Hydrogeology Report by Law Engineering were impacted since the time of the report. Compare the potentiometric surface from 1992 report with the current potentiometric surface. TVA shall report how the transition from wet ash operations to dry ash operations has impacted ground water.

TVA Response

Springs

The 1992 Hydrogeology Report by Law Engineering identified five springs shown on Figure 7. None of the five is in the immediate area of the CUF impoundments. The five springs evaluated in the Law Engineering report are approximately 3,000 feet to 6,500 feet from Wells Creek. As part of the 1992 study, they were surveyed for embankment seep elevations and results were compared to the pool level of Wells Creek. As presented by Table 4 in the Law report, those spring elevations are up-gradient of the Wells Creek Pool elevation. The potentiometric map TVA provided in the Investigation Conference (Slide 54) noted the off-site surface water sampling location (Rye spring) adjacent to the site, which is the closest known spring to the site.

TVA will attempt to locate the springs identified in Law (1992b) as shown in Figure 7. However, recently a property owner has decided not to allow TVA access to Rye spring. TVA will identify an alternate sampling location or work with TDEC and the property owner on accessing private property during this investigation. TVA has developed a Water Use SAP, discussed in Section 3.3, which will include methods for evaluating and sampling springs used for sources of water supply.

Potentiometric Surface

TVA has many investigative activities underway at CUF for the CCR Rule, TDEC permitting requirements and capital projects that will provide information that can be used to evaluate groundwater levels for the plant and nearby areas. Some of this work has been conducted, but final reports have not been produced and the results of those investigations are not yet available to include in this EIP. However, TVA will incorporate pertinent data from these investigations that meet the QA/QC requirements of the CUF QAPP into the development of groundwater contour maps. TVA will use these maps to compare how the transition from wet handling operations to dry ash handling has affected groundwater elevations. TVA will summarize this information in the EAR.

3.3 C. WATER USE SURVEY

TVA has identified ground water contamination as a part of its Solid Waste Landfill Ground Water Monitoring Program. TVA shall also provide:

3.3.1 C.1 TDEC Water Use Survey Request No. 1

The Water Use Survey revealed a water well at the Plant Site. Has TVA sampled and analyzed this well? Please provide all analytical results from samples collected from this well.

TVA Response

TVA developed a map to show water supply wells located near CUF and presented the map at the Investigation Conference. The coordinates used to plot well locations were from a TDEC well database that did not have the required detail to accurately locate the wells. The well identified on the water use survey map as being located on the plant site is listed in the database as being owned by Synthetic Materials, a facility located along the eastern portion of CUF. Synthetic Materials staff has informed TVA that two production wells were installed in approximately 1998 and that these wells were sealed with concrete in 2000 and are no longer in use. The status of these wells will be confirmed during the water supply survey discussed in Section 3.3.2.

3.3.2 C.2 TDEC Water Use Survey Request No. 2

TVA shall conduct a water survey for all private water wells within 1/2 mile of the boundary of the TVA Cumberland Plant and report the results of the survey. TDEC and TVA shall discuss the construction, depth and location of private water wells identified in the survey. If TDEC determines that TVA is required to develop an offsite ground water sampling plan, TVA shall submit the plan to TDEC for approval before work begins.

TVA Response

TVA's Water Use Survey SAP (Appendix O) includes details to complete a water survey for the CUF property. TVA will review existing documentation and the state database to identify existing water supply wells within 1/2 mile of the boundary of the CUF property, including water well inventory records on file with TDEC for Stewart County. TVA will also review the local Cumberland City Public Utilities water service map area to identify water service hookup locations in the search area. These locations will be compared with the water wells identified in the 1992 Law Engineering Hydrogeology Report.

As clarified in Section B of the General Guidelines, TVA will develop a field verification plan to demonstrate the procedure for conducting a water use survey for off-site water wells and surface water supplies.

The plan will include a field verification map with the location of identified water wells, homes, and businesses within 1/2 mile of the boundary of the CUF property, and will consist of the following steps:

- Conduct a door-to-door survey to identify registered and unregistered surface water sources and water supply wells and their construction metrics, based on the homes and businesses located on the field verification map;
- Obtain permission (in writing) from the property owner to access their property;
- Physically verify water supply wells and surface water-supply sources;
- Obtain permission (in writing) from the property owner to sample the water well(s) and/or surface water supply, from the wellhead or closest tap, [Note: samples will not be collected without the well owner's approval];
- Take a GPS reading of the verified water well(s) and of surface water supply intakes (e.g., pumps) for map updates; and
- Update and prepare the field verification map and survey report after completion of survey for inclusion in the EAR submittal to TDEC.

In the event that TVA is unable to gain permission to enter a property for field verification of private water wells and surface water supplies, TDEC has offered assistance in field verifying the locations, well construction information, withdrawal rates, and collecting samples. Property access and water well sampling permission forms will be developed by TVA for use during field verifications.

TVA and TDEC will discuss the construction, depth, and location of private water-supply wells identified during the survey as detailed in the Water Use Survey SAP and evaluate the method of sampling. Details of sampling methods and analytical parameters are included in the Water Use Survey SAP.

If results for CCR-related constituents that may be attributable to CUF are detected at levels exceeding MCLs during the first round of sampling, confirmatory sampling will be performed. A final private water well(s) and surface-water supply survey report, and associated map showing the updated and verified location of private water well(s) and surface-water supplies, and associated sampling locations (if sampling is required) will be provided in the EAR.

If sampling reveals CCR constituents present above MCLs that may be attributable to CUF within the ½ mile initial survey boundary, TVA will promptly report the information to TDEC.

3.4 D. GROUNDWATER MONITORING

The EPA CCR rules specify constituents that should be included for analysis for ground water sampling. The constituents for Ground Water Detection Monitoring are listed in Table 3 of the EPA CCR regulations and the constituents for Ground Water Assessment Monitoring are listed in Table 4 of the EPA CCR regulations. Given that the TVA Cumberland Plant is currently in Ground Water Assessment Monitoring under the TN Solid Waste Management regulations, TVA shall provide:

3.4.1 D.1 TDEC Groundwater Monitoring Request No. 1

The existing background water quality that has been determined using spring water samples. TVA shall install a background ground water monitoring well(s), upon approval by TDEC. This well(s) shall be used to determine background concentrations of chemical constituents.

TVA Response

TVA has many investigative activities underway at CUF for the CCR Rule, TDEC permitting requirements and capital projects that will provide information that can be used to respond to TDEC's Information Requests related to the identification of background groundwater monitoring locations for CUF. Some of this work has been conducted, but final reports have not been produced and the results of those investigations are not yet available to include in this EIP. However, TVA will incorporate pertinent data from these investigations that meet the QA/QC requirements of the CUF QAPP into the identification of proposed background monitoring well locations.

As part of TVA's ongoing investigations at CUF, two new potential background monitoring wells (CUF-201 and CUF-202) were installed. In addition, 10 other monitoring wells were installed in potential downgradient locations across the site. Figure 17 shows the locations of the new monitoring wells. TVA is in the process of obtaining and reviewing data to determine if the wells may be suitable for use in groundwater monitoring networks. TVA will continue to collect groundwater samples from these existing monitoring wells and review the analytical results as a part of TDEC Solid Waste Management permit requirements and the CCR Rule. If TVA determines that the existing or new wells installed as part of this investigation are suitable, then TVA will propose them to TDEC for concurrence that they are appropriate background groundwater monitoring locations. TVA will communicate with TDEC on the rationale and supporting data and information for selecting each background location prior to finalizing the monitoring well networks.

TVA has conducted a preliminary evaluation of the analytical results reported for samples collected from monitoring well CUF-213. The evaluation included a detailed review of the boring logs produced during installation of monitoring wells CUF-213 and B110 and boring CUF-214. The boring log for CUF-214 showed bottom ash and fly ash from approximately elevation 355 to 370 feet mean sea level (MSL). The boring log for CUF-213 shows potential CCR material from approximately elevation 360 to 370 feet MSL. The sand pack for the well screen extends to an elevation of approximately 361 feet MSL. The boring log for B110 shows fly ash and bottom ash from approximately elevation 360 to 370 feet MSL. Because of the potential for the presence of CCR in the interval of the well screen and sand pack for CUF-213, analytical results of samples collected from this monitoring well may not be representative of groundwater quality. Because of this, TVA does not believe that the installation of a monitoring well to the south of CUF-213 is warranted at this time.

In addition to the investigations discussed above, TVA plans to install potential background monitoring wells at three locations as part of this investigation. Proposed background well locations CUF-1000 and CUF-1001 were discussed and selected during an onsite CUF meeting with TDEC prior to the EIP Revision 1 submittal. During the meeting, the locations of proposed background wells CUF-1000 and CUF-1001 were identified by TDEC with consideration of geologic formations and representativeness of background conditions. The third background monitoring well (CUF-1004) is proposed south of the CCR units.

One location is between the CCR units and the main plant northeast of the CCR units. This location is inferred to be in an area that will provide background groundwater samples in relation to the CCR units based on preliminary groundwater elevation contours and was located to be above the Stones River Group. Groundwater in this area may flow to the southwest beneath the CCR units to Wells Creek. The second location is west of the CCR units in alluvial deposits. This area is in the flood plain of Wells Creek and is intended to be located in a depositional setting similar to the native soils beneath the CCR units. The third location is south/southwest of the CCR units and Wells Creek. This location is proposed to characterize groundwater quality above the Knox Dolomite, if saturated unconsolidated materials exist. The existing monitoring well network for the CCR units is in unconsolidated materials; therefore, TVA does not propose to install background monitoring wells within bedrock at this time. Monitoring well CUF-204 is not proposed to be included in the monitoring well network for the CCR units because it is screened in bedrock.

The proposed location for potential background monitoring well CUF-1004 was constrained by nearby property boundaries and wetlands, the requirement to be at an elevation above 375 feet MSL to be out of the USACE Flowage Easement and be above the Knox Dolomite in an area with the potential for saturated conditions within the unconsolidated materials. Boring logs from areas to the south of the proposed monitoring well location and the wetland area show less than 15 feet of unconsolidated material and it is unsaturated.

Therefore, because of the presence of wetlands to the southwest of the CCR units and unsaturated conditions above bedrock to the south of the proposed location and the wetlands, those areas are not appropriate locations to install monitoring wells.

In addition, TVA proposes to install one monitoring well along the eastern boundary of the Gypsum Storage Area in the unconsolidated materials to characterize groundwater flow direction near the eastern boundary of the CCR units. The screened interval and sand pack will be placed below CCR materials, if observed during drilling. Two additional monitoring wells are proposed between the CCR units and the main plant as an initial step to characterize groundwater flow direction and quality in the unconsolidated materials between the CCR units and the Cumberland River. After groundwater levels are collected from these monitoring wells and groundwater flow between the CCR units and the plant is better understood, TVA will develop a plan, in collaboration with TDEC, to install monitoring wells in other locations, if necessary.

The exact location of the proposed monitoring wells will be dependent on being able to safely access each area. The Hydrogeological Investigation SAP (Appendix J) provides details of the installation of these wells.

The proposed monitoring wells will be used to collect groundwater samples from the alluvial deposits. Groundwater samples collected from monitoring wells will be analyzed for the CCR parameters listed in Section 3.1.1. In addition, groundwater samples will be analyzed for major cations/anions and total alkalinity. Sampling procedures and parameters are provided in the Groundwater Investigation SAP provided in Appendix P. TVA will provide a summary of background sampling results from the wells in the EAR.

The selection of background monitoring wells will be finalized after monitoring bimonthly for one year (six sampling events) to determine if the wells are appropriate background wells and receiving input from TDEC on the proposed locations.

TVA proposes to implement the proposed plan, evaluate the data collected, and then assess the suitability of the proposed background well locations for the initial investigative phase. If, based on the initial phase of work, data gaps are identified, then TVA may propose additional monitoring wells. Additionally, ongoing hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. The results of those investigation activities will be incorporated into the environmental investigation.

3.4.2 D.2 TDEC Groundwater Monitoring Request No. 2

Information about Monitoring wells 93-2 & 93-2R which have both exceeded the MCL for Arsenic. Well 93-2R replaced 93-2 in 2005 because well 93-2 was apparently screened partially in coal ash. Why was well 93-2 installed and screened in coal ash?

TVA Response

The original well 93-2 was constructed in an area that was built using the upstream construction over ash method. It was later found that part of the well was inadvertently screened within ash. It is possible that the installation approach to well 93-2 was to install it in first water encountered, and this could have led to the inadvertent installation of a portion of the screen in ash.

TVA will provide the well installation report for wells 93-2 and 93-2R in the EAR along with correspondence that is on file regarding the use and sampling of 93-2 and 93-2R. Monitoring well 93-2R is currently included in the CUF State landfill permit monitoring program and will continue to be monitored as part of the Ground Water Monitoring Program.

3.4.3 D.3 TDEC Groundwater Monitoring Request No. 3

Provide TDEC with a date and the procedure TVA shall follow to properly close abandoned Ground Water Monitoring Well 93-2 to prevent any potential migration of CCR constituents into the aquifer below.

TVA Response

TDEC approved the installation of CUF 93-2R by correspondence dated August 9, 2005. The new well installation was completed September 23, 2005. TDEC approved closure of CUF 93-2 in April 2011 and again by e-mail on May 17, 2016. A copy of TDEC's approval is included in Appendix B.

Subsequently, TVA closed Groundwater Monitoring Well 93-2 between May 31, 2016 and June 1, 2016. The well decommissioning procedure, including closure materials, were provided to TDEC prior to closure of 93-2. Generally, CUF 93-2 was decommissioned following TVA Technical Instruction Standard Procedure SCSI-TI-MW-02 for Monitoring Well Decommissioning. The technical instruction is referenced in the CUF QAPP.

Based on the amount and context of data available to support a response, additional field work is not anticipated at this time to answer this information request.

3.4.4 D.4 TDEC Groundwater Monitoring Request No. 4

Provide TDEC with an updated ground water potentiometric surface map. The current map does not use all monitoring points available (i.e. 10-1, 10-2, springs, etc.) to establish an accurate description for groundwater flow and direction. TVA shall use these points and re-evaluate ground water flow rate and direction. TVA shall use data from all Ground Water Monitoring wells to determine the ground water potentiometric surface at TVA Cumberland and if the data demonstrates there is a perched aquifer above the bedrock and a second aquifer within the rock structure, the potentiometric surface of both aquifers should be determined and illustrated.

TVA Response

TVA has many investigative activities underway at CUF for the CCR Rule, TDEC permitting requirements and capital projects that will provide information that can be used to evaluate groundwater levels for the aquifer or aquifers below the plant and nearby areas. Some of this work has been conducted, but final reports have not been produced and the results of those investigations are not yet available to include in this EIP. However, TVA will incorporate pertinent data from these investigations that meet the QA/QC requirements of the CUF QAPP into the development of groundwater contour maps. TVA will use these maps and information regarding hydraulic conductivities of saturated materials to evaluate groundwater flow direction and rate. TVA will summarize this information in the EAR.

As discussed in Sections 3.4.1 and 3.4.6, additional monitoring wells are proposed to be installed as part of this investigation. The results of the investigative activities noted in the first paragraph of this response and the results of this investigation will be used to update existing groundwater elevation contour maps and characterize the hydrogeology of CUF. Corresponding Cumberland River and Wells Creek water levels will be included on the groundwater elevation contour maps. As discussed in Section 3.4.5, analysis of correlations between groundwater and surface water elevations and seasonal variations will be included in the EAR. The hydrogeological characterization will also be presented in the EAR.

3.4.5 D.5 TDEC Groundwater Monitoring Request No. 5

A discussion of the fluctuations in groundwater elevation change. TVA shall explain whether the changes are connected to Cumberland River levels, Wells Creek levels, seasonal variations, or other factors. Discuss if these ground water elevation variations impact ground water below the surface impoundment and the landfill.

TVA Response

This information request is similar to other requests regarding the level of saturation in CCR units and groundwater levels below CUF (see Sections 3.1.14 and 3.4.4). TVA will review and evaluate existing and new data on groundwater and surface water elevation fluctuations. Data collected from this investigation and other investigative activities will be used for this review. The investigation will include measurement of water levels at one surface water gauging station currently installed in the Cumberland River and one gauging station that will be established by TVA in Wells Creek. The measuring schedule and methods for measuring water levels are included in the Groundwater Investigation SAP (Appendix P). Analysis of correlations between groundwater and surface water elevations, seasonal variations, and effects on the saturation level in the CCR units will be included in the EAR.

3.4.6 D.6 TDEC Groundwater Monitoring Request No. 6

A discussion of TVA's plans to install additional piezometers between the plant site and the Impoundments that were discussed during the March 16, 2016 TVA Cumberland site meeting. The location and construction of the piezometers shall be part of the amended Ground Water Assessment Plan.

TVA Response

TVA has many investigative activities underway at CUF for the CCR Rule, TDEC permitting requirements and capital projects that will provide information that can be used to respond to TDEC's Information Requests related to the installation of new monitoring or observation wells for groundwater assessment for CUF. Some of this work has been conducted, but final reports have not been produced and the results of those investigations are not yet available to include in this EIP. However, TVA will incorporate suitable monitoring well locations from these investigations that meet the QA/QC requirements of the CUF QAPP into the final groundwater monitoring network. If, after completion of the above referenced investigations and others included in this EIP, data gaps exist, then TVA, in communication with TDEC, will perform additional investigations to fill those data gaps. The results of investigations will be reported in the EAR.

As part of TVA's ongoing investigations at CUF two new observation wells (CUF-101 and CUF-102) were installed in November 2015 between the Cumberland River and the Gypsum Storage Area in order to better define groundwater gradients at the site. In addition, in June 2016 an observation well (CUF-120) was installed in the same area. The observation well locations are shown on Figure 1. These observation wells were not intended to be part of the TDEC permitted groundwater monitoring network, but can be used for measuring groundwater levels. They were not constructed for the purposes of obtaining groundwater samples for chemical analysis.

Observation wells CUF-101 and CUF-120 were proposed for inclusion in the revised Groundwater Quality Assessment Plan for CUF, which was submitted to TDEC on December 11, 2017. The Groundwater Quality Assessment Plan is included as Appendix Q. Observation well CUF-102 is not being included because it is screened in bedrock.

In addition, TVA plans to install two additional monitoring wells (CUF-1002 and CUF-1003), shown on Figure 17, between the CCR units and the main plant as an initial step to characterize groundwater flow direction and quality in the unconsolidated materials between the CCR units and the Cumberland River. After groundwater levels are collected from these monitoring wells and groundwater flow between the CCR units and the plant is better understood, TVA will develop a plan, in collaboration with TDEC, to install monitoring wells in other locations, if necessary. Other investigative activities include plans to install piezometers in these general areas. If instrumentation from those investigations is sufficient to close data gaps regarding groundwater elevations in these areas, then no additional observation wells will be installed as part of this investigation. If the instrumentation is insufficient in either area, then TVA will install additional observation wells in accordance with the procedures provided in the Hydrogeological Investigation SAP and provide investigation results in the EAR.

3.5 D. GROUNDWATER – CHEMICAL AND PHYSICAL PROPERTIES

The TVA Cumberland site has historically had levels of CCR constituents above a ground water protection standard identified in the site Ground Water Monitoring Program. Please address the following concerns:

3.5.1 D.1 TDEC Groundwater – Chemical and Physical Properties Request No. 1

Are there any ongoing environmental impacts at the TVA Cumberland Plant caused by the 1997 Bypass or any other releases? Please provide the information that supports TVA's position.

TVA Response

TVA will review its files and compile information regarding the referenced "1997 Bypass" (including the information provided to TDEC as part of the Investigation Conference), and other releases within the historical records. The evaluation of potential ongoing impacts will include a proposed well survey, hydrogeological characterization reports, and the implementation of new surface stream, sediment, benthic invertebrate, and fish tissue studies. Surface stream and sediment SAPs have been developed to collect surface stream and sediment samples that will be analyzed for the CCR Parameters, to determine if CCR is being or has historically been released into Wells Creek, its tributaries, or the Cumberland River. Benthic invertebrate and fish tissue SAPs have been developed to assess the impact of selected CCR Parameters on those populations. A summary of proposed sediment and benthic invertebrate sampling is provided in Section 4.5.2. A discussion of proposed surface stream sampling is provided in Section 4.5.5, and the fish tissue sampling is addressed in Section 4.5.8. TVA will report its findings and supporting documentation in the EAR.

3.5.2 D.2 TDEC Groundwater – Chemical and Physical Properties Request No. 2

The groundwater protection standard or MCL for Arsenic was exceeded multiple times prior to 2013 at the TVA Cumberland site. Arsenic levels have decreased in last 4 sampling events; please provide an explanation for the decrease of As and other parameters in ground water.

TVA Response

Several groundwater constituents have demonstrated stable or decreasing trends in the historical data set. Thirteen consecutive sampling events from July 2013 through July 2016 did not show MCL exceedances for the analyzed parameters. Intermittent exceedances of MCLs for some constituents over time may be due to analytical interferences or bias produced by suspended solids containing naturally-occurring metals in unfiltered groundwater samples. The concentrations may also be influenced by changes in hydraulic loading as a result of modified ash and gypsum management operations since the 2010 timeframe. Concurrent with the initiation of assessment monitoring, operational changes were implemented regarding the Gypsum Disposal Area ash handling to mitigate stability risks on the stack. The gypsum sluice water was temporarily diverted in 2009 from the normal handling area on top of the Gypsum Disposal Area until a new handling operation was configured that would prevent an increase of phreatic levels in the Gypsum Disposal Area. To achieve this, in spring 2013, new lined gypsum slurry settling channels and a gypsum dewatering pad went into operation on the northwest side of the Gypsum Disposal Area. The channels included a flexible membrane liner to minimize infiltration of water into the stack. As a result of diverting the routine sluicing operations from the top of the stack, infiltration of transport water into the gypsum byproduct was eliminated. These operational changes may explain the observed decreasing concentrations of arsenic and other parameters and will be included in the evaluation.

TVA will research and review historical and recent groundwater analytical data for arsenic and other parameters. In addition, data developed during implementation of the EIP and other ongoing or planned investigative activities will be incorporated into the evaluation. The review of the data will include a statistical analysis of analytical results and an evaluation of observed variations of background groundwater concentrations, sampling procedures, analytical methods, plant processes and construction activities at the site that may explain the decreases in arsenic and other chemical constituents in the groundwater. TVA will report its findings and supporting documentation in the EAR.

Historical groundwater data that meets the requirements of the CUF QAPP will be incorporated with the groundwater evaluation in the EAR and presented in table format. The table format will include one set of tables with samples collected from each individual well over time. The second set of tables will include a comparison of groundwater sample results from samples collected during the same sampling event. Historical groundwater data that does not meet the requirements of the CUF QAPP will remain in the table provided in Appendix J of the EIP for reference purposes.

3.5.3 D.3 TDEC Groundwater – Chemical and Physical Properties Request No. 3

TDEC will require more information about the potentiometric surface of groundwater under and near the landfill. The potentiometric surface included in groundwater monitoring reports indicates which direction to expect most groundwater below the fill areas to flow, but does not take into account subtle radial flow from each pond. TVA shall provide additional information to determine where additional CCR monitoring wells shall be placed around each area, including information about the ground water flow from the CCR landfills towards the Cumberland River.

TVA Response

This request is similar to Information Requests A.14, D.4 and D.6 above (Sections 3.1.14, 3.4.4 and 3.4.6). The scope of work and supporting documentation to respond to this information request, A.14, D.4 and D.6 are similar are similar as they request information regarding the saturated level within the CCR units and updated groundwater contour maps. Therefore, the scope to address this information request is provided in the responses to A.14, D.4 and D.6, including the ability to account for radial flow and information about the groundwater flow towards the Cumberland River. Additional information related to groundwater flow in the northeastern part of CUF is provided below.

From January 2017 through August 2017, groundwater levels measured in observation wells CUF-101, CUF-102 and CUF-120 ranged as follows:

- 382.37 to 384.82 feet MSL;
- 390.71 to 393.02 feet MSL; and
- 385.68 to 386.30 feet MSL, respectively.

Site data indicates that groundwater flows from the area of well CUF-120 toward the CCR units. Based on this information, there is no indication that groundwater flows from the CCR units to the area north of wells CUF-101 and 96-9.

Because the existing dataset indicates flow from areas of the plant toward the CCR units, TVA has proposed monitoring wells CUF-1002 and CUF-1003 to provide additional resolution for evaluating groundwater flow directions and placement of additional monitoring wells, if necessary.

After groundwater levels are collected from monitoring wells CUF-1002 and CUF-1003 and groundwater flow between the CCR units and the plant is better understood, TVA will develop a plan, in collaboration with TDEC, to install monitoring wells in other locations, if necessary.

The proposed piezometers and monitoring wells between the CCR units and plant are designed to characterize groundwater flow in the northeastern part of CUF. In addition, hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology in the southern, eastern, southwestern, and southeastern parts of CUF. TVA proposes to implement the initial plan, evaluate the data collected, and then consider the need for additional wells northeast, south, southwest, and southeast of the CCR units. Additional investigations will be proposed if warranted by the results of the initial investigation.

3.6 E. STRUCTURAL AND SEISMIC STABILITY

3.6.1 E.1 TDEC Structural and Seismic Stability Request No. 1

TVA shall provide cross section(s) for both the ash and gypsum stack that indicate materials and the properties of the materials from maximum proposed top of ash down to the top of bedrock.

TVA Response

TVA understands the information request is to compile the subsurface geometry and material parameters that are used in the Dry Ash Stack and Gypsum Storage Area slope stability analyses. This includes slope stability analyses for maximum proposed geometry. Further, the request is to understand how the subsurface geometry will be used to support the material quantity analyses.

TVA will use existing data to respond to the information request. The adequacy of existing data to support this response is presented in Sections 3.1.13 (slope stability cross section geometry), 3.1.15 (slope stability material parameters), and 3.1.10 (material quantity analysis).

TVA also presents a plan for additional field efforts, to be performed during the Investigation and documented in the EAR, to supplement existing data to aid in modeling the subsurface conditions to the top of bedrock within the Dry Fly Ash Stack and Gypsum Storage Area. Refer to Section 3.1.10, Section 3.1.13, and Appendix G and H for details of the proposed field efforts.

3.6.2 E.2 TDEC Structural and Seismic Stability Request No. 2

TVA shall provide the stability calculations for final permitted design elevation for both the Gypsum and the CCR Fly Ash & Bottom Ash Landfills. If the stability calculations have not been completed, then TVA shall provide stability calculations for each landfill based upon either the permitted final elevation for each or for the planned final elevation for each; should TVA decide it does not need to use the entire permitted capacity of each TVA Cumberland landfill.

TVA Response

TVA understands the information request is to provide documentation of the static and seismic slope stability (as it relates to potential release of CCR) of the Dry Ash Stack and the Gypsum Storage Area, for the final permitted geometries.

TVA will use existing data to respond to the information request. The adequacy of existing data to support this response is presented in Sections 3.1.13 (slope stability cross section geometry), 3.1.15 (slope stability material parameters), and Appendix F (detailed discussion of existing data and analyses).

The static slope stability of the final permitted geometry for both permitted landfills has been analyzed. The Operations Manual (TVA 2003) includes static analyses performed in 1992 to support permitting of the Dry Ash Stack and Gypsum Storage Area. Stantec (2010b) included updated static analyses for the permitted final configurations of both landfills. Both documents have been provided to TDEC as part of the Investigation Conference data transmittal.

For certain seismic load cases in which the final permitted geometry was not explicitly analyzed, discussions in Appendix F clarify why the upcoming analysis (as part of an ongoing seismic stability evaluation) of existing geometry is still representative for the final permitted geometry. The ongoing closure design will include veneer stability analyses (static and seismic) of the final cover. In general, the existing perimeter geometry and subsurface conditions are representative of the final condition. Further, the changes anticipated between the existing and final conditions would not change the critical stability failure modes.

The proposed exploratory drilling to install the temporary wells does include borings from the top of each unit to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to various index tests per the Exploratory Drilling SAP. As discussed previously, new shear strength testing and new stability analyses are not necessary, as current, and ongoing analysis for other projects were performed to industry standards. Consistent with conventional practice, additional shearing resistance due to unsaturated soil conditions is neglected in the derivation of strengths and in the analysis performed by TVA.

After evaluating the adequacy of the existing and upcoming analyses presented above and in Appendix F, the data is considered suitable for use in responding to this information request.

3.6.3 E.3 TDEC Structural and Seismic Stability Request No. 3

TVA shall clarify the construction and properties of the drainage layer below the dry CCR ash stack; including whether the drainage layer discharges to the perimeter ditch like the gypsum stack, whether the "free-draining" bottom ash layer, referenced in the "Operations Manual Dry Ash and Gypsum Stacking Facility" date September 2003 and prepared by TVA, directs water from under the ash stack and where the "drain" discharges.

TVA Response

TVA understands the information request is to clarify the nature of the drainage layer below the Dry Ash Stack, including a comparison to a potentially similar layer below the Gypsum Storage Area.

These units were permitted as a solid waste facility under TDEC Solid Waste Permit No. IDL 81-0086. An underdrain system was installed when the units were converted from surface impoundments to stacks. However, as described in Section 3.1.6, underdrain pipes have not been identified for the Dry Ash Stack. TVA (2003) and TVA drawing series 10W302 describe the underdrain system. A more detailed discussion regarding the underdrain system in the Dry Ash Stack and Gypsum Storage Area can be found in the Evaluation of Existing Geotechnical Data (Appendix F).

With regard to slope stability, the key issue is whether representative (or conservative) pore water pressures within the unit are used in the stability analyses. The existing piezometers and proposed temporary wells and piezometers to be installed as part of the Investigation and/or other ongoing projects will aid in understanding this issue. The functionality of the bottom ash blanket drain will be evaluated by reviewing piezometer data from within the Dry Ash Stack. This evaluation will be documented in the EAR.

Discussion will be added to the EAR regarding how the findings of the geotechnical borings compare to the interface geometry shown on the referenced drawings. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects as outlined in the EIP.

In the EAR, TVA will summarize the referenced existing and upcoming information and clarify the properties and function of the Dry Ash Stack drainage layer.

3.6.4 E.4 TDEC Structural and Seismic Stability Request No. 4

TVA shall review Section VI.D.S (page 21373) of the section of the Federal CCR Preamble referenced in our March 17th, 2016 meeting that points out areas of concern regarding an overfill. TVA shall explain how concerns about an overfill will be addressed.

TVA Response

The Dry Ash Stack and Gypsum Storage Area do not meet the definition of an overfill per the CCR Rule, *i.e.*, "a new CCR landfill constructed over a closed CCR surface impoundment," 40 CFR Part 257.53. A "new CCR landfill" is defined as "a CCR landfill or lateral expansion of a CCR landfill that first receives CCR or commences construction after October 14, 2015," 40 CFR Part 257.53. The Dry Ash Stack and Gypsum Storage Area are "existing CCR landfills" which "means a CCR landfill that receives CCR both before and after October 14, 2015," 40 CFR Part 257.53. Therefore, this information request does not apply to CUF.

Regarding the Dry Ash Stack and Gypsum Storage Area, it should be noted that the EPA excluded from regulation inactive CCR landfills, § 257.50(d), as well as CCR surface impoundments that no longer impound water and that are "capped or otherwise maintained," 80 Fed. Reg. at 21343. EPA explained in its preamble that these exclusions are due to the lower risk associated with such units. Section VI.A.5 (page 21342) of the preamble states:

> "As noted, EPA's risk assessment shows that the highest risks are associated with CCR surface impoundments due to the hydraulic head imposed by impounded water. Dewatered CCR surface impoundments will no longer be subjected to hydraulic head so the risk of releases, including the risk that the unit will leach into the groundwater, would be no greater than those from CCR landfills."

Throughout their service life, TVA has constructed and operated the Dry Ash Stack and Gypsum Storage Area in compliance with the state and/or federal regulatory frameworks in effect at the time. In 1996, TDEC issued Class II landfill permit IDL 81-102-0086 to allow portions of the existing surface impoundments to be transitioned to the Dry Ash Stack and Gypsum Storage Area. Since 1996, TDEC has approved various permit modifications for these CCR units. The CCR Rule became effective in 2015, and does not apply retroactively to the surface impoundments that were transitioned to landfills in compliance with the 1996 TDEC permit.

Because the Dry Ash Stack and Gypsum Storage Area are existing landfills as defined by the EPA CCR Rule, TVA is actively performing demonstrations to document compliance with the CCR Rule. In particular, existing landfills are subject to the "Unstable Areas" location restriction per §257.64. Due to TVA's construction of its CUF landfills on top of a closed CCR surface impoundment, §257.64 shall therefore require TVA to demonstrate that "good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."

TVA has recently developed a scope of work to perform unstable area assessments for the Dry Ash Stack and Gypsum Storage Area. These assessments will focus on determining whether the stability of the CCR unit is affected by the following factors: on-site or local soil conditions that may result in significant differential settling, on-site or local geologic or geomorphologic features, and on-site or local human made features or events. If such factors are present, the assessment will address whether the design of the disposal areas will prevent damage resulting from potential instability.

In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.

3.6.5 E.5 TDEC Structural and Seismic Stability Request No. 5

TVA shall provide the stability calculations for final permitted design elevation for both the Gypsum and the CCR Fly Ash & Bottom Ash Landfills. If the stability calculations have not been completed, then TVA shall provide stability calculations for each landfill based upon either the permitted final elevation for each or for the planned final elevation for each; should TVA decide it does not need to use the entire permitted capacity of each TVA Cumberland landfill.

TVA Response

See the response to E.2 (Section 3.6.2).

3.6.6 E.6 TDEC Structural and Seismic Stability Request No. 6

TVA shall provide any information or assessments regarding seismic stability for the TVA Cumberland surface impoundment and landfill cells. TVA shall include the size of the seismic event that would cause structural failure. If TVA has not completed seismic stability analysis for the TVA Cumberland site, then TVA shall propose for TDEC approval a plan to determine seismic stability and any improvements need to ensure seismic stability for the site, as it exists today and for closure in place. Soils below the surface impoundments and landfill cells shall be evaluated for liquefaction potential. If these soils are found to be susceptible to liquefaction, stability calculations shall be performed which account for liquefaction.

TVA Response

The industry standard practice for seismic analysis during design is to select an earthquake return period that is appropriate for a particular scenario. The design condition is then evaluated for adequate performance under the design earthquake(s). For example, this approach was used for the CCR Rule seismic safety factor assessments of the Bottom Ash Pond and Stilling Pond (including Retention Pond) (Geocomp 2016a; 2016b).

See the response to Item A.13 (Section 3.1.13) and Appendix F for a summary of the existing and upcoming seismic slope stability and liquefaction analyses that will be used to support the response in the EAR.

As described previously, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix F demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of an ongoing seismic stability evaluation) of existing geometry is still representative for the final permitted geometry. The ongoing closure design includes veneer stability (static and seismic) analyses for the final cover.

The proposed exploratory drilling to install temporary wells or geotechnical borings (Appendix G) does provide supplemental borings from the top of each unit to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to index tests. New shear strength testing and new stability analyses are not necessary but could be added if unexpected soil or CCR materials are encountered.

Note that certain prior seismic analyses (TVA 2003; Stantec 2011, 2012) are being considered, and are being supplemented by more recent existing and upcoming data and analyses summarized in Item A.13. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance. This conclusion is generally due to an updated characterization of the seismic hazards (return period, magnitude, accelerations, etc.) and/or the subsurface conditions (shear strengths, liquefaction triggering, etc.). The more recent existing analyses and the upcoming analyses are based on an updated understanding of the seismic hazards, as well as additional subsurface information specifically targeted to support seismic analyses.

3.6.7 E.7 TDEC Structural and Seismic Stability Request No. 7

TVA shall describe any plans to promote positive drainage in the drainage ditches around the disposal complex. Resolving the drainage problems is necessary given that standing water is still present in portions of the ditch.

TVA Response

Proposed drainage improvements to the Gypsum Storage Area and Dry Fly Ash Stack Landfill are documented in TVA's June 20, 2017 Permit #: IDL 81-102-0086 Modification Submittal to TDEC.

3.6.8 E.8 TDEC Structural and Seismic Stability Request No. 8

The April 4, 2011 WP-11- Grading and Drainage Improvements Plan suggests additional work is considered for the site. TVA shall detail its plan for site improvements.

TVA Response

Proposed drainage improvements to the Gypsum Storage Area and Dry Fly Ash Stack Landfill are documented in TVA's June 20, 2017 Permit #: IDL 81-102-0086 Modification Submittal to TDEC.

3.6.9 E.9 TDEC Structural and Seismic Stability Request No. 9

The September 22, 2011 report prepared by Stantec provides the following statement:

"Although the minimum Factors of Safety for the stacks under the conditions analyzed are less than the target of 1.0, it is judged that the risk of slope stability failure under seismic loading conditions is acceptable, considering that:

a) The resulting minimum FS failure surfaces are upstream of the perimeter dike systems;

b) Deeper seated failure surfaces that would result in a failure of the perimeter dikes meet the target of 1.0;

c) TVA plans to close the facilities in 2021 and will further consider seismic risks during closure design as previously described"

Will the existing gypsum landfill, fly ash and bottom ash landfills and the surface impoundments be permanently closed by 2021?

TVA Response

As part of the Investigation, TVA will review current and projected stacking plans and will provide TDEC with anticipated stacking and closure dates in the EAR.

The Stantec (2011) seismic analysis, which is the subject of this information request, is being considered, and is being supplemented by more recent data and analyses as discussed in the response to E.6 (Section 3.6.6). See the response to A.13 (Section 3.1.13) for additional discussion regarding existing and upcoming seismic stability analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.

The existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix F demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of an ongoing seismic stability evaluation) of existing geometry is still representative for the final permitted geometry. The ongoing closure design includes veneer stability (static and seismic) analyses for the final cover.

In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.

3.6.10 E.10 TDEC Structural and Seismic Stability Request No. 10

After review of the cohesion calculations and associated terminology used (stacked, sluiced, drained and undrained), stability calculations appear to be inconsistent in the documentation TVA provided TDEC. TVA shall explain/clarify the data presented and any changes needed given changes in site conditions or planned final elevations of both cells.

TVA Response

See the responses to A.13 (Section 3.1.13) and A.15 (Section 3.1.15) for additional discussion regarding existing and upcoming seismic stability analyses and related shear strength parameters. Also, refer to Appendix F for detailed evaluation of adequacy of information from each of the existing data sources. This includes the adequacy of analyses and parameters, considering changes in site conditions over time.

Characterization of material parameters, including shear strengths (friction angle, cohesion, or other means of defining strength) may differ from one evaluation to the next and can be due to multiple factors, such as:

1. Different loading cases (long-term static, short-term static, seismic, etc.) that necessitate different strengths;
2. Spatial variation in subsurface conditions and analyses that consider different locations;
3. New information (field data, laboratory data, etc.) that allows updates to the material characterization;
4. Changes in subsurface conditions due to the passage of time and/or geometric/operational changes at the site; and
5. Evolution of the standard of practice and differences in professional engineering judgement with respect to material characterization and/or stability analyses.

Such differences are common within geotechnical engineering practice, particularly over a long period of time, with multiple studies performed by various professionals, and as additional data becomes available through various field and laboratory testing efforts. The relevancy of the above factors, with respect to the existing and upcoming analyses will be included as part of the response in the EAR.

3.6.11 E.11 TDEC Structural and Seismic Stability Request No. 11

Verify the material properties utilized in the stability calculations. Indicate when the material properties are assumed or based on field investigation and laboratory data. Please provide bases for assumption or provide results of laboratory data.

TVA Response

See the responses to A.13 (Section 3.1.13) and A.15 (Section 3.1.15) for additional discussion regarding existing and upcoming seismic stability analyses and related shear strength parameters. Also, refer to Appendix F for detailed evaluation of adequacy of information from each of the existing data sources. This includes the adequacy of analyses and parameters, considering changes in site conditions over time. This discussion will be included as part of the response in the EAR.

3.6.12 E.12 TDEC Structural and Seismic Stability Request No. 12

Justify the horizontal seismic coefficient of 0.083g.

TVA Response

TVA provided TDEC a letter that documents the 2011 seismic analyses of the CUF CCR units (Stantec 2011) with the Investigation Conference Data Transmittal. The analyses were performed to support EPA assessment of the CUF CCR units. As noted in the letter, a ground motion level corresponding to a return period of 500 years was used to select horizontal seismic coefficients. For purposes of the referenced simplified analysis, the pseudostatic seismic coefficient was set equal to the peak ground acceleration of 0.083 g for a 500-year return period. This acceleration value was selected from Table 16 of the region-specific seismic hazard study performed by AMEC Geomatrix, Inc. (2011). This peak ground acceleration is representative for rock at the ground surface, where the rock has a shear wave velocity of approximately 9,000 feet per second.

The Stantec (2011) seismic analysis, which is the subject of this information request, is being considered, and is being supplemented by more recent data and analyses as discussed in the response to E.6 (Section 3.6.6). See the response to A.13 (Section 3.1.13) for additional discussion regarding existing and upcoming seismic stability analyses. The newer information (used in conjunction with historic information) can account for current site conditions.

Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.

The existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix F demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of an ongoing seismic stability evaluation) of existing geometry is still representative for the final permitted geometry. The ongoing closure design includes veneer stability (static and seismic) analyses for the final cover.

In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.

4.0 TDEC GENERAL GUIDELINES FOR EIP

As per its letter dated June 14, 2016, TDEC divided the General Guidelines for Environmental Investigation Plans, TVA Fossil Plants, into the following five categories:

A. Site Information
B. Water Use Survey
C. Groundwater Monitoring and Mapping
D. TVA Site Conditions
E. Surface Water Impacts

Each category and its related tasks are addressed in the following subsections, and follow the numbering sequence format of the General Guidelines. The information requests are further distinguished from the responses by being printed in italics.

Several of the requests in the General Guidelines were similar to those in the CUF Investigation Conference Response Letter. In those instances, the response is referenced to the similar request in Section 3. Where the General Guidelines are different requests, or request additional information/data than the similar CUF Investigation Conference Response, TVA's plan to address the additional requested information is presented below in Section 4.

4.1 A. SITE INFORMATION

TVA shall provide information about CCR storage and disposal sites at the TVA Fossil Plant. TDEC expects TVA to include how it will provide the following information about each TVA Fossil Plant site as a part of its EIP:

4.1.1 A.1 TDEC Site Information Request No. 1

All information about the natural chemistry of the soils in the area of the TVA Fossil Plant. This includes the naturally occurring levels of metals and other CCR constituents present in the soil. TVA shall propose, in the EIP, the collection of soil samples within a one-mile radius of the specific fossil plant to supplement the information gained from local soil studies, reports or soil profiles. Of particular interest are all constituents listed in the federal CCR regulations Appendix 3 Detection Monitoring and Appendix 4 Assessment Monitoring found on page 21500 of the Friday, April 17, 2015 Federal Register (Appendices 3 and 4 CCR constituents).

TVA shall report the levels of naturally occurring CCR constituents as reported in existing documents and the results of soil samples collected per a TDEC Approved EIS in the (EAR) for that site. TVA shall submit maps that identify the location of soil samples in proximity to the TVA Fossil Plant when the EAR is submitted.

TVA Response

This TDEC General EIP Guideline request is similar to the information requested in Item A.1 of the Investigation Conference Response Letter (Section 3.1.1). However, the General Guideline adds the requirement of a map showing the location where soil samples were taken, and clarifies the use of 40 CFR Part 257, Appendices III and IV, in defining the constituents of concern for soil sampling and analytical purposes. The decision has been made to add five inorganic constituents from Appendix 1 of TN Rule 0400-11-01-.04 as discussed in Section 3.1.1. The constituents from the EPA CCR Appendices III and IV, and the TDEC Appendix 1 inorganic list, have been consolidated and are now referred to as CCR parameters. The scope of work to address this General Guideline is also addressed in Section 3.1.1.

4.1.2 A.2 TDEC Site Information Request No. 2

TVA shall propose a sampling plan to determine the leachability of CCR constituents from CCR material in surface Impoundments, landfills, and non-registered sites at each TVA site. The plan should include sampling points at each disposal area and at different depths in each disposal area. TVA shall describe sample collection methods, sample transport, analytical methodology and the qualifications of the laboratory selected to perform the analyses.

TVA Response

As requested, the proposed leachability study will involve the implementation of a CCR Material Characteristics SAP, and an evaluation of CCR parameters from pore water samples and CCR material samples.

The CCR Material Characteristics SAP will help determine the leachability of CCR constituents from material in a CCR unit. The approach will include the collection and analysis of both pore water and CCR material from the Gypsum Storage Area, the Dry Ash Stack, and the Stilling Pond.

Temporary wells will be installed, then filtered and unfiltered pore water samples will be collected from the phreatic zone at the base of a unit and from above any applicable drainage layer to obtain in-situ leaching information for the material. The pore water analyses will provide real-time measurements of constituents that have leached from the CCR material.

Samples of CCR material will be collected from the temporary wells during their installation, from both saturated and unsaturated zones in the CCR unit. These samples will be analyzed for the parameters described below, after application of the most applicable method based on emerging science in the industry, which could include the Synthetic Precipitation Leaching Procedure (SPLP) method.

The pore water and CCR material samples will be analyzed for the constituents listed in 40 CFR Part 257, Appendices III and IV, and the five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations) which include copper, nickel, silver, vanadium, and zinc. The combined Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as the "CCR Parameters." Total organic carbon (TOC), iron, and manganese have been added to the CCR Parameters list as specific parameters of interest under this SAP.

The CCR Material Characteristics SAP will provide procedures necessary to conduct the sampling of pore water and CCR material in the CCR units, and methods to analyze them for the CCR Parameters list. Proposed activities will include the following major tasks:

- Verify proposed sampling locations using the global positioning system (GPS)
- Develop temporary wells in the ash disposal area (drilling and installation procedures of the temporary wells are outlined in the Exploratory Drilling SAP)
- Collect CCR material samples during installation of the temporary wells
- Collect pore water samples from the temporary wells
- Conduct laboratory testing and analysis

Once sampling is complete and analytical results have been received, the CCR material leaching results will be compared to the pore water data and evaluated for trends. Conclusions and recommendations will be addressed in the EAR.

4.1.3 A.3 TDEC Site Information Request No. 3

Information about the area surrounding the TVA Fossil Plant location before the TVA Fossil Plant was constructed. TVA shall provide in its EIP, geologic maps before the impoundment was created; if an impoundment is adjacent to the TVA Fossil Plant site. TVA discuss topographic maps from the pre-embayment time period and how these maps will be used to identify surface water features such as springs, the original flow of surface streams, etc. in the Environmental Assessment Report (EAR);

TVA Response

This TDEC General EIP Guideline request is similar to the information requested in Item A.2 of the Investigation Conference Response Letter (Section 3.1.2). The difference is this General Guideline also requests TVA discuss topographic maps from the pre-embayment time period and how these maps will be used to identify surface water features such as springs, the original flow of surface streams, etc. in the EAR. Therefore, the scope to address this General Guideline is provided in Section 3.1.2.

4.1.4 A.4 TDEC Site Information Request No. 4

Discuss if construction design information for original CCR surface impoundments, specifically any construction drawings or engineering plans, are available. It is important to identify the surface elevation and location of surface impoundments, landfills or non-registered disposal areas when originally constructed. TVA should explain if/how the information to identify the materials used to construct these disposal areas.

TVA Response

This TDEC General EIP Guideline request is similar to the information requested in Items A.4 and A.5 of the TDEC Investigation Conference Response Letter (Sections 3.1.4 and 3.1.5); however, this General Guideline also requests TVA identify the surface elevation and location of surface impoundments, landfills or non-registered disposal areas when originally constructed. This General Guideline also states TVA should plan to identify the materials used to construct these disposal areas. The scope of work to address this General Guideline is provided in Sections 3.1.4 and 3.1.5.

4.1.5 A.5 TDEC Site Information Request No. 5

Discuss the information available and additional information that will be gathered to provide a three-dimensional profile of the CCR materials from the current elevation of all surface impoundments, landfills, and/or non-registered disposal sites to the natural occurring surface below each structure. Also discuss how TVA plans to provide an estimated amount of CCR material disposed within each structure and the total amount of CCR material disposed at each site. Discuss the methods that TVA will use to provide drawings (to scale) that illustrate the height, length, and breadth of the CCR disposal areas in relation to the naturally occurring features of each site. Comprehensively define the amount and location off CCR material at each site.

TVA Response

TVA prepared a Material Quantity SAP, provided as Appendix H, to describe the methods TVA will use to answer related information requests regarding CCR unit geometry, CCR material quantity, piezometric levels of saturation within the CCR units, top of bedrock contours, and other subsurface materials. A summary of the Material Quantity SAP is provided in Section 3.1.10 which includes a description of how existing and new data will be used to develop a three-dimensional model of the CCR units and use the model to develop volumetric estimates and drawings; therefore, the scope to address this information request is provided in Section 3.1.10.

4.1.6 A.6 TDEC Site Information Request No. 6

Describe the method TVA shall use to provide a water balance analysis for active surface impoundments at each TVA site. This should include all wastewater and surface water runoff entering the impoundment from the TVA site and the amount of water discharged from the surface impoundment(s) into receiving streams at the NPDES permitted discharge point. TVA shall also describe briefly how it will determine the transpiration rate of water from the surface impoundment(s) into the atmosphere;

TVA Response

This General Guideline request is similar to the information requested in Item A.11 of the Investigation Conference Response Letter (Section 3.1.11). The scope of work to address this General Guideline is provided in Section 3.1.11.

4.2 B. WATER USE SURVEY

As a part of the Environmental Assessment, TVA is required to conduct a water use survey. The purpose of the water use survey is to determine if any surface water or ground water (water wells or springs) are being used by local residents or by TVA as domestic water supplies. TVA shall describe how it will conduct a water use survey within ½ mile of the boundary of the TVA site. TVA shall describe how it will determine the construction, depth and location of private water wells identified in the survey. If TVA determines local surface water and/or ground water is used as a source of domestic water supply within a ½ mile radius of the TVA site, the EIP shall include an offsite ground water and surface water sampling plan as a part of the EIP.

4.2.1 B.1 TDEC Water Use Survey Request No. 1

TVA Response

This General Guideline request is similar to the information requested in Item C.2 of the Investigation Conference Response Letter (Section 3.3.2). However, this General Guideline adds the requirements of demonstrating how TVA shall conduct the water use survey, how it shall estimate the construction, depth, and location of private water wells identified in the survey, and if local surface water and/or groundwater is used as a source of domestic water supply within a 0.5-mile radius of the TVA site. TVA is to develop an off-site water supply sampling plan. The scope of work to address this General Guideline is provided in Section 3.3.2.

4.3 C. GROUNDWATER MONITORING AND MAPPING

The EPA CCR rule specify constituents that should be included for analysis for ground water sampling. The constituents for Ground Water Detection Monitoring are listed in Appendix 3 of the EPA CCR regulations and the constituents for Ground Water Assessment Monitoring are listed in Appendix 4 of the EPA CCR regulations. TDEC is requiring TVA to include a description of the ground water monitoring plan it will implement at each TVA site. All ground water samples collected as a part of the Ground Water Monitoring Plan will be analyzed for the CCR constituents listed in Appendices 3 and 4 of the federal CCR regulations. Items to include in the EIP are:

4.3.1 C.1 TDEC Groundwater Monitoring and Mapping Request No. 1

A discussion of all ground water monitoring wells TVA has installed/abandoned/closed at the TVA site as well and any springs that have been monitored at the TVA site or adjacent to the TVA site. TVA shall discuss the data it TVA has generated from historical sampling of ground water monitoring wells and springs. TVA shall include all ground water monitoring construction information, location, and historical ground water monitoring data in each TVA site's EAR.

TVA Response

This General Guideline request is similar to the information requested in Item A.12 of the Investigation Conference Response Letter (Section 3.1.12). However, this request clarifies the groundwater monitoring data to include monitored springs, and installed, abandoned, or closed groundwater monitoring wells at the site, as well as a discussion of wells and springs on site. The request also requires the inclusion of construction information and locations in the EAR. The scope of work to address this General Guideline is provided in Section 3.1.12.

4.3.2 C.2 TDEC Groundwater Monitoring and Mapping Request No. 2

A discussion of the location of at least two background ground water monitoring wells including the reasons for proposed their proposed location.

TVA Response

This General Guideline request is similar to the information requested in Item D.1 of the Investigation Conference Response Letter (Section 3.4.1). The scope of work to address this General Guideline is provided in Section 3.4.1.

4.3.3 C.3 TDEC Groundwater Monitoring and Mapping Request No. 3

A discussion of additional ground water monitoring wells that will be installed to complete a ground water monitoring network at the TVA site around all surface impoundments, landfills, and/or non-registered disposal sites; including the location of existing or proposed ground water monitoring wells down gradient of all CCR disposal areas on the TVA site. TVA shall propose a ground water monitoring network that will provide data to develop a TVA site wide ground water potentiometric surface map. TVA shall ensure that the ground water monitoring locations (current and proposed) in the EIP will accurately determine groundwater flow and direction.

TVA Response

This General Guideline request is similar to the information requested in Items D.4 and D.6 of the Investigation Conference Response Letter (Sections 3.4.4 and 3.4.6, respectively). The scope of work to address this General Guideline is provided in Sections 3.4.4, and 3.4.6.

4.3.4 C.4 TDEC Groundwater Monitoring and Mapping Request No. 4

A discussion of the construction methods TVA will use to install additional ground water monitoring wells. This includes drilling method, methods and personnel for logging cuttings and cores, well construction and well development. A scaled diagram of a properly completed monitoring well shall be provided in the EIP.

TVA Response

TVA is proposing to install new monitoring wells as discussed in General Guidelines Item D.1 (Section 3.4.1) to support the objectives of the TDEC Multi-Site Order. The Hydrogeological Investigation SAP (Appendix J) provides drilling, logging, and monitoring well installation procedures. In addition, the TVA Technical Instruction for Monitoring Well and Piezometer Installation and Development (ENV-TI-05.80.25), which is referenced in the CUF QAPP, addresses drilling methods, record keeping (logging), construction and development.

4.3.5 C.5 TDEC Groundwater Monitoring and Mapping Request No. 5

A ground-water monitoring plan for sampling all wells and springs included in the monitoring network. This should include the methods TVA shall use to collect ground water samples, the analytical methods to be used for ground water sample analyses, methods for sample transport from point of collection to the laboratory and identification and qualification of the laboratory(ies) that will perform sample analyses.

TVA Response

The Groundwater Investigation SAP (Appendix P) provides the methods that TVA will use to collect groundwater samples, analytical methods, chain-of-custody procedures, packaging and shipping and transportation requirements. Additional information regarding laboratories to be used for analysis of the samples is provided in the CUF QAPP (Appendix C).

4.3.6 C.6 TDEC Groundwater Monitoring and Mapping Request No. 6

Describe any existing information available and additional data needed to develop a map which identifies the current ground water surface elevation under the landfill(s), surface impoundment(s) and/or non-registered site(s). If additional data is needed to provide ground water elevations across the TVA site, below the footprint of the landfill(s), surface impoundment(s) and/or non-registered site(s), describe the methods TVA plans to use to collect the data. TVA shall collect sufficient data to create a map that clearly delineates the ground water surface in the ash disposal areas such that (1) the CCR material between the original ground surface and the top of the current ground water table is defined and (2) CCR material between the current ground water surface and the surface elevation of the CCR disposal area is clearly defined. TVA shall also collect pore water samples from CCR material that is below the current ground water surface and from CCR material that is below the projected ground water surface with closure in place. TDEC has not determined that closure in place is a corrective action option at any TVA site; however; this information is needed should TVA propose closure in place.

TVA Response

This TDEC General EIP Guideline request is similar to the information requested in Item A.14 of the Investigation Conference Response Letter (Section 3.1.14). The scope of work to address this General Guideline is primarily provided in Section 3.1.14.

However, the General Guideline adds the new task of collecting pore water samples from CCR material that is below the current ground water surface, and from CCR material that is below the projected ground water surface with closure in place. Seven pore water samples will be taken at the base of the Gypsum Storage Area, the Dry Ash Stack, and the Stilling Pond, and three pore water samples will be taken in the phreatic zone of the Gypsum Storage Area above the drainage layer. Samples will be analyzed for the CCR parameters (see Section 4.1.2 for a description of the objective and approach). The CCR Material Characteristics SAP which addresses pore water and CCR material sampling protocols is provided as Appendix I.

From the results of the pore water sampling study, TVA will report the levels of the constituents analyzed and summarize the results in the EAR in accordance with the CUF QAPP. A map identifying the pore water sampling locations will accompany the report.

4.3.7 C.7 TDEC Groundwater Monitoring and Mapping Request No. 7

Describe how TVA will define groundwater contaminant plumes identified using currently available groundwater monitoring data and new groundwater monitoring data gathered from the installation and sampling of new groundwater monitoring wells. TVA will also discuss its strategy to determine the extent of any CCR constituent plume should the initial groundwater monitoring network not define the full extent of the CCR constituent groundwater plume at the site. This should include the science it will use to extend its groundwater monitoring network.

TVA Response

This General Guideline request is similar to Information Requested D.6 of the Investigation Conference Response Letter (Section 3.4.6). TVA recently installed 12 new monitoring wells (CUF-201, CUF-202, and CUF-204 through CUF-213) and one observation well (CUF-120) at locations across the site (see Figure 1). TVA will continue to collect groundwater samples and review the analytical results as a part of TDEC Solid Waste Management permit requirements and the CCR Rule. The results of the evaluation will be used to determine if these wells may be suitable for use in groundwater monitoring networks. If TVA determines that the new wells are suitable for addition into the TDEC permitted groundwater monitoring network, then TVA will include them in an amended groundwater monitoring network.

The initial phase of the environmental investigation is to characterize the site by assessing current subsurface conditions at CUF. Potential groundwater impacts will be identified by collecting background and downgradient groundwater. TVA will use industry accepted methods for delineating the extent of CCR constituents, if needed, and will install additional wells in appropriate locations based on groundwater flow conditions.

Methodologies and procedures for installing monitoring wells are provided in TVA Technical Instruction for Monitoring Well and Piezometer Installation and Development (ENV-TI-05.80.25). New monitoring wells will be monitored bimonthly for one year.

TVA may propose additional methods of evaluation, such as groundwater flow and transport models, as appropriate and guided by sound scientific principles based on the data collected. The proposed investigation is designed to collect groundwater data representative of site conditions that would be needed as input into models. Groundwater data collected during the environmental investigation will be evaluated to determine an appropriate modeling method. After the data set has been developed, TVA will collaborate with TDEC to agree on the most appropriate model.

4.4 D. TVA SITE CONDITIONS

4.4.1 D.1 TDEC Site Conditions Request No. 1

Discuss all current information available about the geologic lithology (formations, bedding planes, etc.) and their relevance to natural seeps, springs, and karst features on the TVA site; including the CCR disposal areas. Some limestone formations are very susceptible to solution channeling, especially when they have been disturbed through natural events or construction activities such as blasting. TVA shall describe the methods it will use to determine whether solution channeling has occurred at and near the soil/rock interface;

TVA Response

This General Guideline request is similar to the information requested in Item A.16 of the Investigation Conference Response Letter (Section 3.1.16). The scope of work to address this General Guideline is provided in Section 3.1.16.

4.4.2 D.2 TDEC Site Conditions Request No. 2

Discuss all current information about the geologic structure below the TVA site and how it may be used to help determine if faults and/or fractures have been identified in the subsurface. TVA shall describe the methods it will use to collect additional data (faults, fractures, bedding planes, karst features, etc.) to determine whether faulting and fracturing has impacted and/or controls groundwater movement. Describe how TVA will determine if identified faults, fractures, bedding planes, karst features, etc. are filled to the point that they limit or eliminate ground water flow.

TVA Response

This General Guideline request is similar to the information requested in Item A.17 of the Investigation Conference Response Letter (Section 3.1.17); therefore, the response to this General Guideline is provided in Section 3.1.17.

4.4.3 D.3 TDEC Site Conditions Request No. 3

Discuss existing data available to TVA to map top of bedrock; i.e. existing boring and ground water monitoring well construction data. TVA shall describe the methods (surface geophysics; installation of borings/ground water monitoring wells) it will use to collect additional data to map top of bedrock. The EIP shall include a description of the data collection methods TVA will use to determine the thickness and types of natural material overlying bedrock as well as the top of bedrock contours. For all new soil borings, TVA shall provide the location of the borings, the information used to determine boring location, the drilling method to be used, how the borings will be logged. Logging shall be performed by a Professional Geologist licensed to practice in Tennessee. Logs shall provide the following information when presented in the EAR; soil type, depth, and changes, identify geologic formations, depth of formation, karst features, fractures, bedding planes, and any other pertinent information. TVA shall provide an example of a boring log in the EIP.

TVA Response

This General Guideline request is similar to the information requested in Item A.18 of the TDEC Investigation Conference Response Letter (Section 3.1.18). However, this General Guideline includes additional requirements related to information and logging procedures for new borings. These requirements are addressed in the Exploratory Drilling SAP provided as Appendix G.

4.4.4 D.4 TDEC Site Conditions Request No. 4

When/if TVA divided original Coal Combustion Residual (fly ash, bottom ash and gypsum) surface impoundments into individual units (surface impoundments, non-registered disposal areas and or landfills), TVA shall discuss where this has happened on each TVA site. As a part of the EAR, TVA shall discuss the source of information reviewed to provide the specifications of those structural changes. Discuss if there are as built drawings or engineering plans for the modifications TVA has made at each site made. If there is not existing information that describes the structural changes in the original surface impoundment(s) or non-registered site(s), TVA shall discuss in the EIP how it will collect the information needed to document structural changes over time. This information is needed in determining the structural and seismic stability of each TVA site.

TVA Response

This General Guideline request is similar to the information requested in Item A.5 of the TDEC Investigation Conference Response Letter (Section 3.1.5). However, this General Guideline adds the requirement of providing the history of when impoundments have been divided. Therefore, the scope of work to address this General Guideline is provided in Section 3.1.5.

4.4.5 D.5 TDEC Site Conditions Request No. 5

Stipulate whether there are any as-built designs for the interface between the originally disposed CCR material and any disposal structures constructed above the original disposal area.

TVA Response

This General Guideline request is similar to the information requested in Items A.6 and A.7 of the Investigation Conference Response Letter (Sections 3.1.6 and 3.1.7). Therefore, the scope of work to address this General Guideline is provided in Sections 3.1.6 and 3.1.7.

4.4.6 D.6 TDEC Site Conditions Request No. 6

TVA shall discuss any existing stability calculations for final permitted design elevation for all landfills. Unless TDEC specifies otherwise, TVA shall conduct new stability calculations for all landfills, surface impoundments and/or non-registered disposal sites. The EIP shall describe the method TVA will use to determine structural stability. TVA shall provide stability calculations for each disposal area based upon (1) the permitted final elevation or planned final elevation for each landfill, (2) the current elevation for all surface impoundments and/or (3) the current elevation for all non-registered disposal location.

TVA Response

A discussion of existing stability calculations for the final permitted design elevation for the landfills is addressed in Item E.2 of the Investigation Conference Response Letter (Section 3.6.2).

As discussed in Section 3.1.13, existing and upcoming slope stability assessments and structural stability assessments of the CUF CCR units are detailed in Appendix F. These analyses are considered adequate to answer this information request.

There are no “non-registered” disposal sites at CUF.

4.4.7 D.7 TDEC Site Conditions Request No. 7

TVA shall specify how it will determine the construction methods and properties of the drainage layers between each "stacked layer" for permitted CCR landfills; including where the drainage layer discharges.

TVA Response

Dry Ash Stack, Gypsum Storage Area: This General Guideline request is similar to the information requested in Items A.6, A.7, and E.3 of the Investigation Conference Response Letter (Sections 3.1.6, 3.1.7, and 3.6.3). Therefore, the scope of work to address this General Guideline is provided in Sections 3.1.6, 3.1.7, and 3.6.3.

Stilling Pond (including Retention Pond), Bottom Ash Pond: These units are not permitted CCR landfills, and do not have drainage layers within the units; therefore, this information request does not apply to these units.

4.4.8 D.8 TDEC Site Conditions Request No. 8

TVA shall review Section VI.D.5 (page 21373) of the section of the Federal CCR Preamble that describes areas of concern regarding overfill at landfills. TVA shall explain how it will determine if there are potential overfill situations for each surface impoundment/landfill at the TVA site.

TVA Response

This General Guideline request is similar to the information requested in Item E.4 of the Investigation Conference Response Letter (Section 3.6.4). The scope of work to address this General Guideline is provided in Section 3.6.4.

4.4.9 D.9 TDEC Site Conditions Request No. 9

Discuss current information/data that is available to estimate the shear strength of the CCR materials in the landfill(s), surface impoundment(s) and/or nonregistered sites. If there is not sufficient data available to determine shear strength, describe the methods TVA shall use to collect this data. If there is existing data collected during installation of soil/rock borings or construction of ground water monitoring wells, provide a brief description of this data and how it will be presented for use in the EIP.

TVA Response

This General Guideline request is similar to the information requested in Items A.15 and E.11 of the Investigation Conference Response Letter (Sections 3.1.15 and 3.6.11). The scope of work to address this General Guideline is provided in Sections 3.1.15 and 3.6.11.

4.4.10 D.10 TDEC Site Conditions Request No. 10

TVA shall provide static, seismic and liquefaction analysis in accordance with 257.63 and 257.73 of the Federal CCR regulations for final permitted design elevations for Landfills that are defined by the Federal Regulations as overfills. If the analyses have not been completed, then TVA shall provide analyses for each landfill based upon either the permitted final elevation for each or for the planned final elevation for each; should TVA decide it does not need to use the entire permitted capacity of any permitted CCR landfill. TVA shall identify and analyze the critical cross section(s) and document that the modeling represents the actual field conditions at the cross-section location(s). TVA shall also address foundation settlement of these Landfills.

TVA Response

As noted in Section 3.6.4, none of the CUF CCR units in the Study Area meet the definition of an overfill per the CCR Rule. Therefore, this information request does not apply to CUF.

However, the Dry Ash Stack and Gypsum Storage Area are the subject of an ongoing seismic stability evaluation, as discussed in Section 3.1.13. This evaluation will include seismic slope stability and liquefaction analyses to meet the intent of this information request.

4.4.11 D.11 TDEC Site Conditions Request No. 11

TVA shall discuss any current dam safety analysis performed at the TVA site for all landfills, surface impoundments and/or non-registered disposal areas. If dam safety analysis has not been performed for each disposal area or if TDEC determines the dam safety analysis is inadequate, then TVA shall describe the method(s) it will use to determine the "dam safety factor" for all disposal areas at the TVA site.

TVA Response

The perimeter dikes of the Bottom Ash Pond, Dry Ash Stack, and Gypsum Storage Area do not constitute dams, as defined by TVA Standard Programs and Processes (SPP) manual on Dam Safety (TVA-SPP-27.0). Likewise, these perimeter dikes do not constitute dams under Federal Emergency Management Agency (FEMA) guidelines, which consider both dam height and impounding capacity. The above-listed units at CUF no longer have the capacity to impound 50 acre-feet or more, thus they do not meet the definition of a dam. Therefore, this information request does not apply to these units.

However, the perimeter dike of the existing Stilling Pond (including Retention Pond) does meet the definition of a dam. In addition, the perimeter dike system around the Stilling Pond (including Retention Pond), Bottom Ash Pond, Dry Ash Stack, and Gypsum Storage Area has been included in TVA's Dam Safety Program (because prior to converting a portion of the footprint to landfills, the entire perimeter dike system historically acted to impound water for sluiced ash disposal). TVA has applicable SPP manuals that govern dam safety analyses. TVA's Dam Safety Governance and Oversight department provides TVA with procedural standards for managing dam safety activities, oversight, and support. Objectives of the program include:

- Establish and maintain a complete inventory of TVA dams and impoundments.
- Ensure dams and impoundments are designed, constructed, operated, maintained, and repaired in accordance with the Federal Guidelines for Dam Safety and TVA Procedures.
- Maintain a Dam Safety Independent Review Board to provide technical expertise and guidance.
- Perform assessments to provide quality assurance.
- Prepare programmatic performance metrics and reporting including the biennial report to FEMA.
- Provide a forum for dam safety related communications, lessons learned and best practices sharing.
- Facilitate consistent and effective administration of dam safety work through management of the Dam Safety Steering Committee, with the goal of efficiently reducing TVA's overall dam safety risk.

TVA has completed, or will perform slope stability evaluations for each CCR unit in the Study Area as outlined in Section 3.1.13 of this EIP. These evaluations include the stability of the perimeter dike system, where present, of each unit. TVA has also performed, or will perform assessments of the disposal areas in accordance with Item D.13 of the General Guidelines, which include structural stability and safety factor assessments. See Section 4.4.13 for a description of these assessments. These assessments will be summarized in the EAR.

4.4.12 D.12 TDEC Site Conditions Request No. 12

TVA shall discuss any current information or assessments regarding seismic stability for the TVA site, including existing seismic analysis for each surface impoundment(s), landfill(s) and/or nonregistered site(s) s at the TVA site. TVA shall describe in the EIP the method it will use to determine the size of the seismic event that would cause structural failure for entire area of the surface impoundments, landfills, and/or non-registered disposal sites at the TVA site.

The seismic analysis method proposed by TVA shall provide seismic data comparable to the requirements for seismic analysis in the federal CCR regulations at CFR 257.63. The seismic analysis plan shall determine the seismic stability of the entire TVA site and any improvements need to ensure seismic stability for the site, as it exists today and for closure in place. Soils below the surface impoundments and landfill shall be evaluated for liquefaction potential. If these soils are found to be susceptible to liquefaction, stability calculations shall be performed which account for liquefaction.

TVA Response

This General Guideline request is similar to the information requested in Item E.6 of the Investigation Conference Response Letter (Section 3.6.6); therefore, the scope of work to address this General Guideline is provided in Section 3.6.6.

4.4.13 D.13 TDEC Site Conditions Request No. 13

TVA shall discuss how the structural integrity of the entire area of CCR disposal (surface impoundment(s), landfill(s) and non-registered sites) shall be determined. TVA shall include in the EIP the methods and models it will use to evaluate structural integrity as discussed in CFR 257.73(d) and (e).

TVA Response

TVA has recently performed structural stability assessments as required by CFR Part 257.73(d) and (e) for the CUF surface impoundments (Stantec 2016d, 2016e). The scope of work for those assessments is provided in Section 3.1.13.

TVA further promotes structural integrity of the units by performing routine inspections and by evaluating proper abandonment of hydraulic structures and pipe penetrations through the unit perimeter. A summary of the structural evaluations will be presented in the EAR.

As required by the CCR Rule, TVA is performing Unstable Areas assessments in accordance with CFR Part 257.64 on the CUF Landfills and surface impoundments, as outlined in Section 3.6.4. Additionally, the stability program described in Sections 4.4.6 and 4.4.12 will consider the safety factor aspects of the CCR Rule CFR Part 257.73(e) such as static and seismic stability.

4.4.14 D.14 TDEC Site Conditions Request No. 14

Discuss any current information available that may be used to determine the ability of the local geology to provide sufficient structural stability for the existing surface impoundments, landfills, and/or non-registered disposal areas at the TVA site as well as any disposal area considered for closure in place. TDEC anticipates there will not be sufficient existing structural stability information for this analysis. Describe the methods TVA shall employ to collect data that may be used to determine the capability of the geologic formation at the TVA site to provide structurally sound/load bearing strength for existing CCR disposal areas as well as for those disposal areas should TVA consider closure in place of those areas.

TVA Response

This General Guideline request is similar to the information requested in Item A.13 of the Investigation Conference Response Letter (Section 3.1.13); therefore, the scope of work to address this General Guideline is provided in Section 3.1.13.

4.5 E. SURFACE WATER IMPACTS

Because of the long operating history of the TVA Fossil Plants, there have been potential opportunities for CCR materials to move into surface water and for dissolved CCR constituents to migrate via ground water flow into surface water. As part of the EIP, TVA shall describe how it will determine if CCR material and/or dissolved CCR constituents have entered surface water at or adjacent to TVA sites. TVA will also describe how it will assess any impact CCR material and/or dissolved CCR constituents may have had on water quality and/or fish and aquatic life.

The requests above are addressed in Items E.1 through E.8 below.

4.5.1 E.1 TDEC Surface Water Impacts Request No. 1

TVA shall discuss any current information it has for the TVA site that identifies CCR deposition on the streambed for surface water on the TVA site or surface water adjacent to the TVA site.

TVA Response

A limited sediment sampling study was conducted in Wells Creek in 2002 as part of an investigative study (EES 2002). The study was initiated to investigate the presence of an unknown milky white substance observed intermittently in Wells Creek, and the tributary leading into Wells Creek, where the creek runs between CUF's Gypsum Storage Area and Standard Gypsum's access roads; Standard Gypsum is a drywall construction company adjacent to the plant. The study included two sampling events with analytical results addressing approximately half of the CCR parameters.

The sediment samples were analyzed for arsenic, barium, beryllium, boron, cadmium, calcium, lead, nickel, thallium, strontium, and sulfate.

The United States Army Corps of Engineers (USACE) also collected water quality and sediment data in the general vicinity of CUF. The USACE collected sediment samples from four locations in the Cumberland River [Cumberland River Miles (CuRM) 31.5, 71.0, 100.1, and 124.0] and two locations in smaller tributaries (Little River Mile 9.3 located downstream from CuRM 71.0 and Red River Mile 0.4 located upstream from CuRM 124.0) in 1997, 2002, 2007, and 2012. The CuRM 100.1 sampling location is the nearest USACE sampling location to CUF, which is located at CuRM 102.8. The sediment samples were analyzed for multiple parameters including some of the CCR Parameter metals (antimony, arsenic, barium, cadmium, chromium, cobalt. Lead, mercury, molybdenum, mercury, selenium, and thallium).

TVA conducts aquatic community studies and whole effluent toxicity analyses per its NPDES permit requirements. This existing sediment data will be reviewed and evaluated in accordance with the CUF QAPP, along with the new data obtained from the proposed sediment study discussed in Section 4.5.2, and addressed in the EAR.

4.5.2 E.2 TDEC Surface Water Impacts Request No. 2

TVA shall describe in the EIP the methods it will use to determine if CCR material has moved from the TVA site into surface water on the TVA site or adjacent to the TVA site. TVA shall propose a procedure for sampling the streambed for CCR material. TVA shall describe sample collection methods, sample preservation and sample analysis methods for CCR materials. All samples shall be analyzed for the CCR constituents listed in Appendices 3 and 4 of the federal CCR regulations. Further, TVA shall propose how it will test sediment and CCR samples taken from riverbeds to determine if CCR constituents dissolve into surface water.

TVA Response

TDEC has requested a sampling plan to determine if CCR material has moved into surface water (see Section 4.5.5 for the Surface Stream Characterization Study), to characterize sediment in streambeds for the CCR parameters, and to assess whether CCR has been deposited on the streambed.

The objectives of the sediment characterization study include:

- Delineation of CCR material deposited on streambeds; and
- Assessment of potential transport of CCR constituents from CCR units to surface streams on or adjacent to the TVA site.

The sediment characterization study will include the following steps:

1. Research and review existing documentation on sediment analyses;
2. Finalize a sediment sampling location map;
3. Finalize Benthic SAP;
4. Record sediment sample locations using GPS during the investigation;
5. Collect and analyze sediment samples per a two-phased approach in accordance with the SAP;
6. Review and evaluate existing and new analytical data; and
7. Prepare the EAR.

A two-phased approach is proposed in conducting the sediment characterization study, as provided in the Benthic SAP (Appendix R). Phase 1 will include:

- Conduct three Vibracore borings at each of twenty-four transects, to six-foot depth or refusal, whichever comes first.
- Collect samples of top six inches of sediment at each sampling location (for a total of seventy-two samples).
- Collect grab samples of remainder of each sediment core, segregated by strata types. Native soils will not be collected, since the focus is on deposited sediment material.
- Analyze samples for percent ash, using PLM.
- Analyze all of the top six-inch sediment samples for CCR parameters and strontium.
- Hold the deeper sediment samples for potential future analyses in Phase 2 (if >20% ash).

Proposed sampling locations for Phase 1 of the Benthic SAP have been selected based on areas subject to past/potential CCR releases or ongoing operations that have potential to impact adjacent surface waters including:

- The 1997 bypass of process water from the Gypsum Storage Area due to heavy rainfall;
- Historic seep areas bordering Wells Creek; and
- Locations in the Cumberland River directly downstream from the NPDES outfall.

A map of proposed sediment sampling locations for Phase 1 is provided as Figure 18, and a complete description of the sampling methods and protocols is provided in the Benthic SAP, which can be found in Appendix R.

Quantitative benthic macroinvertebrate (invertebrate) samples will be collected during Phase 1 and are included in the Benthic SAP in Appendix R. The benthic invertebrate samples will be collected along transects at the locations depicted on Figures 19 and 20. The results of the quantitative sampling will be used to assess the status of the benthic community. The benthic invertebrate evaluation will also include collecting composite samples of mayfly nymphs from locations within the areas indicated on Figure 21. During mayfly nymph sampling activities, composite adult mayfly samples will be collected by direct removal from vegetation or other structures along the shoreline or by use of sweep nets. The mayfly nymphs (collected for both depuration and non-depuration) and adult mayflies will be submitted for laboratory analysis of metals included in the CCR parameters list (excluding radium) and strontium. The mayfly analytical results will be used in conjunction with sediment and fish tissue data to evaluate contaminant bioaccumulation.

Should ash in an individual sediment sample exceed 20 percent, Phase 2 sediment sampling will be implemented for that location, and would include:

- Analysis of held sediment core sample(s) at sampling locations that exceeded the 20 percent ash content for the CCR parameters and strontium.
- Preparation of sampling location map showing new boring sampling locations adjacent to and including the original coring location(s) exhibiting a greater than 20 percent ash content.
- Analysis of new sediment core samples for the CCR parameters, strontium, and percent ash.

A Phase 2 sediment sample location map will be prepared for the new sampling locations, and sediment samples will be collected and analyzed for the CCR parameters, strontium, and percent ash. Phase 2 sampling will follow the same sampling methods and protocols as Phase 1.

Once sampling is complete and analytical results have been received for the required phases of the study, the results will be evaluated in accordance with the CUF QAPP and reported in the EAR.

4.5.3 E.3 TDEC Surface Water Impacts Request No. 3

TVA shall describe how streambed sample results will be used to develop a map identifying the location of CCR material on the streambed and the depth of the CCR material on the streambed.

TVA Response

If CCR material is found during the sampling conducted to address Item E.2 above, the results will be used to prepare maps showing the distribution and depths of CCR material in Wells Creek and the Cumberland River near CUF. The maps and volume estimates will be presented in the EAR.

4.5.4 E.4 TDEC Surface Water Impacts Request No. 4

TVA shall discuss any current information it has for the TVA site that identifies the movement of ground water with dissolved CCR constituents into surface streams on or adjacent to the TVA site. This includes any surface water analyses TVA has performed for samples taken from the seeps and surface stream(s).

TVA Response

TVA is currently sampling Wells Creek quarterly at a state compliance sampling point upgradient (south) of the CUF site, outside the plant's property boundary. The intent of this monitoring location is to represent background concentrations, unaffected by CCR units.

USACE collected water quality samples in the general vicinity of CUF in 2005 and 2012-2015, with the closest location at CuRM 100.1; CUF is located at approximate CuRM 102.6. Surface water data included results from individual grabs (not composites) collected from the surface, mid-depth, and the lower water column. Total and dissolved concentrations were obtained for arsenic, cadmium, chromium, copper, lead, and selenium. The existing surface stream data will be reviewed and evaluated in accordance with the CUF QAPP, along with the new data obtained from the proposed surface stream study discussed in Section 4.5.5, and addressed in the EAR.

4.5.5 E.5 TDEC Surface Water Impacts Request No. 5

TVA shall propose a plan to collect and analyze water samples from seeps and surface stream(s) on the TVA site and/or adjacent to the TVA site. This plan shall include sampling locations, sample collection methods, sample preservation and transport and methods for sample analysis. All samples shall be analyzed for the CCR constituents listed in Appendices 3 and 4 of the federal CCR regulations.

TVA Response

This response has been broken into two parts, one addressing seeps and one addressing surface streams.

Seep Characterization Study and Associated SAP

TDEC has requested a sampling plan to characterize seeps on the TVA site and/or adjacent to the TVA site at CUF, for the CCR parameters. To this end, TVA will investigate mitigated and active seeps or areas historically noted as seeps that have occurred in the CCR unit dikes and berms. The analytical results from located seep water and soil samples will be evaluated and the information provided to help inform assessment of potential movement of groundwater with dissolved CCR parameters into surface streams on or adjacent to the TVA site, as requested in Section 4.5.4.

Historically, CUF has addressed wet areas and seepage areas in a very conservative manner, out of an abundance of caution to anticipate and stay ahead of potential structural concerns. Wet areas with poor drainage were automatically classified as seepage areas. Some wet areas eventually were found not to be seeps, but rather, simply the result of poor drainage. A historic seepage summary is provided in Appendix S.

Areas historically noted as seeps at CUF have been managed in two different ways, according to their location on the Gypsum Storage Area and the Dry Ash Stack. For areas with emergent water at ground surface located on the upper dike slopes above the perimeter ditch surrounding the CCR units, the flows are directed by the perimeter ditch system into the Stilling Pond treatment area which discharges to the NPDES-permitted outfall into the Cumberland River. These areas above the perimeter ditch are either mitigated for structural stability issues if warranted per engineering design standards, or monitored for further evaluation.

Areas historically noted as seeps found on the external dike slopes below the perimeter ditch have the potential to flow into Wells Creek or the Cumberland River. These are included in the EIP investigation, as discussed herein. A map depicting historic seepage areas and seep mitigation areas, both above and below the perimeter ditch is shown on Figure 22.

The objective of the seep characterization study is to assess the potential for transport of CCR constituents from CCR units to surface streams on or adjacent to the TVA site by water from seeps below the perimeter ditch on the Gypsum Storage Area, Dry Ash Stack, and Stilling Pond perimeter dike system.

TVA's approach in conducting the seep characterization study consists of the following steps:

1. Research and review existing documentation on seep analyses;
2. Finalize a map to identify location of active and mitigated seeps;
3. Finalize the Seep SAP;
4. Investigate site for active seeps;

5. Record sample location using GPS;
6. Collect seep soil and water samples;
7. Analyze seep soil and water samples for CCR parameters per the Seep SAP in accordance with the CUF QAPP;
8. Review and evaluate existing and new analytical data; and
9. Prepare the EAR.

TVA has conducted annual ash pond dike inspections at CUF under the Tennessee NPDES Permit No. TN0005789 for at least two decades. These inspections focused on stability issues pertaining to seeps; no soil or water samples were collected.

There are currently four mitigated seep areas along the Gypsum Storage Area and the Dry Ash Stack perimeter dike system below the perimeter ditch. The mitigation areas are designed to address structural stability issues potentially arising from seeps. A graded filter was placed in the location of each seep to prevent the erosion of soil from seepage flow; the graded filter is designed to keep soil particles from leaving the dike, to prevent piping from occurring within the interior of the dike and weakening its structure. By preventing the occurrence of piping, the graded filter promotes the continued stability of the dike.

As part of the Seep SAP, a seep investigation will be conducted to discover whether active seeps or continued seepage from mitigated seep areas are present below the perimeter ditch. The seep investigation will focus on repaired seep areas below the perimeter ditch since they have the potential to discharge into the adjacent surface stream waters of Wells Creek or the Cumberland River, as well as an area of interest from prior inspections located south of the bridge across Wells Creek, along the bank of the Dry Ash Stack. Field investigation will include inspecting dike areas below the perimeter ditch for the following signs of potential seepage:

- Soil and/or vegetation discoloration,
- Flowing water,
- Unnatural saturation of the soil,
- Plant growth.

Inspection of mitigated areas will likely require the use of a boat in Wells Creek since the mitigation riprap often extends to the bank and/or waterline of Wells Creek. The inspection will include examining the bank at the base of the riprap to determine if there are continuing water discharges at those locations. In addition, the stream channel and surface water at the water's edge shall be field-tested for pH, temperature, dissolved oxygen, and conductivity using a multiparameter Sonde.

By using the protocol outlined in the Seep SAP, if field testing indicates a significant difference between the stream channel samples and samples adjacent to the stream bank, further investigation will be required to determine if there is a seepage flow that is not visible.

Should active seeps be discovered, a seep sampling location map will be finalized and placed in the Seep SAP.

Field sampling activities will include verifying the seep sampling location(s) using GPS and collecting seep soil and seep water samples as described in the Seep SAP. Filtered and unfiltered water samples will be taken. Samples will be analyzed for the CCR parameters. A complete description of the sampling methods and protocols is provided in the Seep SAP (Appendix T).

Once sampling is complete and analytical results have been received, the CCR parameters analyses for the seep samples will be evaluated in accordance with the CUF QAPP and reported in the EAR.

Surface Stream Characterization Study and Associated SAP
TDEC has requested a sampling plan to characterize surface streams on and/or adjacent to CUF for the CCR parameters. TVA will obtain surface stream samples from Wells Creek, an unnamed tributary to Wells Creek, the CUF discharge channel, a stormwater pond, and from the Cumberland River. The analytical results from the surface stream samples will be evaluated and the information provided to address the discussion on identifying the movement of groundwater with dissolved CCR parameters into surface streams on or adjacent to the TVA site, as requested in Section 4.5.4.

The purpose of the Surface Stream SAP (Appendix U) is to characterize water quality on or adjacent to the CUF plant for CCR constituents.

A two-phased approach is proposed for conducting the surface stream characterization study as described below.

Phase 1:

- Collection of general water quality parameters insitu using a Hydrolab® multi-probe water quality meter along twenty-five transects in the Cumberland River, Wells Creek and its unnamed tributary, the Discharge Channel, and an adjacent stormwater pond. Hydrolab data will be evaluated in the field to determine the presence of thermal stratification across the transects. As described below, discreet water quality samples will be collected from the thalweg (deepest point), right bank, and left bank of each transect. Based on the results of field measurements, one of the following sample plans will be implemented:

- If thermally stratified, collect near-bottom (epibenthic) sample 0.5 m above streambed, mid-hypolimnion sample (midway between bottom of thermocline and streambed), mid-epilimnion sample (midway between top of thermocline and water surface, and near-surface (0.5 m depth) sample.
- If not thermally stratified, collect surface, mid-depth, and epibenthic samples.
- For waterbodies that may not have adequate depth to collect multiple samples from the water column, the field sampling team may adjust the number of samples to accommodate. Similarly, if the width of the waterbody along a sampling transect is not sufficient to support the collection of multiple samples along the transect, the field sampling team may adjust the procedure accordingly.

Samples will be analyzed for total and dissolved CCR parameters, as listed in Appendices III and IV of the CCR Rule, as well as TN Rule 0400-11-01-.04 Appendix 1. A map of proposed surface stream sampling locations is provided in Figure 23. Sample locations are co-located with sediment sampling locations. To account for seasonal variations, two surface stream sampling events are proposed.

Phase 2

Should ash in an individual sediment sample (as collected in accordance with the Benthic SAP) exceed 20 percent, Phase 2 surface stream sampling will be implemented for that location. A Phase 2 surface stream sample location map will be prepared for the new sampling locations. Surface stream samples upstream and downstream from the location of the 20 percent ash exceedance will be collected and analyzed for CCR parameters. Phase 2 sampling will follow the same sampling methods as Phase 1.

Once sampling is complete and analytical results have been received for the required phases of study, the CCR parameters analyses for the surface stream samples will be evaluated in accordance with the QAPP and reported in the EAR.

4.5.6 E.6 TDEC Surface Water Impacts Request No. 6

TVA shall describe how seep and stream sample results will be used to develop a map identifying the location of seep and stream sampling points and the results of the analyses. This map shall also include the location of any public water intakes within 1 mile of the downstream side of the TVA site.

TVA Response

Maps identifying the proposed surface stream and seep sampling locations are provided in their respective SAPs. After samples have been analyzed, new maps will be provided to include the analytical results. CUF is located at River Mile 103. Based on a review of the Cumberland River Navigation Charts, the closest downstream intake is near River Mile 89, a distance of 14 miles from the plant. The charts were published in 2013.

4.5.7 E.7 TDEC Surface Water Impacts Request No. 7

TVA shall provide a brief discussion of any studies conducted by TVA or any other agency to determine if CCR materials or dissolved CCR constituents have impacted fish and/or aquatic life.

TVA Response

TVA presented the results of Biological Monitoring from the Cumberland River in the Investigation Conference (Slides 63-72) and Investigation Conference Data Transmittal.

TVA has collected and analyzed biological data upstream and downstream of its fossil-fueled power plants to assess the quality of the aquatic communities surrounding them. These data include monitoring of fish and benthic macroinvertebrate assemblages and visual encounter surveys for wildlife along the shoreline. The studies suggest CUF's operation has not had an adverse environmental impact on the aquatic community. The results of these studies will be evaluated in accordance with the CUF QAPP and presented more fully in the EAR.

4.5.8 E.8 TDEC Surface Water Impacts Request No. 8

Upon a determination by TDEC of the need to assess the impact of CCR material in surface streams or migration of ground water containing dissolved CCR constituents, TVA shall provide a plan to study the impact of CCR materials and/or constituents on fish and/or aquatic life in surface streams on the TVA site or adjacent to the TVA site.

TVA Response

TVA has developed a Fish Tissue SAP (Appendix V) for CUF to help assess the potential impact of site activities on fish and/or aquatic life in surface streams on or adjacent to CUF, and to characterize moisture content, strontium, and metals from the CCR constituent list (excluding radium) in fish tissues collected within surface streams near CUF. The results from the analysis of fish tissue will be used to determine whether fish in the immediate vicinity and downstream of CUF have higher concentrations of CCR-related constituents than fish from reference locations not adjacent to or downstream from CUF. The results from implementation of this SAP will be evaluated and addressed in the EAR. A map of proposed fish tissue sampling locations is provided in Figure 24.

Other biological studies TVA will include as part of the investigation include a benthic invertebrate sediment study developed to assess the status of the benthic community, and a bioaccumulation study on mayflies. These biological studies are included in the Benthic SAP (see Section 4.5.2).

5.0 ENVIRONMENTAL ASSESSMENT REPORT (EAR)

The EIP and EAR process is described in the Order. Within 60 days of completion of the EIP activities, TVA will submit the EAR to TDEC. The EAR will address the list of tasks required by TDEC in its response to TDEC's April 11, 2016 and June 14, 2016 letters.

TDEC will review the report to evaluate whether the tasks have been addressed in helping determine if there are unacceptable risks resulting from the management and disposal of CCR. The EIP and EAR process will be repeated until TDEC concludes that there is sufficient information to adequately characterize the extent of CCR contamination in the soil, surface water, and groundwater at the site.

Upon approval of the EAR by TDEC, TVA will then submit within 60 days, a Corrective Action/Risk Assessment (CARA) Plan. The CARA Plan will specify the actions TVA will take at the site and the basis of those actions. Corrective measures may include (1) soil, surface water, and groundwater remediation, (2) risk assessment and institutional controls, or (3) no further corrective action.

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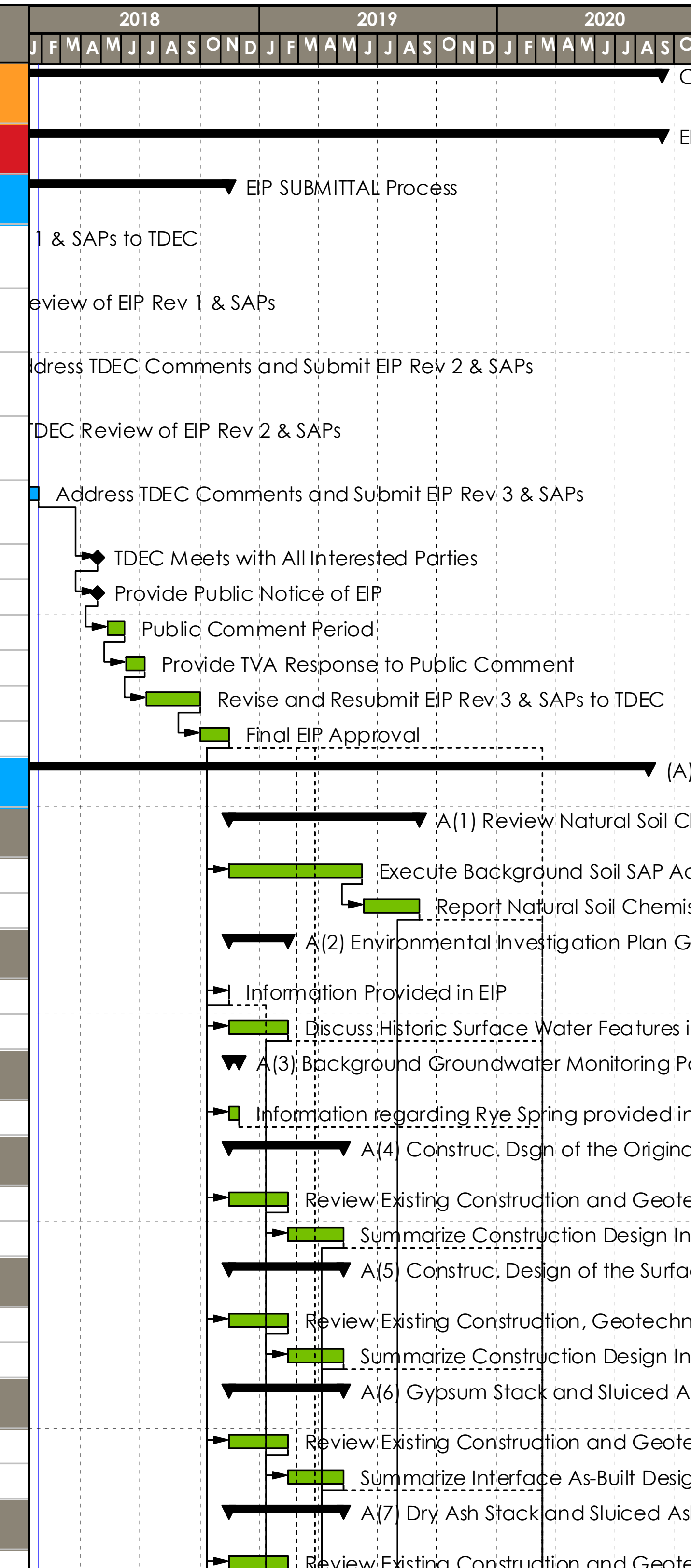
APPENDIX A
SCHEDULE

ST609489 CUF EIP Implementation Schedule

Activity ID	Activity Name	Remaining Duration	Total Float	Start	Finish	Predecessors
	CUF EIP Implementation Schedule	663d	0d	12-May-17 A	11-Sep-20	
	EIP Development	663d	0d	12-May-17 A	11-Sep-20	
	EIP SUBMITTAL Process	205d	3d	12-May-17 A	15-Nov-18	
STN-10001	Submit EIP Rev 1 & SAPs to TDEC	0d		12-May-17 A		
TVA-10001	TDEC Review of EIP Rev 1 & SAPs	0d		12-May-17 A	31-Aug-17 A	STN-10001
STN-10016	Address TDEC Comments and Submit EIP Rev 2 & SAPs	0d		01-Sep-17 A	09-Nov-17 A	TVA-10001
TVA-10002	TDEC Review of EIP Rev 2 & SAPs	0d		13-Nov-17 A	11-Dec-17 A	STN-10016
STN-10018	Address TDEC Comments and Submit EIP Rev 3 & SAPs	2d	3d	12-Dec-17 A	26-Jan-18	TVA-10002
TVA-10006	TDEC Meets with All Interested Parties	0d	3d		26-Apr-18	STN-10018
TVA-10026	Provide Public Notice of EIP	0d	3d		26-Apr-18	TVA-10006
TVA-10003	Public Comment Period	20d	3d	11-May-18	08-Jun-18	TVA-10026
TVA-10004	Provide TVA Response to Public Comment	20d	3d	11-Jun-18	09-Jul-18	TVA-10003
STN-10008	Revise and Resubmit EIP Rev 3 & SAPs to TDEC	60d	3d	10-Jul-18	02-Oct-18	TVA-10004
TVA-10010	Final EIP Approval	30d	3d	03-Oct-18	15-Nov-18	STN-10008
	(A) SITE INFORMATION	603d	4d	29-Dec-17 A	21-Aug-20	
	A(1) Review Natural Soil Chemistry	200d	153d	16-Nov-18	03-Sep-19	
STN-21010	Execute Background Soil SAP Activities	140d	153d	16-Nov-18	07-Jun-19	TVA-10010
STN-21070	Report Natural Soil Chemistry Evaluation Results in EAR	60d	153d	10-Jun-19	03-Sep-19	STN-21010
	A(2) Environmental Investigation Plan Geologic Maps	60d	293d	16-Nov-18	13-Feb-19	
STN-22010	Information Provided in EIP	0d	293d	16-Nov-18	16-Nov-18	TVA-10010
STN-22020	Discuss Historic Surface Water Features in EAR	60d	293d	16-Nov-18	13-Feb-19	STN-22010
	A(3) Background Groundwater Monitoring Point	10d	343d	16-Nov-18	30-Nov-18	
STN-23060	Information regarding Rye Spring provided in EIP	10d	343d	16-Nov-18	30-Nov-18	TVA-10010
	A(4) Construc. Dsgn of the Original CCR Surface Impound.	120d	233d	16-Nov-18	09-May-19	
STN-24010	Review Existing Construction and Geotechnical Documents	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-24020	Summarize Construction Design Information in EAR	60d	233d	14-Feb-19	09-May-19	STN-24010
	A(5) Construc. Design of the Surface Impoundmnt Divided	120d	233d	16-Nov-18	09-May-19	
STN-25010	Review Existing Construction, Geotechnical, and Inspection Documents	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-25020	Summarize Construction Design Information in EAR	60d	233d	14-Feb-19	09-May-19	STN-25010
	A(6) Gypsum Stack and Sluiced Ash Interface	120d	233d	16-Nov-18	09-May-19	
STN-26010	Review Existing Construction and Geotechnical Documents	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-26020	Summarize Interface As-Built Design Information in EAR	60d	233d	14-Feb-19	09-May-19	STN-26010
	A(7) Dry Ash Stack and Sluiced Ash Interface	120d	233d	16-Nov-18	09-May-19	
STN-27010	Review Existing Construction and Geotechnical Documents	60d	233d	16-Nov-18	13-Feb-19	TVA-10010



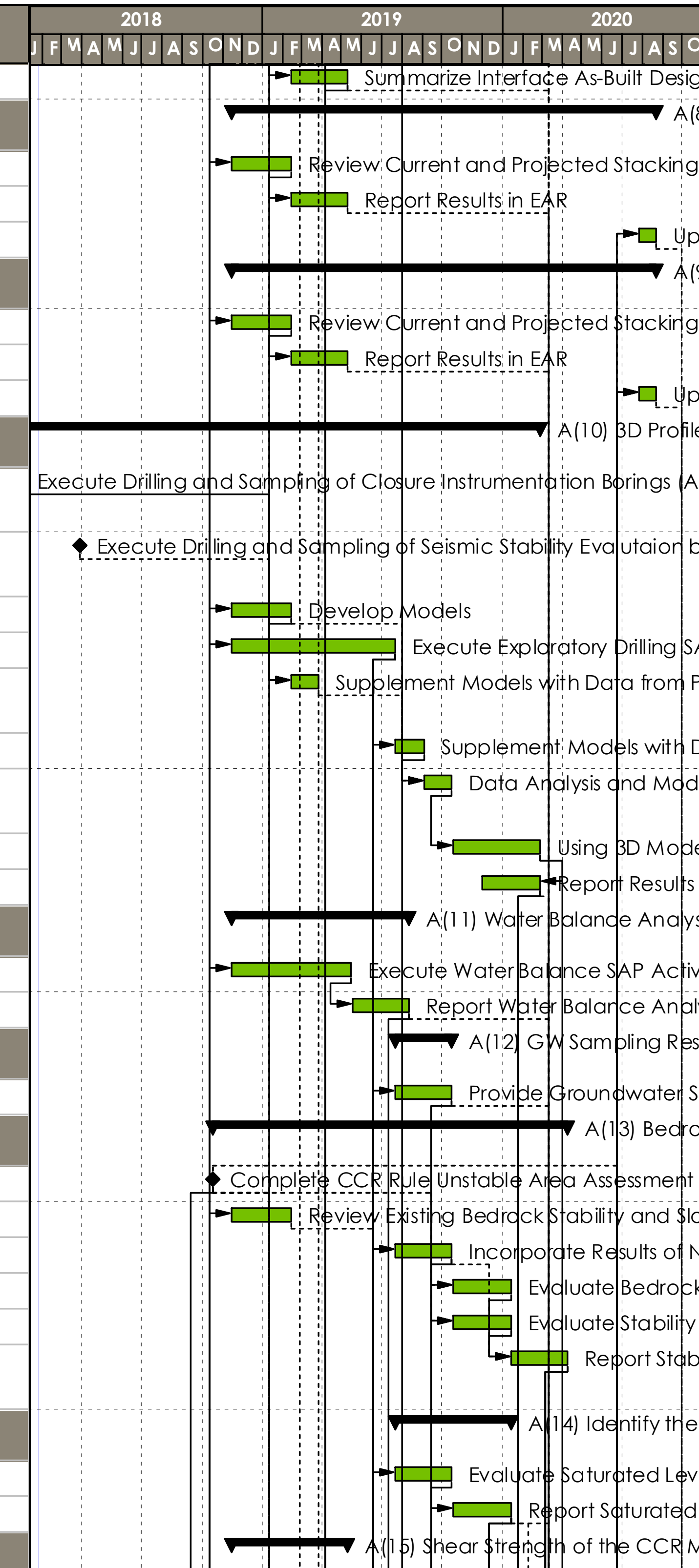
Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

Layout: Earned Value (WBS)

Data Date:25-Jan-18
Print Date:25-Jan-18

ST609489 CUF EIP Implementation Schedule

Activity ID	Activity Name	Remaining Duration	Total Float	Start	Finish	Predecessors
STN-27020	Summarize Interface As-Built Design Information in EAR	60d	233d	14-Feb-19	09-May-19	STN-27010
A(8) Final Elev of the Gypsum Landfill & Projected Dates		444d	4d	16-Nov-18	21-Aug-20	
STN-28010	Review Current and Projected Stacking Plans	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-28020	Report Results in EAR	60d	233d	14-Feb-19	09-May-19	STN-28010
STN-28030	Update Results in EAR (if Required)	20d	4d	27-Jul-20	21-Aug-20	STN-33070, STN-10035
A(9) Final Elev of the CCR Fly Ash & Bottom Ash Landfill		444d	4d	16-Nov-18	21-Aug-20	
STN-29010	Review Current and Projected Stacking Plans	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-29020	Report Results in EAR	60d	233d	14-Feb-19	09-May-19	STN-29010
STN-29030	Update Results in EAR (if Required)	20d	4d	27-Jul-20	21-Aug-20	STN-33070, STN-10035
A(10) 3D Profile of the CCR Units		479d	33d	29-Dec-17 A	27-Feb-20	
STN-30008	Execute Drilling and Sampling of Closure Instrumentation Borings (Approximate Milestones only - Not for TDEC order)	0d			29-Dec-17 A	
STN-30002	Execute Drilling and Sampling of Seismic Stability Evalutaion borings (Approximate Milestones only - Not for TDEC order)	0d	0d		30-Mar-18*	
STN-30020	Develop Models	60d	143d	16-Nov-18	13-Feb-19	TVA-10010
STN-30025	Execute Exploratory Drilling SAP Activities	170d	3d	16-Nov-18	22-Jul-19	TVA-10010
STN-30040	Supplement Models with Data from Proposed Borings for other Ongoing TVA Projects	30d	143d	14-Feb-19	28-Mar-19	STN-30008, STN-30002, STN-30020
STN-30030	Supplement Models with Data from Proposed TDEC Order Borings and Temporary Wells	30d	33d	23-Jul-19	03-Sep-19	STN-30025
STN-30050	Data Analysis and Model Update	30d	33d	04-Sep-19	16-Oct-19	STN-30040, STN-30020, STN-30030
STN-30060	Using 3D Model to Develop Drawings and Complete Volumetric Estimates	90d	33d	17-Oct-19	27-Feb-20	STN-30050
STN-30080	Report Results in EAR	60d	33d	02-Dec-19	27-Feb-20	STN-30060
A(11) Water Balance Analysis for TVA Cumberland Site		185d	168d	16-Nov-18	12-Aug-19	
STN-31010	Execute Water Balance SAP Activities	125d	168d	16-Nov-18	16-May-19	TVA-10010
STN-31070	Report Water Balance Analysis Results in EAR	60d	168d	17-May-19	12-Aug-19	STN-31010
A(12) GW Sampling Results from TVA Cumberland Site		60d	123d	23-Jul-19	16-Oct-19	
STN-32010	Provide Groundwater Sampling Results in EAR	60d	123d	23-Jul-19	16-Oct-19	STN-30025
A(13) Bedrock, Waste, and Side-Slope Berm Stability		370d	3d	17-Oct-18	09-Apr-20	
STN-33070	Complete CCR Rule Unstable Area Assessment (Milestone only - Not for TDEC order)	0d	0d		17-Oct-18*	
STN-33020	Review Existing Bedrock Stability and Slope Stability	60d	113d	16-Nov-18	13-Feb-19	TVA-10010
STN-33030	Incorporate Results of New Drilling and Sampling	60d	3d	23-Jul-19	16-Oct-19	STN-33020, STN-30025
STN-33050	Evaluate Bedrock Stability	60d	3d	17-Oct-19	14-Jan-20	STN-33030, STN-33070
STN-33060	Evaluate Stability of Waste and Berms	60d	3d	17-Oct-19	14-Jan-20	STN-33030, STN-33070
STN-33040	Report Stability Results in EAR	60d	3d	15-Jan-20	09-Apr-20	STN-33030, STN-33050, STN-33060
A(14) Identify the Current Groundwater Surface Elev		120d	23d	23-Jul-19	14-Jan-20	
STN-34010	Evaluate Saturated Levels within CCR Units	60d	23d	23-Jul-19	16-Oct-19	STN-30025
STN-34020	Report Saturated Levels Results in EAR	60d	23d	17-Oct-19	14-Jan-20	STN-34010
A(15) Shear Strength of the CCR Materials		120d	233d	16-Nov-18	09-May-19	



Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | Milestone

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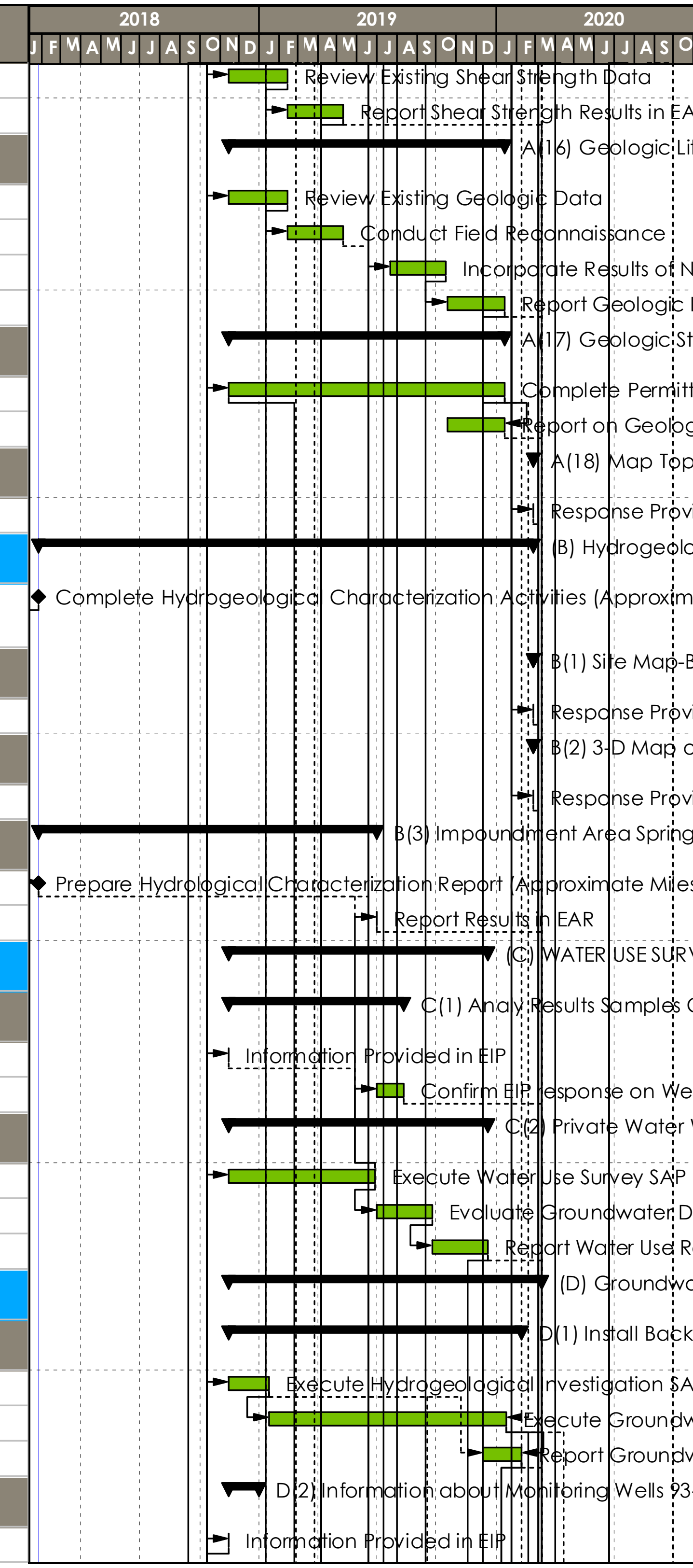
Activity ID	Activity Name	Remaining Duration	Total Float	Start	Finish	Predecessors
STN-35010	Review Existing Shear Strength Data	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-35020	Report Shear Strength Results in EAR	60d	233d	14-Feb-19	09-May-19	STN-35010, STN-33070
A(16) Geologic Lithology		290d	63d	16-Nov-18	14-Jan-20	
STN-36020	Review Existing Geologic Data	60d	113d	16-Nov-18	13-Feb-19	TVA-10010
STN-36050	Conduct Field Reconnaissance	60d	113d	14-Feb-19	09-May-19	STN-36020
STN-36030	Incorporate Results of New Drilling and Sampling	60d	63d	23-Jul-19	16-Oct-19	STN-30025, STN-36050
STN-36040	Report Geologic Lithology Results in EAR	60d	63d	17-Oct-19	14-Jan-20	STN-36030
A(17) Geologic Struc. below TVA Cumberland Plant		290d	63d	16-Nov-18	14-Jan-20	
STN-36080	Complete Permitting, Capital Projects, and Ongoing Hydrogeological Studies	290d	47d	16-Nov-18	14-Jan-20	TVA-10010
STN-36100	Report on Geologic Structure in EAR	60d	63d	17-Oct-19	14-Jan-20	STN-36080
A(18) Map Top of Bedrock/Overlying Material		0d	33d	28-Feb-20	28-Feb-20	
STN-36090	Response Provided under A(10)	0d	33d	28-Feb-20	28-Feb-20	STN-30080
(B) Hydrogeological Report		525d	33d	25-Jan-18	28-Feb-20	
STN-37000	Complete Hydrogeological Characterization Activities (Approximate Milestones Only - not for TDEC Order)	0d	498d		25-Jan-18*	
B(1) Site Map-Bedrock Contours-Ponds, Impound, Landfill		0d	33d	28-Feb-20	28-Feb-20	
STN-37010	Response Provided under A(10)	0d	33d	28-Feb-20	28-Feb-20	STN-30080
B(2) 3-D Map of Impoundment/Landfill Clay Thickness		0d	33d	28-Feb-20	28-Feb-20	
STN-38010	Response Provided under A(10)	0d	33d	28-Feb-20	28-Feb-20	STN-30080
B(3) Impoundment Area Springs Impact		360d	198d	25-Jan-18	01-Jul-19	
STN-38050	Prepare Hydrological Characterization Report (Approximate Milestones Only - not for TDEC Order)	0d	498d		25-Jan-18	STN-37000
STN-38060	Report Results in EAR	0d	198d	01-Jul-19	01-Jul-19	STN-39010, STN-38050
(C) WATER USE SURVEY		275d	78d	16-Nov-18	20-Dec-19	
C(1) Analy Results Samples Collected from Water Well		185d	168d	16-Nov-18	12-Aug-19	
STN-38070	Information Provided in EIP	0d	323d	16-Nov-18	16-Nov-18	TVA-10010
STN-38080	Confirm EIP response on Well in EAR	30d	168d	01-Jul-19	12-Aug-19	STN-39010, STN-38070
C(2) Private Water Well Survey		275d	78d	16-Nov-18	20-Dec-19	
STN-39010	Execute Water Use Survey SAP Activities	155d	78d	16-Nov-18	28-Jun-19	TVA-10010
STN-39060	Evaluate Groundwater Data	60d	78d	01-Jul-19	24-Sep-19	STN-39010
STN-39070	Report Water Use Results in EAR	60d	78d	25-Sep-19	20-Dec-19	STN-39060
(D) Groundwater Monitoring		330d	23d	16-Nov-18	12-Mar-20	
D(1) Install Background GW Monitoring Well(s)		308d	45d	16-Nov-18	10-Feb-20	
STN-41010	Execute Hydrogeological Investigation SAP Activities	40d	45d	16-Nov-18	15-Jan-19	TVA-10010
STN-41080	Execute Groundwater Investigation SAP Activities	252d	45d	16-Jan-19	16-Jan-20	STN-41010, STN-36080
STN-41070	Report Groundwater Sampling Results in EAR	40d	45d	12-Dec-19	10-Feb-20	STN-41010, STN-41080
D(2) Information about Monitoring Wells 93-2 & 93-2R		30d	323d	16-Nov-18	31-Dec-18	
STN-42010	Information Provided in EIP	0d	323d	16-Nov-18	16-Nov-18	TVA-10010



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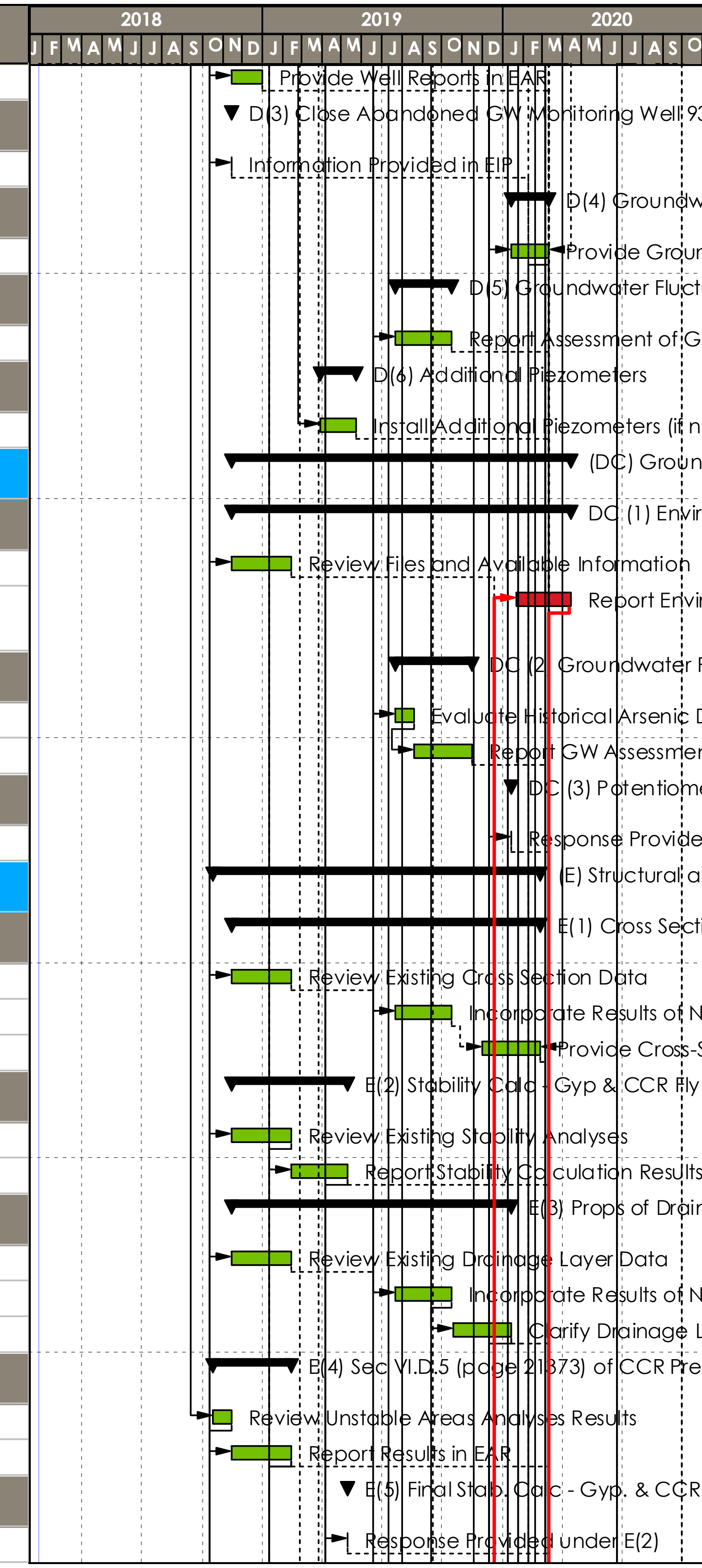
Activity ID	Activity Name	Remaining Duration	Total Float	Start	Finish	Predecessors
STN-42020	Provide Well Reports in EAR	30d	323d	16-Nov-18	31-Dec-18	STN-42010
D(3) Close Abandoned GW Monitoring Well 93-2		0d	353d	16-Nov-18	16-Nov-18	
STN-43010	Information Provided in EIP	0d	353d	16-Nov-18	16-Nov-18	TVA-10010
D(4) Groundwater Potentiometric Surface Map		40d	23d	15-Jan-20	12-Mar-20	
STN-44010	Provide Groundwater Potentiometric Maps in EAR	40d	23d	15-Jan-20	12-Mar-20	STN-34020, STN-41080
D(5) Groundwater Fluctuations		60d	123d	23-Jul-19	16-Oct-19	
STN-45010	Report Assessment of GW Fluctuations in EAR	60d	123d	23-Jul-19	16-Oct-19	STN-38050, STN-30025
D(6) Additional Piezometers		40d	223d	29-Mar-19	23-May-19	
STN-46040	Install Additional Piezometers (if needed)	40d	223d	29-Mar-19	23-May-19	STN-36080
(DC) Groundwater - Chemical & Physical Properties		353d	0d	16-Nov-18	14-Apr-20	
DC (1) Environmental Impacts		353d	0d	16-Nov-18	14-Apr-20	
STN-47010	Review Files and Available Information	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-47070	Report Environmental Impact Assessment Results in EAR	60d	0d	21-Jan-20	14-Apr-20	STN-47010, STN-92010, STN-95110
DC (2) Groundwater Protection Standard		80d	103d	23-Jul-19	14-Nov-19	
STN-48030	Evaluate Historical Arsenic Data	20d	103d	23-Jul-19	19-Aug-19	STN-41010, STN-30025
STN-48040	Report GW Assessment Results in EAR	60d	103d	20-Aug-19	14-Nov-19	STN-48030
DC (3) Potentiometric Surface		0d	63d	15-Jan-20	15-Jan-20	
STN-49010	Response Provided under A(14)	0d	63d	15-Jan-20	15-Jan-20	STN-34020
(E) Structural and Seismic Stability		340d	33d	18-Oct-18	27-Feb-20	
E(1) Cross Section(s) for Ash and Gypsum Stack		320d	33d	16-Nov-18	27-Feb-20	
STN-51020	Review Existing Cross Section Data	60d	173d	16-Nov-18	13-Feb-19	TVA-10010
STN-51030	Incorporate Results of New Drilling and Sampling	60d	63d	23-Jul-19	16-Oct-19	STN-51020, STN-30025
STN-51040	Provide Cross-Sections in EAR	60d	33d	02-Dec-19	27-Feb-20	STN-51030, STN-30060
E(2) Stability Calc - Gyp & CCR Fly Ash/BA Landfills		120d	233d	16-Nov-18	09-May-19	
STN-52020	Review Existing Stability Analyses	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-52030	Report Stability Calculation Results in EAR	60d	233d	14-Feb-19	09-May-19	STN-52020, STN-33070
E(3) Props of Drainage Layer Below Dry CCR Ash Stack		290d	63d	16-Nov-18	14-Jan-20	
STN-53020	Review Existing Drainage Layer Data	60d	173d	16-Nov-18	13-Feb-19	TVA-10010
STN-53030	Incorporate Results of New Drilling and Sampling	60d	63d	23-Jul-19	16-Oct-19	STN-53020, STN-30025
STN-53040	Clarify Drainage Layer in EAR	60d	63d	17-Oct-19	14-Jan-20	STN-53030
E(4) Sec VI.D.5 (page 21373) of CCR Preamble (Overfill)		80d	293d	18-Oct-18	13-Feb-19	
STN-54030	Review Unstable Areas Analyses Results	20d	293d	18-Oct-18	15-Nov-18	STN-33070
STN-54040	Report Results in EAR	60d	293d	16-Nov-18	13-Feb-19	STN-54030
E(5) Final Stab. Calc - Gyp. & CCR Fly Ash/BA Landfills		0d	233d	10-May-19	10-May-19	
STN-55010	Response Provided under E(2)	0d	233d	10-May-19	10-May-19	STN-52030



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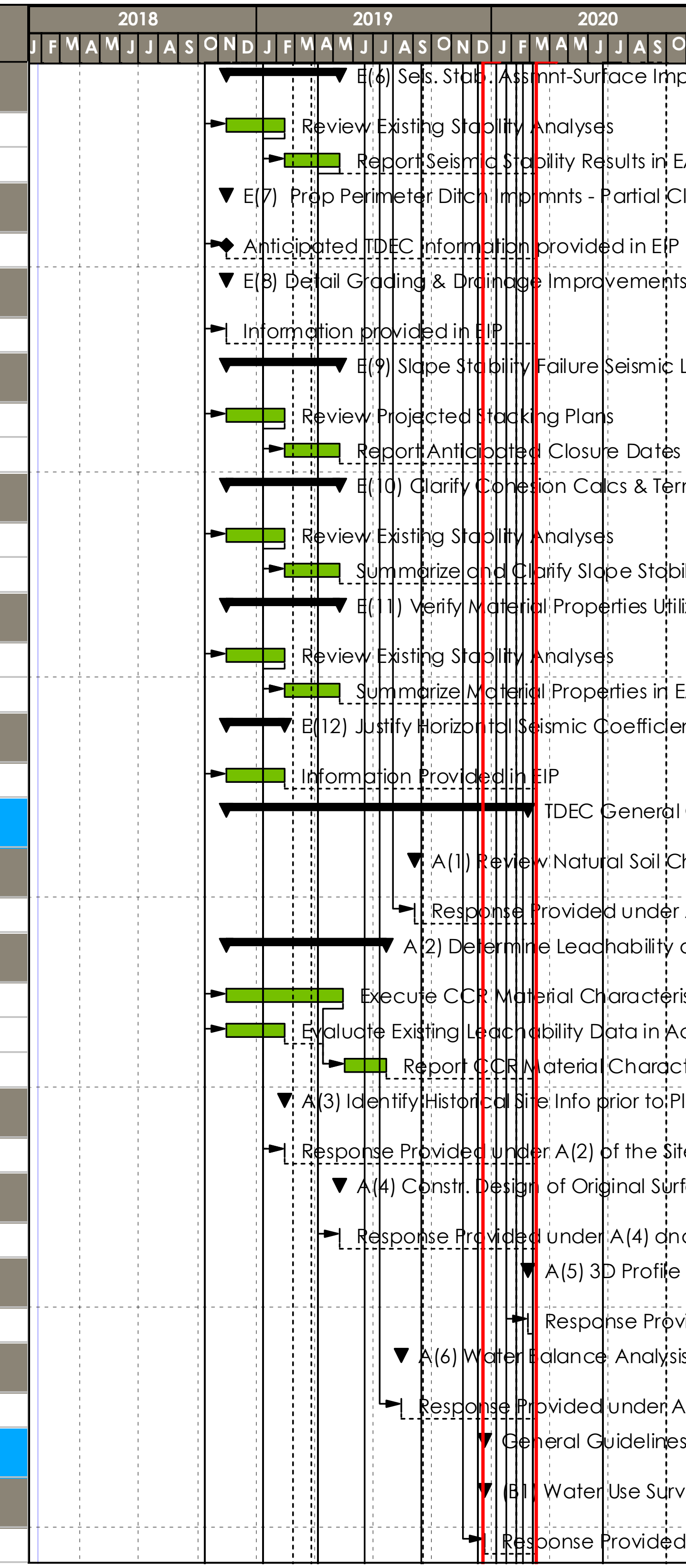
	E(6) Seis. Stab. Assmnt-Surface Impoundmt & Landfill	120d	233d	16-Nov-18	09-May-19	
STN-56030	Review Existing Stability Analyses	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-56040	Report Seismic Stability Results in EAR	60d	233d	14-Feb-19	09-May-19	STN-56030, STN-33070
	E(7) Prop Perimeter Ditch Imprmnts - Partial Clos. Plan	0d	353d	16-Nov-18	16-Nov-18	
STN-57030	Anticipated TDEC Information provided in EIP	0d	353d	16-Nov-18		TVA-10010
	E(8) Detail Grading & Drainage Improvements Plan	0d	353d	16-Nov-18	16-Nov-18	
STN-58010	Information provided in EIP	0d	353d	16-Nov-18	16-Nov-18	TVA-10010
	E(9) Slope Stability Failure Seismic Loading Questions	120d	233d	16-Nov-18	09-May-19	
STN-59030	Review Projected Stacking Plans	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-59040	Report Anticipated Closure Dates and Stacking Plans in EAR	60d	233d	14-Feb-19	09-May-19	STN-59030
	E(10) Clarify Cohesion Calcs & Terminology	120d	233d	16-Nov-18	09-May-19	
STN-60030	Review Existing Stability Analyses	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-60040	Summarize and Clarify Slope Stability Assessment in EAR	60d	233d	14-Feb-19	09-May-19	STN-60030, STN-33070
	E(11) Verify Material Properties Utilized in Stability Calc.	120d	233d	16-Nov-18	09-May-19	
STN-61030	Review Existing Stability Analyses	60d	233d	16-Nov-18	13-Feb-19	TVA-10010
STN-61040	Summarize Material Properties in EAR	60d	233d	14-Feb-19	09-May-19	STN-61030, STN-33070
	E(12) Justify Horizontal Seismic Coefficient of 0.083g	60d	293d	16-Nov-18	13-Feb-19	
STN-62030	Information Provided in EIP	60d	293d	16-Nov-18	13-Feb-19	TVA-10010
	TDEC General Guidelines - (A) Site Information	320d	33d	16-Nov-18	28-Feb-20	
	A(1) Review Natural Soil Chemistry	0d	153d	04-Sep-19	04-Sep-19	
STN-71010	Response Provided under A(1) of the Site-Specific EIP Request	0d	153d	04-Sep-19	04-Sep-19	STN-21070
	A(2) Determine Leachability of CCR constituents	170d	183d	16-Nov-18	22-Jul-19	
STN-72010	Execute CCR Material Characteristics SAP Activities	125d	183d	16-Nov-18	16-May-19	TVA-10010
STN-72080	Evaluate Existing Leachability Data in Accordance with QAPP	60d	248d	16-Nov-18	13-Feb-19	TVA-10010
STN-72070	Report CCR Material Characteristics Results in EAR	45d	183d	17-May-19	22-Jul-19	STN-72010, STN-72080
	A(3) Identify Historical Site Info prior to Plant Construc.	0d	293d	14-Feb-19	14-Feb-19	
STN-73010	Response Provided under A(2) of the Site-Specific EIP Request	0d	293d	14-Feb-19	14-Feb-19	STN-22010, STN-22020
	A(4) Constr. Design of Original Surface Impoundments	0d	233d	10-May-19	10-May-19	
STN-74010	Response Provided under A(4) and A(5) of the Site-Specific EIP Request	0d	233d	10-May-19	10-May-19	STN-24020
	A(5) 3D Profile of the CCR Units	0d	33d	28-Feb-20	28-Feb-20	
STN-75010	Response Provided under A(10) of the Site-Specific EIP Request	0d	33d	28-Feb-20	28-Feb-20	STN-30080
	A(6) Water Balance Analysis of Active Impoundments	0d	168d	13-Aug-19	13-Aug-19	
STN-76010	Response Provided under A(11) of the Site-Specific EIP Request	0d	168d	13-Aug-19	13-Aug-19	STN-31070
	General Guidelines - (B) Water Use Survey	0d	78d	23-Dec-19	23-Dec-19	
	(B1) Water Use Survey	0d	78d	23-Dec-19	23-Dec-19	
STN-77010	Response Provided under C(2) of the Site-Specific EIP Request	0d	78d	23-Dec-19	23-Dec-19	STN-39070



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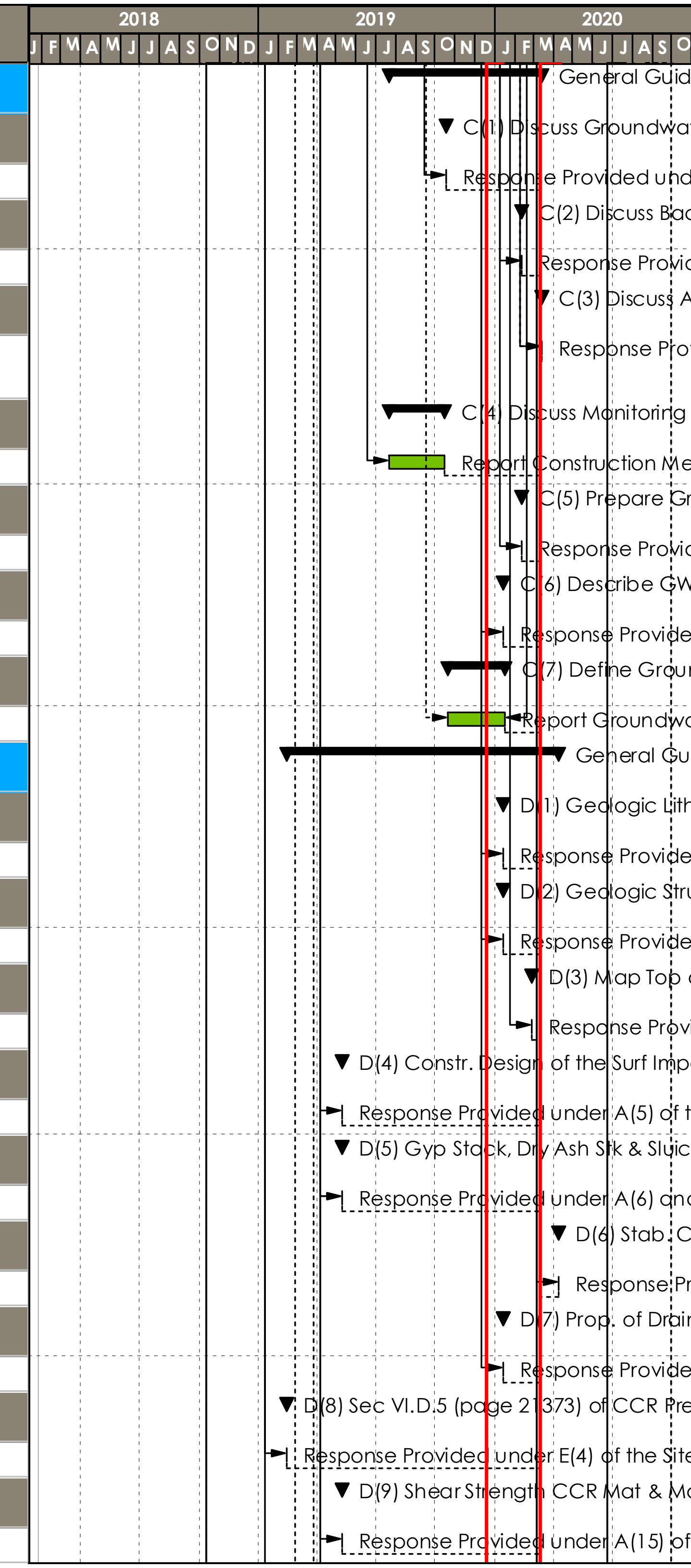
General Guidelines - (C) GW Monitoring Mapping		160d	23d	23-Jul-19	13-Mar-20	
C(1) Discuss Groundwater Monitoring Wells		0d	123d	17-Oct-19	17-Oct-19	
STN-81010	Response Provided under A(12) of the Site-Specific EIP Request	0d	123d	17-Oct-19	17-Oct-19	STN-32010
C(2) Discuss Background GW Monitoring Wells		0d	45d	11-Feb-20	11-Feb-20	
STN-82010	Response Provided under D(1) of the Site-Specific EIP Request	0d	45d	11-Feb-20	11-Feb-20	STN-41070
C(3) Discuss Additional GW Monitoring Wells		0d	23d	13-Mar-20	13-Mar-20	
STN-83010	Response Provided under A(14), D(4), D(3) of the Site-Specific EIP Request	0d	23d	13-Mar-20	13-Mar-20	STN-44010, STN-43010, STN-34020
C(4) Discuss Monitoring Well Construction Methods		60d	123d	23-Jul-19	16-Oct-19	
STN-84030	Report Construction Methods in EAR	60d	123d	23-Jul-19	16-Oct-19	STN-30025
C(5) Prepare Groundwater Monitoring Plan		0d	45d	11-Feb-20	11-Feb-20	
STN-85010	Response Provided under D(1) of the Site-Specific EIP Request	0d	45d	11-Feb-20	11-Feb-20	STN-41070
C(6) Describe GW Surface Elevation under Landfill		0d	63d	15-Jan-20	15-Jan-20	
STN-86010	Response Provided under A(14) of the Site-Specific EIP Request	0d	63d	15-Jan-20	15-Jan-20	STN-34020
C(7) Define Groundwater Contaminant Plumes		60d	61d	21-Oct-19	16-Jan-20	
STN-87010	Report Groundwater Monitoring Results in EAR	60d	61d	21-Oct-19	16-Jan-20	STN-41010, STN-41080
General Guidelines - (D) TVA Site Conditions		290d	3d	14-Feb-19	10-Apr-20	
D(1) Geologic Lithology		0d	63d	15-Jan-20	15-Jan-20	
STN-88010	Response Provided under A(16) of the Site-Specific EIP Request	0d	63d	15-Jan-20	15-Jan-20	STN-36040
D(2) Geologic Structure below the TVA Cumberland Plant		0d	63d	15-Jan-20	15-Jan-20	
STN-88110	Response Provided under A(17) of the Site-Specific EIP Request	0d	63d	15-Jan-20	15-Jan-20	STN-36080
D(3) Map Top of Bedrock/Overlying Material		0d	33d	28-Feb-20	28-Feb-20	
STN-88210	Response Provided under A(10) of the Site-Specific EIP Request	0d	33d	28-Feb-20	28-Feb-20	STN-30080
D(4) Constr. Design of the Surf Impoundments Divided		0d	233d	10-May-19	10-May-19	
STN-88310	Response Provided under A(5) of the Site-Specific EIP Request	0d	233d	10-May-19	10-May-19	STN-25020
D(5) Gyp Stack, Dry Ash Stk & Sluiced Ash Interfaces		0d	233d	10-May-19	10-May-19	
STN-88410	Response Provided under A(6) and A(7) of the Site-Specific EIP Request	0d	233d	10-May-19	10-May-19	STN-26020, STN-27020
D(6) Stab. Calcs: Gypsum & CCR FA/Bot Ash Landfills		0d	3d	10-Apr-20	10-Apr-20	
STN-88510	Response Provided under A(13) of the Site-Specific EIP Request	0d	3d	10-Apr-20	10-Apr-20	STN-33040
D(7) Prop. of Drainage Layer Below Dry CCR Ash Stack		0d	63d	15-Jan-20	15-Jan-20	
STN-88610	Response Provided under E(3) of the Site-Specific EIP Request	0d	63d	15-Jan-20	15-Jan-20	STN-53040
D(8) Sec VI.D.5 (page 21373) of CCR Preamble (Overfill)		0d	293d	14-Feb-19	14-Feb-19	
STN-88710	Response Provided under E(4) of the Site-Specific EIP Request	0d	293d	14-Feb-19	14-Feb-19	STN-54040
D(9) Shear Strength CCR Mat & Mat. Prop Utilized Stab Cal		0d	233d	10-May-19	10-May-19	
STN-88810	Response Provided under A(15) of the Site-Specific EIP Request	0d	233d	10-May-19	10-May-19	STN-35020



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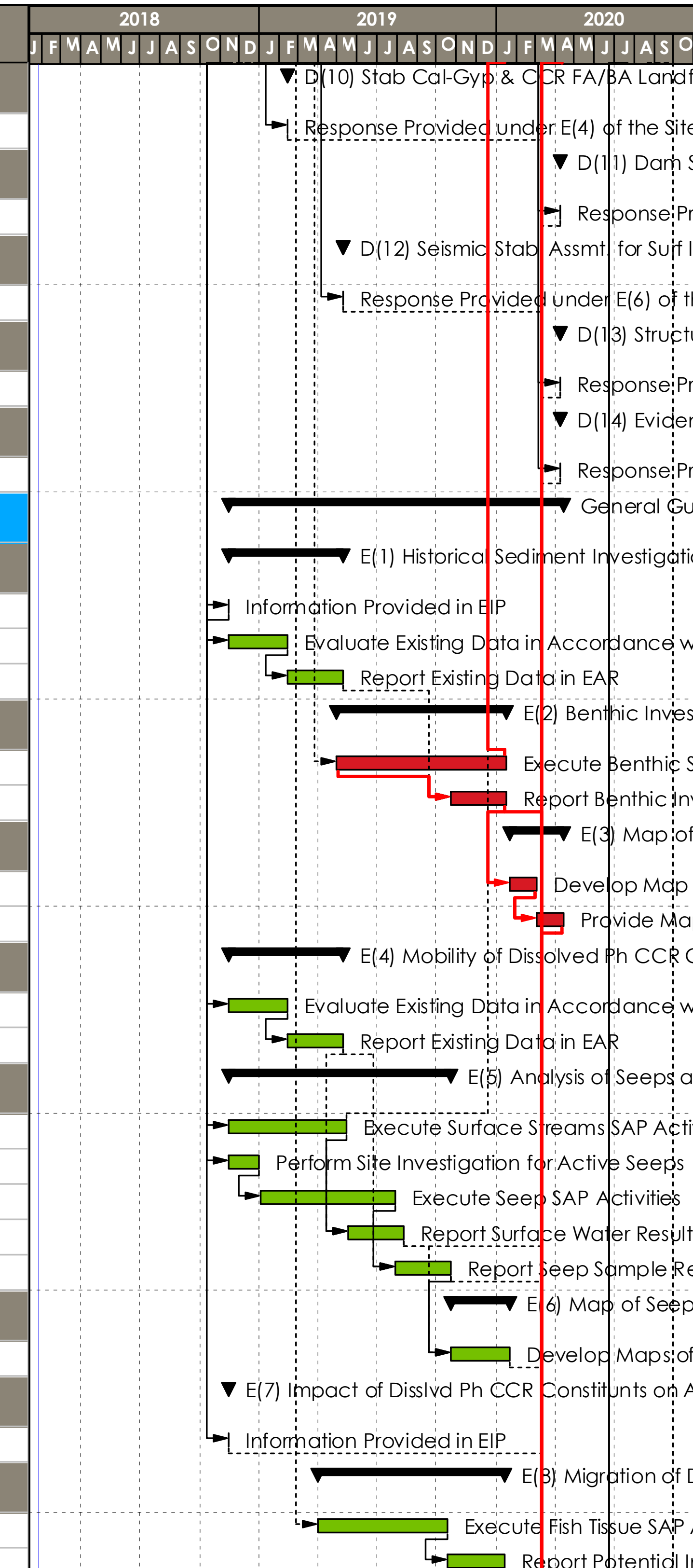
D(10) Stab Cal-Gyp & CCR FA/BA Landfills,Seis Stab Asmt.		0d	293d	14-Feb-19	14-Feb-19	
STN-88910	Response Provided under E(4) of the Site-Specific EIP Request	0d	293d	14-Feb-19	14-Feb-19	STN-54040
D(11) Dam Safety Analyses		0d	3d	10-Apr-20	10-Apr-20	
STN-89010	Response Provided under A(13) of the Site-Specific EIP Request	0d	3d	10-Apr-20	10-Apr-20	STN-33040
D(12) Seismic Stab. Assmt. for Surf Impound & Landfill		0d	233d	10-May-19	10-May-19	
STN-89110	Response Provided under E(6) of the Site-Specific EIP Request	0d	233d	10-May-19	10-May-19	STN-56040
D(13) Structural Integrity of CCR Disposal Area		0d	3d	10-Apr-20	10-Apr-20	
STN-89210	Response Provided under A(13) of the Site-Specific EIP Request	0d	3d	10-Apr-20	10-Apr-20	STN-33040
D(14) Evidence of Bedrock, Waste, Side-Slope Berm Stab		0d	3d	10-Apr-20	10-Apr-20	
STN-89310	Response Provided under A(13) of the Site-Specific EIP Request	0d	3d	10-Apr-20	10-Apr-20	STN-33040
General Guidelines - (E) Surface Water Impacts		353d	0d	16-Nov-18	14-Apr-20	
E(1) Historical Sediment Investigation		120d	113d	16-Nov-18	09-May-19	
STN-91040	Information Provided in EIP	0d	113d	16-Nov-18	16-Nov-18	TVA-10010
STN-91050	Evaluate Existing Data in Accordance with QAPP	60d	113d	16-Nov-18	13-Feb-19	STN-91040
STN-91060	Report Existing Data in EAR	60d	113d	14-Feb-19	09-May-19	STN-91050
E(2) Benthic Investigation		180d	0d	01-May-19	17-Jan-20	
STN-92010	Execute Benthic SAP Activities	180d	0d	01-May-19*	17-Jan-20	TVA-10010
STN-92070	Report Benthic Investigation Results in EAR	60d	0d	22-Oct-19	17-Jan-20	STN-92010, STN-91060
E(3) Map of CCR Materials on Streambed		60d	0d	21-Jan-20	14-Apr-20	
STN-93010	Develop Map and Estimate of CCR on Streambed	30d	0d	21-Jan-20	03-Mar-20	STN-92070
STN-93020	Provide Map and Volume Estimate in EAR	30d	0d	04-Mar-20	14-Apr-20	STN-93010
E(4) Mobility of Dissolved Ph CCR Constituents to Surf. Wtr		120d	113d	16-Nov-18	09-May-19	
STN-94010	Evaluate Existing Data in Accordance with QAPP	60d	113d	16-Nov-18	13-Feb-19	TVA-10010
STN-94020	Report Existing Data in EAR	60d	113d	14-Feb-19	09-May-19	STN-94010
E(5) Analysis of Seeps and Surface Streams		235d	58d	16-Nov-18	23-Oct-19	
STN-95110	Execute Surface Streams SAP Activities	125d	108d	16-Nov-18	16-May-19	TVA-10010
STN-95030	Perform Site Investigation for Active Seeps	30d	58d	16-Nov-18	31-Dec-18	TVA-10010
STN-95010	Execute Seep SAP Activities	145d	58d	02-Jan-19	29-Jul-19	STN-95030
STN-95220	Report Surface Water Results in EAR	60d	108d	17-May-19	12-Aug-19	STN-95110, STN-94020
STN-95020	Report Seep Sample Results in EAR	60d	58d	30-Jul-19	23-Oct-19	STN-95010, STN-94020
E(6) Map of Seep and Stream Sampling Points		60d	58d	24-Oct-19	22-Jan-20	
STN-96010	Develop Maps of Sample Results and present in EAR	60d	58d	24-Oct-19	22-Jan-20	STN-95220, STN-95020
E(7) Impact of Disslvd Ph CCR Constituents on Aquat. Life		0d	353d	16-Nov-18	16-Nov-18	
STN-97040	Information Provided in EIP	0d	353d	16-Nov-18	16-Nov-18	TVA-10010
E(8) Migration of Dissolved Ph CCR Consts in Surf & GW		200d	62d	01-Apr-19	15-Jan-20	
STN-98010	Execute Fish Tissue SAP Activities	140d	62d	01-Apr-19*	17-Oct-19	TVA-10010
STN-98020	Report Potential Impact on Aquatic Life in EAR	60d	62d	18-Oct-19	15-Jan-20	STN-98010



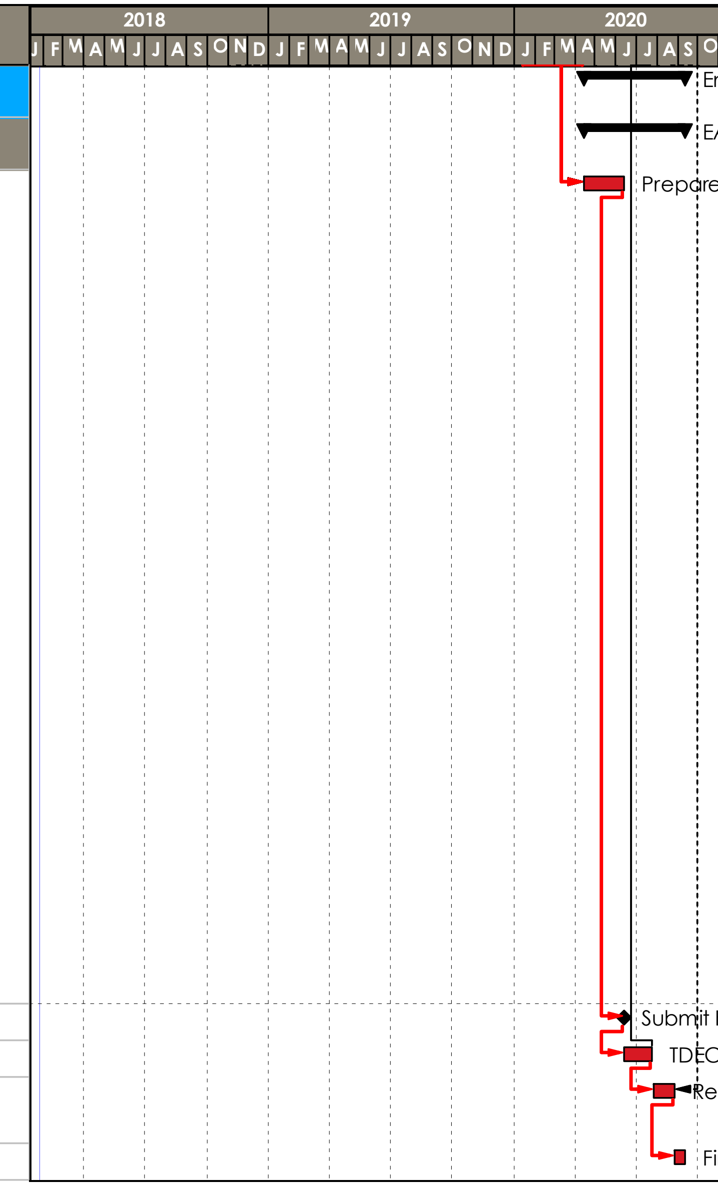
Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

Layout: Earned Value (WBS)

Data Date:25-Jan-18
Print Date:25-Jan-18

ST609489 CUF EIP Implementation Schedule

Activity ID	Activity Name	Remaining Duration	Total Float	Start	Finish	Predecessors
Environmental Assessment Report		105d	0d	15-Apr-20	11-Sep-20	
EAR Submittal Process		105d	0d	15-Apr-20	11-Sep-20	
STN-10015	Prepare EAR	41d	0d	15-Apr-20	11-Jun-20	STN-21070, STN-45010, STN-24020, TVA-10010, STN-25020, STN-26020, STN-27020, STN-28020, STN-29020, STN-30080, STN-31070, STN-33040, STN-35020, STN-36040, STN-39070, STN-41070, STN-48040, STN-52030, STN-54040, STN-56040, STN-59040, STN-60040, STN-61040, STN-72070, STN-84030, STN-92070, STN-95020, STN-95220, STN-32010, STN-34020, STN-38060, STN-47070, STN-53040, STN-36090, STN-37010, STN-38010, STN-44010, STN-49010, STN-55010, STN-71010, STN-73010, STN-74010, STN-75010, STN-76010, STN-77010, STN-81010, STN-82010, STN-83010, STN-86010, STN-87010, STN-88010, STN-88110, STN-88210, STN-88310, STN-88410, STN-88510, STN-88610, STN-88710, STN-88810, STN-88910, STN-89010, STN-89110, STN-89210, STN-89310, STN-96010, STN-22020, STN-38080, STN-42020, STN-62030, STN-93020, STN-97040, STN-85010, STN-51040, STN-46040, STN-36100, STN-98020, STN-23060, STN-57030, STN-58010
STN-10025	Submit EAR to TDEC	0d	0d		11-Jun-20	STN-10015
STN-10035	TDEC Review of EAR	30d	0d	12-Jun-20	24-Jul-20	STN-10025
STN-10045	Revise and Resubmit EAR to TDEC	24d	0d	27-Jul-20	27-Aug-20	STN-10035, STN-28030, STN-29030
STN-10075	Final Approval of EAR	10d	0d	28-Aug-20	11-Sep-20	STN-10045



Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | Milestone

Data Date:25-Jan-18
Print Date:25-Jan-18

APPENDIX B
REGULATORY CORRESPONDENCE

ATM 8/18/05

N.E.F.O. files

ENVIRONMENTAL ASSISTANCE CENTER
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
711 R. S. GASS BOULEVARD
NASHVILLE, TENNESSEE 37243
PHONE (615) 687-7000 STATEWIDE 1-888-891-8332 FAX (615) 687-7078

August 9, 2005
Mr. Gordon G. Park
Manager, Environmental Affairs
5D Lookout Place
1101 Market Street
Chattanooga, TN 37402 – 2801

Attn: Mr. Amos Smith

RE Cumberland City Fossil Plant
Monitor Well 93-2 Replacement
IDL 81-102-0086

Dear Mr. Park,

On August 9, 2005, the Division of Solid Waste Management (Division) received an e-mail regarding the replacement of monitor well 93-2 (MW 93-2) at TVA's Cumberland Fossil Plant (see attachment). Please consider this letter an approval for the planned replacement of MW 93-2 with MW 93-2R.

The in-field operation of installing a monitor well at the Cumberland Fossil Plant will include drilling to the point of establishing a viable source of water to monitor from. Two methods of drilling are used in different environments, depending on the competency and other aspects of the local bedrock. Where bedrock is dense and competent, borings are usually cast and compressed air is used for cooling the drilling tools. Where bedrock is more conductive of water, cores are usually extracted from the bedrock and water is used to cool the drilling tools.

Both drilling methods mentioned above have inherent advantages that allow for making decisions about how the monitor well will be constructed. In the case of Cumberland Fossil Plant, the underlying bedrock is very conductive and hosts extremely irregular structural properties. For this reason and others, it is suggested that water assisted coring be used, instead of air assisted boring.

After MW 93-2R has been developed enough, it will be necessary to extract samples from MW 93-2 and MW 93-2R during the same sampling event. The analysis results of these samples will be reviewed and the Division will determine if it is appropriate to abandon MW 93-2.

If you or your staff has any questions concerning this or other groundwater issues please call me at (615) 687-7107.

Sincerely,

Alan D. Spear, P.G.

Alan D. Spear, P.G.
Geologist
Division of Solid Waste Management

cc:

Mr. Glen Pugh, Manager, Division of Solid Waste Management, Central Office
Mr. Jeff Norman, Manager, Division of Solid Waste Management, Central Office
Mr. Al majors, Manager, Division Solid Waste Management, Nashville EFO
Mr. Lennie Fottrell, Manager, Division Solid Waste Management, Nashville EFO

A60 110414 512

Env. Document Type:
Solid Waste Correspondence

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
NASHVILLE ENVIRONMENTAL FIELD OFFICE
711 R. S. GASS BOULEVARD
NASHVILLE, TENNESSEE 37243
PHONE (615) 687-7000 STATEWIDE 1-888-891-8332 FAX (615) 687-7078

April 7, 2011

Mr. Gordon G. Park
Manager, Environmental Affairs
5D Lookout Place
1101 Market Street
Chattanooga, TN 37402 – 2801

Attn: Ms. Ronda Hooper

RE: Cumberland Fossil Plant
Replacement Monitor Well
IDL 81-102-0086

Dear Mr. Park,

On March 10, 2010, the Division of Solid Waste Management (Division) approved a ground water monitoring plan that had been built by TVA for the Cumberland Fossil Plant Landfill (IDL 81-102-0086). Currently, TVA is making efforts to build an assessment for groundwater contamination plan for the same facility. During the development of the monitoring and assessment plans TVA personnel and personnel from the Division have met and corresponded about many issues related to these plans.

One of the groundwater monitoring issues has been about approving the replacement monitor well for CAF-93-2. TVA personnel originally approached the Division about replacing CAF-93-2 because of its location and that it may have been placed in waste.

Analyses results of groundwater samples from CAF-93-2R (the replacement well) appear to be similar to those of CAF-93-2 at this time. Please let this letter serve as notice that the Division approves the replacement of monitor well CAF-93-2 with CAF-93-2R.

xc: C. M. Anderson, LP 5D-C
J. M. Boggs, WT 9A-K
L. C. Diamond, LP 5U-C
C. S. McCarty, CUF 1A-CCT
L. L. Sheffey, LP 5D-C
M. G. Tritapoe, LP 5D-C
Reading File, LP 5D-C

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APR 14 2011

As with any monitor well taken out of service, CAF-93-2 can be kept intact if TVA has any reason to keep it available for use at another time. Otherwise, CAF-93-2 must be abandoned properly per Solid Waste Processing and Disposal Regulations Rule 1200-1-7-.02(c)(ii)(XII).

If you have any questions concerning this letter, please contact me at (615) 687-7107.

Sincerely,

Alan D. Spear

Alan D. Spear, P.G.
Geologist
Division of Solid Waste Management

cc: Glen Pugh, Manager, Solid Waste Section, Central Office
Jeff Norman, Manager, Technical Section, Central Office
Al Majors, Manager, Nashville Field Office
Lennie Fottrell, Manager, Nashville Field Office

Charles L. Head, Senior Advisor
2nd Floor TN Tower, W.R. Snodgrass Building
312 Rosa L. Parks Avenue
Nashville, TN 37243615 532-0998
e-mail: chuck.head@state.tn.us

January 13, 2017
Paul J. Pearman
Tennessee Valley Authority
1101 Market Street, MR 4K
Chattanooga, TN 37402

RE: TDEC Commissioner's Order OGC 15-1077
TVA Cumberland Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Comments
Revised TVA Cumberland Environmental Investigation Plan
Due Date - March 31, 2017

Dear Mr. Pearman:

The Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order OGC 15-0177 (the Order") to the Tennessee Valley Authority (TVA) that required TVA action at seven TVA Coal Fired Fossil Power Plants (active and inactive) located in Tennessee. The Order was signed on August 6, 2015 and included information about TVA's right to appeal the Order. TVA did not appeal the Order and it is now final.

The Order required TVA to perform environmental investigations and to take appropriate corrective action at seven TVA Coal Fossil Power Plants (CCR sites) in Tennessee. The Order is specific to Coal Combustion Residual (CCR) material. Paragraph VII. of the Order provides the sequence of events for environmental investigation at a TVA CCR site as presented below.

1. TVA and TDEC are required to schedule and conduct an initial meeting to discuss each CCR site. At each CCR site meeting, TVA provides the operational history of the CCR site, all geological and hydrogeological information currently available, results of environmental investigations and sampling, etc. This is basically a summary of TVA's current understanding of each CCR site.

2. TDEC reviews the information provided by TVA (historical information, geophysical properties of the site, operational history, etc.) at the on-site meeting and historical CCR site information provided by TVA. After review of the information provided by TVA, TDEC sends a letter to TVA that sets the date for submission of the draft CCR site Environmental Investigation Plan (EIP) and informs TVA of any additional environmental activities it believes are necessary to complete the CCR site environmental investigation.

3. TVA submits a draft Environmental Investigation Plan for the CCR site. TDEC reviews the draft CCR site EIP and provides TVA with comments that identify opportunities to improve the environmental investigation of the CCR site EIP. This letter also sets a due date for submission of the revised CCR site EIP.

4. TVA submits a revised EIP for the CCR site to TDEC, with a schedule of onsite activities such as installation of ground water monitoring wells, installing soil/rock borings to determine subsurface geological features, methods that will be used to determine the location and amount of disposed CCR material, surface water and ground water monitoring, etc.

5. TDEC provides TVA with its response to the revised EIP. When TDEC finds the CCR site EIP to be complete, TDEC notifies TVA via letter.

6. TVA is required to issue a public notice for the CCR site EIP before it is implemented. The public has 30 days to submit its EIP comments to TDEC. If EIP comments are submitted to TDEC, then TDEC has 30 days to respond to the comments.

7. Once the public comment period has ended, TDEC may provide TVA with CCR site EIP comments as a result of the review of the public comments submitted to TDEC. TVA submits and TDEC approves/disapproves the schedule of activities for environmental investigation at the CCR site. Unless TDEC disapproves the CCR site EIP schedule of activities, TVA proceeds with the environmental investigation, collects and generates data, then prepares an Environmental Assessment Report (EAR).

8. The EAR is submitted to TDEC. TDEC evaluates the EAR and decides if TVA has generated enough environmental investigation data to:

    a. Determine the impact of CCR materials to public health and the environment.
    b. Provide a comprehensive picture of the areas where CCR material disposed.
    c. Assess the structural and seismic stability of the CCR disposal areas.
    d. Determine the extent of CCR constituents in ground water and discharges to surface water.
    e. Determine if CCR material is disposed below the ground water table.

TDEC also determines if there is enough information generated to prepare a comprehensive corrective action plan.

If TDEC determines the EAR is incomplete or deficient, then TDEC informs TVA of its concerns. TVA is then required to further investigate the CCR site, beginning with item 4. above.

<u>Cumberland CCR site EIP Comments</u>

TVA submitted the draft EIP for TVA Cumberland Coal Fired Fossil Power Plant (TVA CUF) on July 11, 2016. TDEC has completed its review of the draft EIP and the documents submitted with the draft TCA CUF EIP. After review of the TVA CUF EIP, It is

TDEC's opinion that the EIP, as currently drafted, will not provide the data necessary to fully define the environmental conditions at this site. This will adversely impact the ability for TVA to prepare a comprehensive Environmental Assessment Report for the TVA CUF CCR site.

In the draft TVA CUF EIP, TVA proposes to use historical data and data that TVA will collect in the future when it performs environmental investigative activities to complete a full environmental assessment of the TVA CUF CCR site. The EIP discusses future investigative activities only in the terms of plans it will submit to TDEC for review and approval. Given this, it is not possible for TDEC to determine if the planned activities will yield all the environmental data needed to properly assess the impact/potential environmental and public health impact of CCR material at the TVA CUF CCR site or adjacent properties and neighboring citizens.

TVA is required to post the TVA CUF EIP for public notice and comment. TDEC is required to respond to all comments received for the TVA CUF EIP. The greater the detail of the EIP, the better TDEC and the public will understand how the TVA CUF site will be investigated. Per this letter the due date for the TVA CUF Revised Environmental Investigation Plan is close of business **Friday**, **March 31, 2017**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA CUF site is complete, accurate and timely. TDEC has attached, with this letter, its comments regarding the draft TVA CUF EIP. Should TVA wish to discuss the suggestions, please contact me so a meeting may be scheduled.

Sincerely,

Chuck Head

Chuck Head

CC:	Susan Smelley	Britton Dotson	James Clark
	Pat Flood	Scotty Sorrells	Rob Burnette
	Tisha Calabrese Benton	Glen Pugh	Joseph E. Sanders

Attachment 1.
TVA Cumberland Coal Fired Fossil Plant - Draft EIP Comments

1. TVA CUF EIP, Section 1.3, Page 2 – TVA should consider including language in the bullet point that provides 45 days in the EIP implementation schedule to allow a TDEC meeting with all interested parties as detailed in Commissioner Martineau's letter date September 28, 2015 to Ms. Angela Garrone.

2. TVA CUF EIP, Section 2.1, Page 4, last paragraph – Consider revising the first sentence to read, "TVA shall provide monthly progress reports to TDEC."

3. TVA CUF EIP, Section 2.2, Page 4 and 5, - All items listed below the last paragraph should be a part of the EIP or as an addendum to the EIP. TDEC will review the description of the planned activity when the TVA submits the revised EIP.TDEC believes it will be much easier for TDEC and the public to understand TVA's planned environmental investigation activities if there is more thorough explanation of the work that will be performed.

4. TVA CUF EIP Section 2.3, page 5 – TVA should include all documents/plans that describe the TVA CUF Quality Control Program to TDEC as part of the revised TVA EIP. If there are specific instances that TVA does not believe it is possible to submit Quality Assurance/Quality Control plans to TDEC, TVA should submit them to TDEC as soon as they are available.

5. TVA CUF EIP Section 3.1.1, page 7, 1st paragraph - TVA should report any CCR material moved from the TVA CUF site and disposed on adjacent or nearby properties, if this has occurred. This also includes any CCR material that has been used off-site as a soil supplement. This information will ensure that soil samples are not collected from an area where CCR material has been disposed. This does not include CCR material that has been provided to a company (ies) for production of wallboard.

6. TVA CUF EIP Section 3.1.1, page 8, 2nd paragraph - TVA should provide a map identifying locations where TVA plans to collect soil samples. Given the area around the TVA CUF site, TDEC believes that more than six soil samples are needed to accurately determine the natural characteristics of native soil. TDEC suggests a minimum of twelve soil samples equidistant from the center of the TVA CUF site should be collected (excluding points that are in Barkley Lake or other water bodies). The soil sampling and analysis plan should be included in the revised EIP.

7. TVA CUF EIP Section 3.1.2, page 10, last paragraph – TVA should report all identified springs and surface streams present prior to the impoundment of Lake Barkley. Including a map with the location of streams and springs will be very helpful

8. TVA CUF EIP Section 3.1.3, pages 9 & 10 – TVA should provide a brief description of the methods it will use to determine the elevation and flow rate of the spring used as a background ground water monitoring point in the revised EIP.

9. TVA CUF EIP Section 3.1.4 – The location of all wells and creeks should be added or overlaid on construction drawings and/or plans. This includes water elevation data.

10. TVA CUF EIP Section 3.1.11, page 16 – TVA should include in the EIP a plan to determine water balance for the NPDES permitted surface impoundment. Measuring the hydrologic balance of the water entering the surface impoundment and the amount of water exiting the NPDES permitted outfall should provide an indication if water is moving through the bottom of the surface impoundment into the ground water below.

11. TVA CUF EIP Section 3.1.13, page 17 – TVA describe the methods and field activities it will employ to assess the stability of the bedrock below the fill areas, the stability of the waste fill and the stability of the side slope berms with the revised EIP. TVA should have all data needed available to prepare this plan. TDEC shall review this additional information when it receives the revised EIP.

12. TVA CUF EIP Section 3.1.14, page 20 – TVA specifies in this section the information it currently has available about ground water levels and additional data it will have collected June 2016. The location of additional ground water monitoring wells described in this section should be located on a map with the understanding that data generated by monitoring wells will be useful in understanding the site's hydrogeology. TVA should include in the revised EIP shall submit the methods it will use to determine the current ground water surface elevation below the landfills and surface impoundment. These activities should provide sufficient information to create a map that identifies the elevation of the potentiometric surface of ground water surface below the footprint of the landfills. The plan should also include the method(s) TVA will use to estimate the amount of CCR material below the ground water potentiometric surface. This includes CCR material located in the surface impoundment and each landfill. TDEC shall this information when it receives the revised TVA EIP.

13. TVA CUF EIP Section 3.1.15, page 21 – TVA states it has data that can be used to determine the shear strength of the CCR materials in each landfill from borings into the Gypsum Landfill and the CCR Fly Ash and Bottom Ash Landfill as well as the soils below the landfills. Given this, TVA should include the methodology it will use to make these calculations.

    TDEC recognizes the value of historical data but also believes current data is important because (1) site conditions change and (2) the methodology used to collect this data historically may be different than the methodology used today. TDEC should install new borings to collect physical data needed to determine shear strength. The location of the borings and the methods used to collect samples to test shear strength should be included in the revised EIP.

14. TVA CUF EIP Section 3.1.17, page 23 – TVA states that it shall identify fractures and/or faults that are filled with quartz or calcite and no longer serve as pathways for conveying ground water using existing data and that additional data will be collected when it completes work through October 2018. The goal of the EIP is to collect enough data to provide a comprehensive picture of the site in the Environmental Assessment Report required in the Order. The work TVA discusses in this section should be described in the revised EIP and completed before TVA submits the Cumberland EAR. TDEC does not believe it is appropriate to wait until after October 2018 to receive a final EAR for the TVA CUF site. TVA should include a description of the work it will perform to collect faulting and fracturing below the TVA CUF site and as schedule of these activities in the revised EIP.

15. TVA CUF EIP Section 3.1.18, page 25 – In the EIP, TVA proposes *"As part of its environmental Investigation Plan, TVA shall map top of bedrock using existing boring data and surface geophysics; installing additional borings/ground water monitoring wells as needed."* TVA should provide the location of existing borings and geophysical information on a map included in the revised EIP. This will allow TDEC to determine if it believes additional borings and associated field activities to map the top of bedrock are needed.

16. TVA CUF EIP Section 3.2.3 page 27– Springs identified by Law (1992b) as shown in Figure 9 of Appendix B may be valuable as background sampling locations if elevations are up-gradient. If TVA does not receive to access springs needed to collect data for this task, TVA shall contact TDEC and TDEC shall work with property owners to gain access to such springs. TVA shall remove the following language from the EIP "Note that access to the springs may be restricted due to lack of right of entry by private owner."

    TVA should describe, in the revised EIP, the methods it will use to implement a surface water and seep sampling program in compliance with the TDEC General Guidelines, part E.5.

17. TVA CUF EIP Section 3.3.1, page 28 – As a part of the water use survey, TDEC has asked TVA to collect data from all identified water supply wells. TVA has identified one well at the TVA CUF site that has been used as a water supply well. TVA should submit all analytical data available for this water supply wells in the EAR. TVA should include this well in the TVA CUF Ground Water Monitoring Program.

18. TVA CUF EIP Section 3.3.2, page 29 – Water Use Survey – TVA describes the Water Well Survey in this section. The section discusses how TVA will identify wells used for domestic water supply within a ½ mile boundary of the TVA CUF site, the process it will use to obtain permission to collect samples and determine the geographic location of each well. In Section 3.4 of this EIP, TVA discusses ground water monitoring. The Water Use Survey is a part of the Ground Water Assessment in Section 3.4 of the EIP. The portion of the Ground Water Assessment concerning the Water Well Use Survey should include:

a. The procedures that TVA will use to locate and identify water wells used for domestic water supplies within ½ mile of the TVA CUF property boundary. Much of this information is included in Section 3.3.
b. The methods TVA will use to collect samples from wells identified in the Water Well Survey. The method does not have to be described in detail; it can simply be a reference to a standard EPA or 3rd party standard such as ASTM.
c. A commitment to include water supply wells identified in the Water Well Survey in the Ground Water Monitoring Program.

All samples should be analyzed for CCR constituents listed in Appendices 3 and 4 of 40 CFR Part 257. TVA shall include the method quantitation limits and method detection limits for each CCR constituent. TVA shall analyze samples for Ra_{226} and $Ra_{228.}$

TDEC will review the Water Well Survey submitted as a part of the revised EIP.

19. TVA CUF EIP Section 3.4.1, page 30 – TVA should include all existing ground water monitoring wells in its ground water monitoring program, including the four ground water monitoring wells mentioned in this section, all wells identified in the Water Well survey and the water supply well at the TVA CUF facility. As a part of the Ground Water Monitoring Program discussed in 18. above, TVA should also include any additional ground water monitoring wells it believes are necessary to identify CCR contamination at or near the TVA CUF facility. A map with the location of current ground water monitoring wells, domestic water supply wells and springs to be used in the ground water monitoring program should be included in the revised EIP. Further, TVA should include the location of additional ground water monitoring wells (on the map mentioned above) that will be installed to establish a comprehensive ground water monitoring program at the TVA CUF site.

20. TVA CUF EIP Section 3.4.2, page 31 – TVA should include Monitoring Well 93-2R in the TVA CUF Ground Water Monitoring Plan unless it has a reasonable scientific reason why this well should not be included.

21. TVA CUF EIP Section 3.4.4, page 32 – TDEC referred to the term “perched aquifer” in its letter to TVA setting the due date for the TVA CUF site. The term “perched aquifer” refers to shallow ground water that is trapped above an impermeable subsurface layer, such as clay. Generally, a perched aquifer is small and does have a hydrologic connection with typical aquifers. At this site, TVA may incur a “perched aquifer”, the 1st aquifer and possibly a second aquifer when drilling into bedrock. TVA should use all data collected at TVA CUF to develop a site wide map (submitted as a part of the Environmental Assessment Report) that identifies all subsurface hydrologic features at the TVA CUF site.

22. TVA CUF EIP Section 3.4.5, page 33 – This section discusses comparing fluctuations in ground water levels with fluctuations in the surface elevation of the Cumberland River. TVA should identify two different locations on the Cumberland River, adjacent to the TVA CUF plant, to be used as the points for measuring surface water elevation. These points should be identified in the Ground Water Monitoring

Program. The surface water elevation should be measured following the same schedule as the ground water monitoring reference points. This information shall be included in the revised EIP.

23. TVA CUF EIP Section 3.4.6, page 33 – TVA discusses piezometers used to define ground water gradients at the TVA CUF site. The location of the piezometers should be included in the Ground Water Assessment Program and identified on the map that also provides the location of existing ground water monitoring wells, springs and proposed ground water monitoring wells. Measuring the ground water elevation in the piezometers should follow the schedule set in the Ground Water Assessment Program for the site

24. TVA CUF EIP Section 3.5, page 34 – As mentioned previously, TVA should submit a Ground Water Assessment Program with the revised EIP for the TVA CUF site. The revised EIP should include a Ground Water Monitoring Program as a part of the Ground Water Assessment. TVA should identify all water supply wells, existing monitoring wells, springs, piezometers and new monitoring wells that will be part of the ground water monitoring program. TVA should measure the ground water elevation in all wells and piezometers quarterly and sample all wells and springs quarterly. Groundwater samples should be analyzed for CCR constituents listed in Appendices 3 and 4 of 40 CFR Part 257.

    a. TVA CUF EIP Section 3.6, page 35 – TVA does not propose to install new soil/rock borings to help determine Structural and Seismic Stability of the TVA CUF site in the draft EIP. TDEC recognizes that drilling has occurred previously at the site and that this information can be helpful in evaluating TVA CUF site stability. However, new borings are needed to ensure that data is collected from borings specifically designed to help determine structural and seismic stability. TVA should also install borings in the landfills to develop an accurate three-dimensional picture of the CCR material disposed and to accurately determine the amount of CCR material in each landfill. TVA should identify the locations of historical borings and proposed new borings on a map that is included in the revised EIP.
    b. TVA should also describe in the revised EIP the drilling methods, drilling schedule, methods used to determine the types of material in each boring from surface to refusal and the methods used to determine the physical properties of ash, soil and rock encountered.

TDEC will review the drilling plan as part of the TVA revised EIP

25. TVA CUF EIP Section 3.6.3, page 37 – TVA should provide a citation from the Federal CCR regulation that verifies the statement “an overfill that was in operation as of October 19, 2015, is regulated as an existing Landfill”. TVA should discuss in the EAR how TVA demonstrated that “good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.” If TVA has not completed this activity, then TVA should describe in the EIP how it will meet the requirement listed in Part § 257.64 of the EPA CCR regulations. TVA mentions a scope of work that includes unstable area assessments in the draft EIP. A plan for

this activity should be included with the revised EIP. TDEC will evaluate this plan as when it reviews the TVA revised EIP.

26. TVA CUF EIP Section 3.6.6, page 38 – TVA has stated that it plans to close the two CCR landfills and the existing CCR surface impoundment in place. Closure in Place is dependent upon the ability of TVA to demonstrate that the current landfills and surface impoundment meet structural and seismic stability requirements and that closure in place is the will result ensures that public health and the environment are appropriately protected.

    TVA states that it plans to "conduct additional soil borings (discussed in Item A.10), field testing, seismic cone penetration test soundings and laboratory testing were performed and seismic analysis is ongoing". TVA should include the plan for performing this work in the revised TVA CUF EIP.

    Also, TVA states in the draft TVA CUF EIP (page 39) "TVA is developing a scope of work to assess closed in place conditions for the CCR Units, and those will be provided to TDEC upon completion." Under the TDEC Consent Order, TVA is required to perform an environmental investigation. Information which will be used to make a final corrective action decision should be collected during the work proposed in the TVA CUF EIP and reported in the Environmental Assessment Report. Only after TDEC has determined that TVA has performed a comprehensive site investigation will TDEC discuss final corrective action options. Should TVA decide to move forward with Closure in Place before TDEC has determined that it is an appropriate corrective action under state law and regulation, TVA moves forward at its own risk. Should TDEC determine from review of the data generated during the TVA CUF site investigation that Closure in Place is not the appropriate corrective action for the CCR landfills and surface impoundment, TVA shall be required to take appropriate corrective action for site conditions and the extent of CCR contamination in the environment.

27. TVA CUF EIP Section 3.6.7, page 39 –TVA plans to perform work at the TVA CUF site "to promote positive drainage in the drainage ditches around the disposal complex", While this work is not a part of the activities to complete the TVA CUF environmental investigation, TVA should submit its plans for review and approval by TDEC before beginning any work.

28. TVA CUF EIP Section 3.6.9, page 40 – TVA includes this statement from a September 22, 2011 Stantec report ***"Although the minimum Factors of Safety for the stacks under the conditions analyzed are less than the target of 1.0, it is judged that the risk of slope stability failure under seismic loading conditions is acceptable, considering that".*** TVA should include in the revised EIP its plans to perform additional work at the TVA CUF site to accurately determine "factors of safety". TDEC believes it is important to determine the Factors of Safety for the "stacks" using data collected during implementation of the EIP. Because site conditions are subject to change and the volume of CCR materials in the stacks increases over time.

29. TVA CUF EIP Section 3.6.10, 3.6.11 and 3.6.12, beginning at page 40 – TVA discusses making stability calculations using historical data. As stated above, site conditions change with time. To ensure structural and seismic stability calculations are correct, TVA should propose, in its revised TVA CUF EIP, the field activities it will conduct to obtain current information for performing stability calculations.

30. TVA CUF EIP Section 4.1.2, page 44 – Determining the leachability of CCR constituents from CCR material is critical to this environmental investigation. TVA should include in the revised EIP a plan that meets the criteria set out in the April 6, 2016 TDEC letter setting the draft TVA CUF due date. The specific language was "TVA shall propose a sampling plan to determine the leachability of CCR constituents from CCR material in surface Impoundments, landfills and non-registered sites at each TVA site. The plan should include sampling points at each disposal area and at different depths in each disposal area. TVA shall describe sample collection methods, sample transport, analytical methodology and the qualifications of the laboratory selected to perform the analyses."

32. TVA CUF EIP Section 4.1.6, page 47 – The draft TVA CUF does not provide the methods TVA will employ to perform a water balance calculation for the TVA CUF surface impoundment. This should be included in the revised EIP. As stated by TDEC "Describe the method TVA shall use to provide a water balance analysis for active surface impoundments at each TVA site. This should include all wastewater and surface water runoff entering the impoundment from the TVA site and the amount of water discharged from the surface impoundment(s) into receiving streams at the NPDES permitted discharge point. TVA shall also describe briefly how it will determine the transpiration rate of water from the surface impoundment(s) into the atmosphere" TDEC agrees the word "evaporation" should have been here rather than the word transpiration.

33. TVA CUF EIP Section 4.2 – TVA should expand the water well survey to include all water wells in use, not just domestic water supply wells. If CCR constituents are detected at the fringe of the initial survey boundary, then TVA should report the information to TDEC and submit an addendum to the Water Well Use Survey.

34. TVA CUF EIP Section 4.3, page 47 – As mentioned earlier in this letter, TVA is required to implement a comprehensive Ground Water Monitoring Program at the TVA CUF site. TVA discusses activities TVA plans to conduct and activities required per the EPA CCR regulations. However, submission of a Ground Water Monitoring Plan and Ground Water Assessment Program is required as part of the TVA CUF EIP.

    TVA should correct CRCR typo in Section 4.3.3. TVA has announced that it plans to close the CCR landfills and impoundments in place. This is confirmed in Section 4.3.6. Given this, TVA should submit a Pore Water Sampling Plan for the TVA CUF site when it submits the revised EIP. Finally, TVA should include language in the revised TVA CUF EIP stipulating that it will extend the boundary of its Ground Water Assessment Program, should the CCR constituents appear at greater than background levels in ground water samples at the boundary

35. TVA CUF EIP Section 4.4 TVA Site Conditions, beginning with page 51 – TVA has not included in the TVA CUF EIP plans to conduct additional work at the site to fully identify site conditions. TVA states that it will use existing data to determine:

a. If solution channeling has occurred at and near the soil/rock interface following Section 3.1.16
b. If faults and/or fractures have been identified in the subsurface and whether faulting and fracturing has impacted and/or controls groundwater movement following Section 3.1.17
c. Mapping the top of bedrock and the characteristics of the subsurface geology following Section 3.1.18
d. The stability calculations for the landfills at the TVA CUF site as described Sections 3.1.13 and 3.6.2
e. The properties of the drainage layers between each stacked layer of waste disposed in the landfills as described in Section 3.6.3
f. The potential overfill situations for the landfills at the TVA CUF site following Section 3.6.4 of the draft EIP.
g. The shear strength of the CCR materials in the landfills and the surface impoundment using the criteria in Section 3.6.15 and 3.6.11.
h. Through static, seismic and liquefaction analysis determine the potential for structural failure of the landfills and surface impoundment as described in Sections 3.6.2 and 3.6.6.
i. The seismic stability of the TVA CUF site as described in Section 3.6.6.
j. The structural integrity of the entire CCR disposal area as discussed in Section 3.6.6.
k. The structural strength and load bearing capacity of the underlying geology to support closure in place of the landfills and the surface impoundment per Section 3.1.13. It is our understanding that TVA plans to close the TVA surface impoundment and landfills in place. TVA shall include with the revised TVA CUF EIP the plans and methods it will use to determine structural and seismic stability.

TDEC has reviewed the draft EIP and the data TVA plans to use to complete the activities listed above. TVA consistently states that it will make these determinations with existing information. TVA states that it will provide TDEC information later regarding the uses of existing data to make the determinations above. TVA states that if it determines new information is needed to make decisions, it will submit a plan to collect that data to TDEC at a later date.

TVA is required to submit a comprehensive EIP to TDEC that provides the details of how TVA will conduct the environmental investigation at the TVA CUF site. This includes how TVA plans to make determinations using existing data and historical information. TVA is also required to submit with the EIP all activities it plans to conduct to collect new data during the environmental investigation. In the revised TVA CUF EIP, TVA should include the “plans” it will implement to make the determinations listed in items a. through k. above. As stated by TDEC earlier in the review of the draft TVA CUF EIP, to properly investigate the TVA CUF site, TVA must collect new data to supplement existing data to complete a comprehensive environmental investigation of the TVA CUF site.

36. TVA CUF EIP Section 4.5 Surface Water Impacts, beginning on page 57 -– TVA has not included in the TVA CUF EIP its plans to conduct additional work at the site to fully identify site conditions. TVA states that it will collect new data to evaluate any impact of CCR material on surface water.

    TVA should consider preparing and including in the EIP the methods it will use to determine if CCR material has migrated from the TVA CUF site into Wells Creek and the Cumberland River. TVA discusses this activity in section 4.5.2. TVA should also discuss in the revised EIP the strategies and methods it will use to prepare maps that accurately portray the distribution and depth of CCR material on the bottom of the streams.

    In Section 4.5.4 TVA states it will provide information about the movement of ground water containing CCR constituents into surface streams on or adjacent to the TVA CUF site. TVA states it will submit data from 2002. This data is old and may not represent current site conditions. TVA should include in the revised EIP the methods it will use to collect new data.

    Section 4.5.5 – TVA states it will develop a Sampling and Analysis Plan for the surface waters of Wells Creek, its unnamed tributaries and the Cumberland River. Per TVA's language in Section 4.5.5, the SAP will include methodologies and procedures for sample collection, collection methods, sample preservation and sample analysis methods for CCR materials. For Surface Water, TVA is proposing a phased approach beginning in Wells Creek and unnamed tributaries. TDEC agrees with this strategy, however, there is little detail about the methods TVA plans to employ to collect this information. This should be better described in the revised EIP. Should TVA extend its surface water sampling boundary, TVA shall notify TDEC of the new sample collection points.

    This plan should also include all seeps along the surface impoundment and the landfills at the TVA CUF facility. Samples shall be analyzed for 40 CFR 257 Appendix 3 and 4 constituents. This plan shall be submitted to TDEC as a part of the TVA CUF EIP.

    In the last paragraph of Section 4.5.5, TVA makes the following statement *"The term "Area of Interest" will be used until such time that TVA determines if the area is wet as a result of lack of drainage or if the area is wet as the result of controlled seepage through the embankments, which is a desirable condition for the stability of an earthen-filled embankment.*

    While TVA may consider seepage through embankments as "desirable" for operation of its surface impoundment, TDEC does not agree that seepage can continue from a repaired seep repair without further action from TVA. TVA is required to repair seeps that release wastewater from the surface impoundment or landfills. When TVA finds seeps along surface impoundments and/or landfills, it is required to repair the seeps and eliminate continued discharge from that point. Should TVA wish to have continued discharge from repaired seeps, TVA must notify TDEC and receive approval to allow this continued discharge.

37. Appendix A – TVA should add 45 days to the EIP implementation schedule to allow time for TDEC to meet meeting with all interested parties as detailed in Commissioner Martineau's letter date September 28, 2015 to Ms. Angela Garrone.

38. Appendix B – TVA should consider updating Figure CUF-1 using recent aerial photograph.

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February 22, 2017

M. Susan Smelley, Director
Environmental Compliance and Operations
Tennessee Valley Authority
1101 Market Street, BR 4A
Chattanooga, TN 37402-1548

RE: TDEC Commissioner's Order OGC 15-1077
TVA Cumberland Coal Fired Fossil Fuel Plant
Revised TVA Cumberland Environmental Investigation Plan
Due Date Extension – May 12, 2017

Dear Ms. Smelley:

The Tennessee Department of Environment and Conservation (TDEC) received your January 30, 2017 letter requesting an extension for submission of the revised TVA Cumberland Fossil Plant (TVA CUF) Environmental Investigation Plan (EIP). Prior to your letter, I spoke with Paul Pearman from your staff about preparing a revised TVA CUF EIP with a specific schedule of activities.

As I spoke with Mr. Pearman, we were in agreement that the TVA Cumberland EIP should have a good description of all environmental activities that would occur during the environmental investigation at TVA CUF as well as a an approvable schedule for the investigative activities. Following this process should ensure a thorough investigation of the TVA CUF site within 12 to 15 months of the approval of the TVA CUF EIP and a complete Environmental Assessment Report within 15 to 18 months of the date the approved TVA CUF environmental investigation begins.

Per your request, TDEC grants TVA an extension to May 12, 2017 for submission of the revised TVA Cumberland EIP. Should you have any questions or comments, please contact me.

Sincerely,

Chuck Head

Chuck Head

CC:	Paul Pearman	Britton Dotson	James Clark
	Pat Flood	Scotty Sorrells	Rob Burnette
	Tisha C. Benton	Glen Pugh	Joseph E. Sanders

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Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

August 31, 2017

Paul J. Pearman
Tennessee Valley Authority
1101 Market Street, MR 4K
Chattanooga, TN 37402

RE: TDEC Commissioner's Order OGC 15-1077
TVA Cumberland Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Revision 1 Comments

Dear Mr. Pearman:

The Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order OGC 15-0177 (the Order") to the Tennessee Valley Authority (TVA) that required TVA action at seven TVA Coal Fired Fossil Power Plants (active and inactive) located in Tennessee. The Order was signed on August 6, 2015 and included information about TVA's right to appeal the Order. TVA did not appeal the Order and it is now final.

The Order required TVA to perform environmental investigations and to take appropriate corrective action at seven TVA Coal Fossil Power Plants (CCR sites) in Tennessee. The Order is specific to Coal Combustion Residual (CCR) material. Paragraph VII. of the Order provides the sequence of events for environmental investigation at a TVA CCR site as presented below.

1. TVA and TDEC are required to schedule and conduct an initial meeting to discuss each CCR site. At each CCR site meeting, TVA provides the operational history of the CCR site, all geological and hydrogeological information currently available, results of environmental investigations and sampling, etc. This is basically a summary of TVA's current understanding of each CCR site.

2. TDEC reviews the information provided by TVA (historical information, geophysical properties of the site, operational history, etc.) at the on-site meeting and historical CCR site information provided by TVA. After review of the information provided by TVA, TDEC sends a letter to TVA that sets the date for submission of the draft CCR site

Environmental Investigation Plan (EIP) and informs TVA of any additional environmental activities it believes are necessary to complete the CCR site environmental investigation.

3. TVA submits a draft Environmental Investigation Plan for the CCR site. TDEC reviews the draft CCR site EIP and provides TVA with comments that identify opportunities to improve the environmental investigation of the CCR site EIP. This letter also sets a due date for submission of the revised CCR site EIP.

4. TVA submits a revised EIP for the CCR site to TDEC, with a schedule of onsite activities such as installation of ground water monitoring wells, installing soil/rock borings to determine subsurface geological features, methods that will be used to determine the location and amount of disposed CCR material, surface water and ground water monitoring, etc.

5. TDEC provides TVA with its response to the revised EIP. When TDEC finds the CCR site EIP to be complete, TDEC notifies TVA via letter.

6. TVA is required to issue a public notice for the CCR site EIP before it is implemented. The public has 30 days to submit its EIP comments to TDEC. If EIP comments are submitted to TDEC, then TDEC has 30 days to respond to the comments.

7. Once the public comment period has ended, TDEC may provide TVA with CCR site EIP comments as a result of the review of the public comments submitted to TDEC. TVA submits and TDEC approves/disapproves the schedule of activities for environmental investigation at the CCR site. Unless TDEC disapproves the CCR site EIP schedule of activities, TVA proceeds with the environmental investigation, collects and generates data, then prepares an Environmental Assessment Report (EAR).

8. The EAR is submitted to TDEC. TDEC evaluates the EAR and decides if TVA has generated enough environmental investigation data to:

   a. Determine the impact of CCR materials to public health and the environment.
   b. Provide a comprehensive picture of the areas where CCR material disposed.
   c. Assess the structural and seismic stability of the CCR disposal areas.
   d. Determine the extent of CCR constituents in ground water and discharges to surface water.
   e. Determine if CCR material is disposed below the ground water table.

TDEC also determines if there is enough information generated to prepare a comprehensive corrective action plan.

If TDEC determines the EAR is incomplete or deficient, then TDEC informs TVA of its concerns. TVA is then required to further investigate the CCR site, beginning with item 4. above.

Cumberland CCR site EIP Rev 1 Comments

TVA submitted the EIP Rev 1 for TVA Cumberland Coal Fired Fossil Power Plant (TVA CUF) on May 12, 2017. TDEC has completed its review of EIP Rev 1 and is providing comments listed in the attached **Table 1 TVA Cumberland EIP Rev 1 Summary of TDEC Comments**.

Please address the attached comments and submit a revised plan (EIP Rev 2) with a cover letter summarizing TVA's response to each comment and subsequent modifications to TDEC by **October 2, 2017**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA CUF site is complete, accurate and timely. Should you have any questions, please do not hesitate to contact me via email at Robert.S.Wilkinson@tn.gov or phone at (615) 253-0689.

Sincerely,

Robert Wilkinson, PG, CHMM

CC:	Susan Smelley	Britton Dotson	James Clark
	Pat Flood	Scotty Sorrells	Rob Burnette
	Tisha Calabrese Benton	Angela Adams	Joseph E. Sanders
	Chuck Head	Peter Lemiszki	Jason Repsher
	Alan Spear		

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
All	All	NA	NA	NA	General content comment - please give titles to sections that reflect the content of the section - "*TDEC Information Request* " is not an appropriate section title.
General Comment	All	NA	NA	NA	TVA has indicated that it plans to close the existing landfill in place, the purpose of the EIP is to determine the proper closure remedy.
General Administrative	NA	NA	NA	NA	The document lacks a signature page that indicates the document has been read and that the various parties (e.g., QA consultant, Investigation Consultant field personal) understand the relevant requirements.
General Administrative	NA	NA	NA	NA	The document lacks an approval page, with all stakeholders listed.
General Administrative	NA	NA	NA	NA	The document lacks a revision log.
General Administrative	NA	NA	NA	NA	TDEC will be notified immediately by the TVA of any problems related to successful completion of field efforts as outlined in this EIP.
Global SAPs	NA	NA	NA	NA	The SAPs lack a list of field equipment and critical spare parts (if applicable) related to the specific tasks described in each SAP.
Global SAPs	NA	NA	NA	NA	There needs to be a maintenance form created to document the routine checks and both the regular and special maintenance that will occur for each instrument. This form needs to include the nature of the maintenance the qualified person and dates.
General Technical	NA	NA	NA	NA	Is there a plan to look at the data for trends when common leachate indicators are compared to the total amount of CCR metals in contaminated water samples. It is important to determine if there is a relationship because of the expected geochemical relationships between chloride, other leachate indicators, and the presence of CCR metals, otherwise only CCR metals can be used to reliably indicate leachate-groundwater interaction.
General Technical	NA	NA	NA	NA	Will Piper diagrams be used to compare the hydrochemical facies of EIP groundwater samples? And if so please identify what comparison(s) will be made (e.g., gypsum storage are vs. dry ash stack; contaminated wells versus background wells, etc.)?

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
General Technical	NA	NA	NA	NA	Has there been any comparison or evaluation of wells to determine if they are hydraulically influenced by river stage (both Wells Creek and Cumberland River)? This is an integral part of understanding the hydrogeological setting of the CCR units. The potentiometric map does not show radial flow to the Cumberland River from CUF-101/CUF-120 area.
2.1	EIP Development and Structure	5	5	1	Please provide a minimum frequency that TVA will be providing progress reports to TDEC.
2.2	Proposed Schedule	6	All	All	The schedule should acknowledge and be in accordance with the February 22, 2017 letter from Chuck Head to Susan Smelley (reference page 140 in Appendix B of this document). Ongoing and planned studies for other programs shall be submitted for TDEC's review and comment and incorporated into the EAR.
2.2	Proposed Schedule	6	2	All	Monthly schedule updates will be provided to TDEC depicting progress for all EIP activities. TVA should include explanations for lagging or incomplete EIP tasks.
2.3	Quality Assurance Project Plan (CUF Quality Plan)	6	1	1	Suggest using common abbreviations for clarity, Appendix C uses CUF QAPP instead of CUF Quality Plan.
2.3	Quality Assurance Project Plan (CUF Quality Plan)	7	2	4	Please include as an appendix to the EIP the referenced "*Data Management Plan* ".
3.1.1	A.1 TDEC Information Request	8	2	7	Line reads "*The General Guidelines removed the requirement for hexavalent chromium analysis* ." This is incorrect. TDEC will require both total chromium and hexavalent chromium to be analyzed.
3.1.1	A.1 TDEC Information Request	8	4	4	Statistics play a major role in determining background concentrations and based on chosen method will effect the sample design and data analysis. Please specify how the background soil will be evaluated and what statistical method will be employed to determine what background levels are for the CCR parameters.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.1	A.1 TDEC Information Request	8	4	4	Will a background concentration be determined for each soil type? Please explain how many samples from each soil type will be considered a valid test population for statistical evaluation.
3.1.1	A.1 TDEC Information Request	9	3	4	This refers to the collection of background soil samples for use at the TVA CUF site. Location is provided in Appendix E, the background Soil Sampling and Analysis Plan on page 297 of the EIP Document at Figure 1. Generally the locations seem appropriate with the exception of SB 01 (possible impact by CCR contaminated surface water and ground water). Also, TVA should consider a boring directly east of SB 05 and south of the pond noted on Figure 1.
3.1.1	A.1 TDEC Information Request	9	4	6	Line reads "*Proximity to existing background groundwater monitoring wells* ;". Sample locations can be near existing background monitor well locations, but this should not be used as a criteria to exclude a sample location.
3.1.1	A.1 TDEC Information Request	9	4	NA	TDEC recommends considering the direction of stormwater and groundwater flow from the CUF ash ponds and potential for historic inundation of sample locations during rain events and river flooding events. Care should be taken not to sample in an area that may have been in contact with CCR constituents during rain events, flood events, or currently being influenced by groundwater flow from CUF.
3.1.1	A.1 TDEC Information Request	10	3	7	It is unclear as to whether or not the sampling is a single grab sample or multiple aliquots that generate one composite sample. Since in the text it states "grab samples". A five foot sample interval seems course in suspected alluvial silts and clays. A 1-2.5 ft interval, or change in lithology is recommended for silts and clay. Five foot intervals may be appropriate in sands. Also if the soil is fine sand and silt the sample should be biased to sampling the interface between sand lenses and silt since these lenses are of the conduits for contaminant movement. In clays the inorganics will tend to adsorb and samples should be collected from soil fractures or areas that show oxidation.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.1	A.1 TDEC Information Request	10	3	11	Grab samples are okay. No composites. This should be reinforced on page 284 of the Adobe document in Section 5.2.1.1, 3rd paragraph.
3.1.3	A.3 TDEC Information Request	11	3	8	TVA shall sample the spring on the Rye property if at all possible. If TVA cannot get access, then TDEC will assist
3.1.5	A.5 TDEC Information Request	12	All	All	TVA should highlight and summarize references in the historical documents that provide data that supports the existence of a continuous constructed or natural clay liner between the coal ash and bedrock and water table.
3.1.6	A.6 TDEC Information Request	14	2	10	The data discussed is relatively old. A clear delineation between the sluiced ash and the gypsum stack is needed. This information is needed is making stability calculations for the gypsum landfill. Should new borings be required to better identify the sluiced ash/gypsum contact.
3.1.6	A.6 TDEC Information Request	14	5	1	TDEC recommends additional borings to characterize the interface between the gypsum stack and sluiced ash for the Gypsum Landfill. There appears to be little data available from the center of the Gypsum Landfill (Figure 8). Additional fieldwork and boring installation will likely be required to fully characterize the interface in this area
3.1.7	A.7 TDEC Information Request	14	2	1	TDEC recommends additional borings to characterize the interface between the dry ash stack and sluiced ash for the Fly Ash and Bottom Ash Landfill. There appears to be little data available from the center of the Landfills (Figure 8). Additional fieldwork and boring installation will likely be required to fully characterize the interface in this area.
3.1.8	A.8 & A.9 TDEC Information Request	15	All	All	TVA should coordinate this request with Activity ID STN-33070 provided in the CUF EIP Implementation Schedule. As an example, if the Federal rule assessment mandates closure of one or both of the units what final grades are anticipated based on a mandated closure date and waste receipts. Modifications to the storm water design, stability analysis, and closure plan maybe required.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.8	A.8 TDEC Information Request	15	3	4	TVA shall present both permitted waste cell height and proposed cell height at closure.
3.1.10	A.10 TDEC Information Request	16	3	5	TVA discusses submission of a proposed three dimensional model of the CCR materials disposed at the CUF site using existing data. This provides a good starting point for the area of waste disposal. However, TVA should be required to submit a revised three dimensional model of the CCR material disposed at the CUF site in the EAR, based on the findings of the EIP. It is tremendously important for TVA to identify any areas at the CUF site where CCR material is disposed below ground water. For closure in place, TVA has to follow the CCR regulations, specifically 257.102(d)(2)(i and ii) which states: ***"(2) Drainage and stabilization of CCR surface impoundments. The owner or operator of a CCR surface impoundment or any lateral expansion of a CCR surface impoundment must meet the requirements of paragraphs (d)(2)(i) and (ii) of this section prior to installing the final cover system required under paragraph (d)(3) of this section. (i) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.*** ***(ii) Remaining wastes must be stabilized sufficient to support the final cover system."***
3.1.10	A.10 TDEC Information Request	16	1	7	The ERI data has not been provided in the EIP and therefore cannot be evaluated, the transects and interpretation should be included both graphically and with a narrative in the EAR. Were the ERI data correlated with existing borehole data in order to calibrate the apparent resistivity values with bedrock? If so how well did the ERI data match boring data? Were structural features or karst features indicated on the transects? On transects that do not have boring data that indicate the top of rock, a boring should be installed to calibrate the values before inclusion into a 3D model of the site.
3.1.10	A.10 TDEC Information Request	16	1	7	Were the ERI data collected at a sufficiently close interval as to image small 3-6 ft wide preferential pathways for groundwater migration along possible fault traces, fracture zones, or joint sets?

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.10	A.10 TDEC Information Request	17	2	9	TVA proposes adding additional borings and temporary wells at the TVA should locate additional borings and monitoring wells within the TVA CUF gypsum and ash landfills and between the landfill and the Cumberland River. There is very little subsurface data available in the area between the landfills/sluice ponds and the river (the plant area). Please see the Figure and Adobe page 372 of the EIP.
3.1.10	A.10 TDEC Information Request	18	2	All	Ongoing and proposed studies for other programs shall be submitted for TDEC's review and comment and incorporate findings into the EAR.
3.1.10	A.10 TDEC Information Request	18	4	4	Along with normal pool elevation, the 3D model should also show maximum and minimum pool elevation of the stilling pond
3.1.11	A.11 TDEC Information Request	19	2	1	The Wastewater Characterization Plan did not include a plan for taking analytical results for CCR Parameters.
3.1.11	A.11 TDEC Information Request	20	7	4	TVA proposes using a rating curve in conjunction with the elevation of the impoundment system to calculate discharge rate. TDEC recommends installing automatic flow meters at the discharge outlet to accurately measure the discharge rate.
3.1.13	A.13 TDEC Information Request	22	All	All	TVA should conduct response to this request with respect to faults/fractures as well as voids/cavities.
3.1.13	A.13 TDEC Information Request	24	NA	NA	Stability of bedrock below fill areas - The EIP discusses the installation of 13 borings in the area of the stilling pond and the landfill. Will these borings provide enough additional information to adequately determine the stability of the rock structure below? - see Figure 1 Adobe Page 423
3.1.14	A.14 TDEC Information Request	27	2	6	Need to report river stage (Cumberland and Wells Creek) on potentiometric map and whether it was a high or low during specific sampling events and if any changes in potentiometric water level either in surficial or bedrock aquifer can be attributed to river stage.

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.15	A.15 TDEC Information Request	28	All	Last	Ongoing and upcoming studies for other programs shall be submitted for TDEC's review and comment and incorporate findings into the EAR.
3.1.15	A.15 TDEC Information Request	28	6	3	Any documents and data used to help determine soil and CCR sheer strengths should be included in the EAR. TVA shall denote how this data was incorporated with other existing data and new data to make sheer strength calculations
3.1.16	A.16 TDEC Information Request	31	1	2	Ongoing and upcoming studies for other programs shall be submitted for TDEC's review and comment and incorporate finding into the EAR.
3.1.16	A.16 TDEC Information Request	31	3	6	Are there enough new borings identified on Figure 11 to meet the needs for accurate assessment?
3.1.16	A.16 TDEC Information Request	31	4	Last	TVA should conduct observations of outcrops with respect to faults/fractures as well as voids/cavities.
3.2.2	B.2 TDEC Information Request	35	1	9	All data used to develop the potentiometric surface changes over time shall be included in the EAR.
3.4	D. Groundwater Monitoring	37	All	All	The permitted landfill was referenced as being in Groundwater Assessment Monitoring, but the Groundwater Quality Assessment Plan was not included in the EIP.
3.4.1	D.1 TDEC Information Request	37	All	All	TVA shall demonstrate that the groundwater chemistry in background wells is indicative of the groundwater flowing under the CCR units.
3.4.1	D.1 TDEC Information Request	37	2	11	TDEC will consider the 2 "new" groundwater monitoring wells TVA has installed to determine if they suffice as background groundwater monitoring wells. TVA shall install new wells upon TDEC's request.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.4.1	D.1 TDEC Information Request	38	1	8	*"If TVA determines that the new wells are suitable for addition into the TDEC permitted groundwater monitoring network, then TVA will include them in an amended groundwater monitoring network".* This will be with TDEC's approval.
3.4.1	D.1 TDEC Information Request	38	2	1	Based on currently available monitoring data it appears that the groundwater flow on the eastern side of the Gypsum Storage Area is not fully characterized. The proposed monitoring well location between the CCR units and the main plant northeast of the CCR units may help clarify the groundwater flow, but since CUF-213 also has had arsenic detections greater than the MCL it may be necessary to evaluate an additional well located across Wells Creek south of CUF-213 near the Rye property boundary. This area potentially exhibits highly fractured (brecciated) bedrock or karstic geology.
3.4.1	D.1 TDEC Information Request	38	2	2	Both "background" wells as outlined in the EIP will be located in the soils above the Stones River Group. However, at least three and possibly four wells in the Gypsum Storage Are are located above the Knox Dolomite. It is recommended that at least one background well be sited above the Knox Dolomite.
3.4.1	D.1 TDEC Information Request	38	2	2	The groundwater is not characterized with respect to the Knox Dolomite. The Knox Dolomite is a highly fractured megabreccia and is mainly limestone and dolomite with lesser shale. CUF-204 is sited in the Stones River Group which is composed of thin bedded limestone with bentonite beds. Preference is for 10-ft well screen in the bedrock within water-bearing fractures. The top of the screen should be at least 5 feet into the bedrock.
3.4.1	D.1 TDEC Information Request	38	4	1	Are 4 quarterly sampling events sufficient to fully assess and compare up gradient versus downgradient groundwater quality? Please address justification for sampling frequency and why a monthly or bi-monthly sampling interval would not be more prudent to determine fluctuations based on seasonality, river stage or provide a more statistically robust dataset. With only four events it is possible that after an additional year there is still not an adequate background monitoring well.

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
3.4.4	D.4 TDEC Information Request	40	2	10	Need to report river stage (Cumberland and Wells Creek) on potentiometric map and whether it was a high or low during specific sampling events and if any changes in potentiometric water level either in surficial or bedrock aquifer can be attributed to river stage.
3.4.4	D.4 TDEC Information Request	40	3	8	There may be the need for an interim report and/or presentation as the background and additional wells are installed and water levels gauged. After new monitoring wells have been installed and developed a report with well construction details and initial water levels should be produced. Subsequently water levels should be recorded and reported to TDEC in the form of either a progress report or presentation monthly to determine network adequacy and also aid in determining if seasonality is a factor. Therefore, if additional points need to be added to address groundwater flow directions they can be addressed in a timely manner.
3.5.1	D.1 TDEC Information Request	42	2	1	TDEC recommends considering impacts to groundwater and MCL exceedances as a component of it's assessment of ongoing environmental impacts caused by the 1997 Bypass and/or any other releases at the CUF.
3.5.2	D.2 TDEC Information Request	43	1	Last	TVA shall report all groundwater data in tables. One set of tables will consist of all samples taken from each individual well over time. The second set of tables shall compare all groundwater sample results from samples collected during the same sampling event.
3.5.3	D.3 TDEC Information Request	43			In the explanation for both the hydrogeological investigation and groundwater sampling there do not appear to be sufficient wells to determine if radial flow to the river is occurring north of CUF-101 and 96-9.
3.5.3	D.3 TDEC Information Request	44	1	All	TDEC recommends additional monitoring well installation outside of the footprint of the ash ponds to the northeast to properly characterize groundwater flow towards the Cumberland River. In addition, TDEC recommends TVA consider installing additional monitoring wells to the south, southwest, and southeast to properly characterize groundwater flow in those areas. These wells should be sampled for CCR constituents as well.

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
3.6.2	E.2 TDEC Information Request	45	1	last	Should TVA be required to collect new data to be used in the seismic and structural stability analysis given the original data collection may have come from borings and tests that were not specifically designed for an analysis of this type. TVA should install multiple borings from the top of each waste cell (gypsum and coal ash) to the original ground surface below the landfill. Samples of the CCR material should be collected at 10' intervals to determine % moisture content, particle size and type of CCR material. This data should be used to determine shear strength of the CCR material from top of fill to the contact point between original ground surface and CCR material. Further, this new data should be used in the stability calculations. If TVA maintains that the water content of the CCR material from this sampling event will decrease with time, thus creating a more stable material for stability analysis, then TVA will need to provide the rationale for their position.
3.6.3	E.3 TDEC Information Request	46	3	2	TVA shall consult with TDEC regarding the use of new data in this analysis. As demonstrated at TVA Kingston, the inefficiency of drainage layers can contribute to structural and seismic stability of the landfilled CCR material.
3.6.4	E.4 TDEC Information Request	46	All	Last	Ongoing and upcoming studies for other programs shall be submitted for TDEC's review and comment and incorporate findings into the EAR.
3.6.4	E.4 TDEC Information Request	46	3	1	40 CFR Part 257.53 "Closed" means placement of CCR in a CCR unit has ceased, and the owner or operator has completed closure of the CCR unit in accordance with 40 CFR Part 257.102 and has initiated post-closure care in accordance with 40 CFR Part 257.104. Provide documentation that the surface impoundments on which the existing landfills are constructed are closed by the Federal CCR rule definitions.
3.6.5 and 3.6.6	E.5 and E.6 TDEC Information Request	47	NA	NA	Stability and seismic calculations should be conducted using the data collected from analysis of CCR material samples from the borings TVA installs into the gypsum and coal ash stacks.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.6.5	E.5 TDEC Information Request	47	1	All	TDEC acknowledges that this request was a duplicate request addressed in Section 3.6.2. This section can be removed from the EIP.
3.6.6	E.6 TDEC Information Request	48	3	1	The line reads "*Note that certain prior seismic analyses (TVA 2003; Stantec 2011, 2012) are considered superseded by the existing and upcoming analyses summarized in Item A.13* ." TDEC acknowledges additional studies and analyses are being conducted, but does not consider any historical data or reports superseded by current data. All current and historic data/reports should be considered when evaluating current and future site conditions.
3.6.7	E.7 TDEC Information Request	48	2	2	TVA need to revise/update schedule on the initiation of the construction of the proposed drainage improvements.
3.6.8	E.8 TDEC Information Request	49	2	2	Provide a site plan locating Section E and F indicated/referenced in the Cumberland Fossil Plant Dry Fly Ash & Gypsum Disposal Complex Grading and Drainage Plan Improvements Work Plan 11 (CUF-110310-WP-11) dated April 4, 2011. Demonstrate that the facility has no existing waste above the vertical limits of the permit drawings. The demonstration is to include conformance with the geometry presented in Section E and F indicated/referenced in the Cumberland Fossil Plant Dry Fly Ash & Gypsum Disposal Complex Grading and Drainage Plan Improvements Work Plan 11 (CUF-110310-WP-11) dated April 4, 2011. Provide a recent topographic map that represents the existing side slope cover grades. Explain discrepancies between the cover grades indicated on Drawing 10W299-05 "Closure Plan Drainage Improvements" R2 dated 8/11/17, Drawing 10W302-17 "Proposed Waste Disposal Facility Proposed Final Contours sheet 2 of 4" R0 dated 10/10/2003, and Drawing 10W551-303 "Grading/Drain Improvements Waste Grading Plan Work Plan 11 (CUF-110310-WP-11)" R3 date 12/14/12.
3.6.9	E.9 TDEC Information Request	49	6	1	The line reads "*The Stantec (2011) seismic analysis, which is the subject of this information request, is considered superseded by the existing and upcoming analyses as discussed in the response to E.6 (Section 3.6.6).* " TDEC acknowledges additional studies and analyses are being conducted, but does not consider any historical data or reports superseded by current data. All current and historic data/reports should be considered when evaluating current and future site conditions.

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
3.6.9	E.9 TDEC Information Request	49	6	last	TVA must determine the Factor of Safety using new data. If the factor of safety is less than 1, then it should be reported in the EAR and the Corrective Action Plan shall describe how TVA will address the Factor of Safety issue.
3.6.12	E.12 TDEC Information Request	51	3	1	The line reads "*The Stantec (2011) seismic analysis, which is the subject of this information request, is considered superseded by the existing and upcoming analyses as discussed in the response to E.6 (Section 3.6.6)* ." TDEC acknowledges additional studies and analyses are being conducted, but does not consider any historical data or reports superseded by current data. All current and historic data/reports should be considered when evaluating current and future site conditions. TVA should conduct a thorough review and justification for the selection of the seismic coefficient (0.083g) in the previous report.
3.6.12	E.12 TDEC Information Request	51	3	4	TVA shall fully explain how the horizontal seismic coefficient was determined previously. TDEC should determine if this should be recalculated based on the results of sampling proposed in this EIP.
4.1.1	A.1 TDEC Information Request	53	1	2	Line reads "*However, the General Guideline adds the requirement of a map showing the location where soil samples were taken, and clarifies the use of 40 CFR Part 257, Appendices III and IV, in defining the constituents of concern for soil sampling and analytical purposes and further removes the original analytical requirement for hexavalent chromium.* " This is incorrect. TDEC will require both total chromium and hexavalent chromium to be analyzed as well as the Appendix III and IV CCR constituents.
4.1.2	A.2 TDEC Information Request	53	2	All	TVA's approach to obtain representative leaching data did not include CCR waste analysis for SPLP, or samples locations for where the 10 obtained samples were taken. Waste profiles have likely changed over the years from different coal sources and plant operations.

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Section Number	Section Title	Page	Paragraph	Line	Comment
4.1.2	A.2 TDEC Information Request	53	2	3	TDEC recommends conducting a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility. The further referenced 2016 CCR Characterization Report may be sufficient to satisfy the solid material sample analysis if there is adequate vertical and horizontal distribution of samples and meets the data requirements set forth in the EIP.
4.1.2	A.2 TDEC Information Request	55	1	1	The line reads "*TVA will characterize the leachability of the CCR parameters from the CCR material at the base of the CCR units..* ". TDEC recommends characterizing leachability from multiple vertical intervals, not only at the base layer.
4.1.2	A.2 TDEC Information Request	55	3	1	The paragraph reads "*The CCR Material Characteristics study is confined to the leachability of CCR parameters from the CCR material (at various locations in the CCR units) into CCR units where the CCR material is deposited. It does not demonstrate the leachability of the CCR parameters (from the CCR material in the CCR units) into the groundwater under the base of the CCR units.* " TDEC requests further explanation from TVA on why the leachability of CCR parameters from CCR materials is not universal and reflective of the leachability into groundwater.
4.3.7	C.7 TDEC Information Request	60	2	All	TVA response does not adequately address the TDEC information request. TVA does not discuss how it will define groundwater contaminant plumes and/or how it would scientifically extend the monitoring network if necessary to fully delineate vertical and horizontal impacts to groundwater. TVA should further define methodologies, procedures, and models it will utilize to characterize and assess contamination in groundwater.

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Section Number	Section Title	Page	Paragraph	Line	Comment
4.4.10	D.10 TDEC Information Request	65	2	All	The line reads "*As noted in Section 3.6.4, none of the CUF CCR units in the Study Area meet the definition of an overfill per the CCR Rule. Therefore, this information request does not apply to CUF.* " TVA previously stated in their response in section 3.6.4that "*Although the Dry Ash Stack and Gypsum Disposal Complex are regulated as "existing landfills" and not "overfills" under the CCR Rule, the CCR Rule still addresses the concern about existing landfills that are constructed over closed CCR surface impoundments. In particular, existing landfills are subject to the "Unstable Areas" location restriction per §257.64. Due to TVA's construction of its CUF landfills on top of a closed CCR surface impoundment, §257.64 will therefore require TVA to demonstrate that "good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."* " TVA needs to explain why their proposed assessment for section 3.6.4 does not apply to section 4.4.10
4.4.11	D.11 TDEC Information Request	65	All	All	TVA response does not adequately address the TDEC information request. TVA does not provide any information regarding historic dam safety analyses that may have been performed and if said analyses were deemed adequate. Given that the perimeter dike system was once included in the TVA Dam Safety Program, this information may be available for review. If these historical analysis were not sufficient for the purpose of the EAR, additional analysis may be required.
4.5.2	E.2 TDEC Information Request	70	1	3	TDEC recommends analyzing all top six-inch sediment samples for CCR parameters.
4.5.2	E.2 TDEC Information Request	70	1	4	Line reads "*Hold remaining composited boring samples for potential future analyses in Phase 2 (if >20% ash).* " TVA previously stated that it will be collecting grab samples, where do the referenced composite samples come from?
4.5.2	E.2 TDEC Information Request	70	1	4	Line reads "*Hold remaining composited boring samples for potential future analyses in Phase 2 (if >20% ash).* " TDEC recommends running additional analysis on boring samples if CCR constituents are detected in the associated top six-inch sediment sample.

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
4.5.2	E.2 TDEC Information Request	70	4	1	TDEC recommends adjusting sediment sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river bed profile.
4.5.2	E.2 TDEC Information Request	71	1	1	TDEC recommends implementing Phase 2 sampling if CCR constituents are detected in the associated top six-inch sediment sample.
4.5.2	E.2 TDEC Information Request	71	1	3	Line reads "*Analysis of held composited sediment core sample(s) at sampling locations that exceeded the 20 percent ash content for CCR parameters.* " TVA previously stated that it will be collecting grab samples, where do the referenced composite samples come from?
4.5.5	E.5 TDEC Information Request	75	2	3	TDEC recommends collecting water column samples (top, middle, and bottom) at each sampling location in Wells Creek, the Cumberland River, and the unnamed tributary flowing into Wells Creek. Effort should be made to co-locate water column samples with sediment samples collected as part of the EIP as well as the already identified sampling locations. TDEC recommends adjusting water column sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river profile.
4.5.5	E.5 TDEC Information Request	76	1	5	Background sample locations in should be upstream of the CUF and ash pond area, outside of any potential influence from site activities and CCR storage/release.
4.5.5	E.5 TDEC Information Request	76	3	1	TDEC recommends implementing Phase 2 sampling if CCR constituents are detected in the associated top six-inch sediment sample.
4.5.6	E.6 TDEC Information Request	77	2	3	TVA states that to it's knowledge, no public water intakes are located within 1 mile downstream of the TVA site. Please provide justification for this statement and/or an assessment plan to make this determination.

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Section Number	Section Title	Page	Paragraph	Line	Comment
4.5.8	E.8 TDEC Information Request	77	All	All	Is TVA proposing a full aquatic life assessment to satisfy this request?
4.5.8	E.8 TDEC Information Request	77	2	1	The text should explain how the data will be evaluated to determine whether there is a risk. There should be some explanation as to why six samples of each fish species will be sufficient to address the question. Is there a minimum weight of sample requirement?
5	Environmental Assessment Report (EAR)	79	1	2	The EAR will address all tasks completed as part of the approved EIP.
Appendix A	Schedule	NA	NA	NA	General comment - The schedule is considered draft at this time. TDEC will work with TVA to develop a final schedule once the EIP is approved. TDEC will provide a draft schedule for the CUF site for TVA review.
Appendix C	All	All	All	All	Please make sure the nomenclature for identified positions is consistent throughout the QAPP. There are many errors including:"*TVA Program Manager, TVA Technical Manager* "
Appendix C, Section 2.1	QAPP	1	1	6	CUF EIP Revision 1 is May 2017 not April 2017
Appendix C, Section 2.1	QAPP	1	2	8	Please provide the Data Management Plan.
Appendix C, Section 2.1	QAPP	2	Fig 2-1		There should be an investigation consultant QA leader in the flow chart above the field team leads. This person would have a dashed line to the data manager as the mechanism for submitting field data.
Appendix C, Section 2.1	QAPP	2	Fig 2-1		QA Oversight Manager should read QA Oversight Consultant Manager to be consistent with section 2.2.5
Appendix C 2.1	Background	1	2	8	Please include as an appendix to the EIP the referenced "*Data Management Plan* ".

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix C 2.2.1	TVA Compliance Lead	3	2	1	The line references the "*TVA Program Manager* " - is this meant to be the "TVA Compliance Lead"? If not, please provide any pertinent information regarding the TVA Program Manager's duties and how this position fits in the organizational structure. Further, define the TVA Compliance Lead's duties as well
Appendix C 2.2.2	TVA Technical Lead	3	1	2	Please define "*Sampling Contractor"* , this position is not defined in the organizational structure or in the QAPP.
Appendix C 2.2.2	TVA Technical Lead	3	1	3	Please define "*Program* ".
Appendix C, Section 2.2.2	QAPP	3	1	2	Is Sampling Contractor equal to Investigation Consultant Project Manager?
Appendix C, Section 2.2.2	QAPP	3	1	2	It appears based on the flow diagram that the TVA Technical Lead also directs the analytical laboratories and the data manager, is this correct?
Appendix C 2.2.3.1	Field Team Leaders	4	1	6	It appears "*Field Personnel* " is being used in place of "*Field Sampling Personnel* " as designated in the organizational chart. Please be consistent throughout with identification of personnel
Appendix C, Section 2.2.3.1	QAPP	4	2	5	Field team leaders should submit field data to the investigation contractor QA leader and that person should after completing the QA check of the field data submit it to the Data Manager.
Appendix C 2.2.4.2	Laboratory Project Manager	7	1	6	The line references the "*TVA Program Manager* " - is this meant to be the "TVA Compliance Lead"? If not, please provide any pertinent information regarding the TVA Program Manager's duties and how this position fits in the organizational structure. Further, define the TVA Compliance Lead's duties as well
Appendix C, Section 2.2.4	QAPP	5	3	7	Identifying and implementing training certification for laboratory personnel was indicated. How will training be documented?
Appendix C, Section 2.2.5	QAPP	7	7	3	For consistency with Figure 2-1. The QA Oversite Consultant Manager reports directly to the TVA Technical Lead
Appendix C, Section 2.2.5.2	QAPP	8	1	1	Based on the responsibilities state in Section 2.2.3.1 the Laboratory Coordinator interfaces with the Field Team leaders not the field samplers.

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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix C, Section 2.2.5.4	QAPP	9	2	3	This implies that a Field Oversight Coordinator will be responsible for training. How will training be documented?
Appendix C, Section 2.2.5.4	QAPP	9	2	9	This implies that a Field Oversight Coordinator will be present at every sampling event, is this feasible? And that they will be with every team should the investigation contractor deploy multiple teams. In the case that a field QA oversight coordinator is not at a specific sampling event who will be responsible for checking the COC prior to submittal?
Appendix C, Section 5.0	QAPP	12	1	6	What certificates are required? What Health and Safety training is required (e.g., site-specific or HAZWOPER 40hr)? How will training be documented?
Appendix C 9.1.1	Chain-of-Custody Record	19	3	1	Need to define "*MAGs* "
Appendix C, Section 9.1.2	QAPP	20	2	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done. If multiple coolers are needed, one COC Record ~~should~~ will accompany each cooler that contains the samples identified on the COC.
Appendix C 9.3.1	Sample Receipt	22	1	4	Line reads " *In the event that aqueous samples for metals analyses are received at pH > 2, acid preservative will be added by the laboratory the samples will equilibrate in the originally received bottle ware for a minimum of 24 hours prior to digestion. Sample preservation and equilibration will be fully documented via laboratory logbooks.* " Will these sampled be flagged as out of compliance with field preservation requirements?
Appendix C, Section10.0	QAPP	23	1	4	Detectability was not mentioned in the quality objectives and criteria for analytical data

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix C, Section 11.1	QAPP	26	4	6	At least 10% of the screening data ~~should~~ will be confirmed using appropriate analytical methods and QA/QC procedures and criteria associated with definitive data.
Appendix C, Section 11.1	QAPP	27	2	2	Based on the procedure outlined in ENV-TI-05.80.46 (Section 3.3.3, bullet [4]) it appears that the pH instrument will be calibrated to the 25degC certified buffer strength, rather than the temperature-adjusted buffer strength. Is this accurate?
Appendix C, Section 13.1	QAPP	33	2	2	Based on the QAPP and ENV-TI-05.80.46 the DO calibration is an air saturated water calibration which is time consuming and could introduce error if not done properly. Is this the method the field teams are actually using? Most field applications of DO that are not long-term, continuous monitoring applications utilize the water saturated air calibration method. Please clarify which calibration method the sampling teams will be utilizing.
Appendix C, Section 13.1	QAPP	34	1	2	Field pH meters used for collecting data will have to meet the calibration requirements of Method 9040C , which is 0.05 pH units of the bracketing buffer solution values. The QAPP references SESDPROC-100-R3, January 2013 and the TVA TI ENV-TI-05.80.46 which only require calibration to 0.1 SU.
Appendix C, Section 13.1	QAPP	34	2	4	Maintenance ~~should~~ will be performed when the instrument will not adequately calibrate. Maintenance of field equipment ~~should~~ will be noted in an instrument logbook or field notebook.
Appendix C, Section 17.0	QAPP	44	3	3	This audit report ~~should~~ will include a list of observed field activities, a list of reviewed documents, and any observed deficiencies.
Appendix C, QAPP Appendix A.2	QAPP Appendix A.1	A-3	1	3	In the event that certain required information is not included on a particular form, the laboratory ~~should~~ will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.
Appendix C, QAPP Appendix A.2	QAPP Appendix A.2	A-15	1	3	In the event that certain required information is not included on a particular form, the laboratory ~~should~~ will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.

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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix C, QAPP Appendix D	QAPP Appendix D	D-1	Table A		Sample matrix codes do not have nomenclature for laboratory supplied deionized water.
Appendix C, QAPP Appendix L	QAPP Appendix L	L-5	Table L-3		At RPDs greater than 20%, the data distribution starts to become non-normal and confidence in the representativeness of the sample results diminishes. If the RPD is greater than 20%, re-sampling may, but not necessarily, be required.
Appendix D	Figure 1	253/ 724	N.A.	N.A.	Provide proposed background soil sample locations overlaying a USDA soil map.
Appendix D	Figure 9	262/ 724	N.A.	N.A.	Additional borings need to be proposed within the CCR unit limits to aid in confirming the presence of a continuous soil liner and soil classification of the liner.
Appendix D	Figure 11	264/ 724	N.A.	N.A.	Provide an additional Figure overlaying Historical Wells Creek alignment and limits of grouting from Drawing 10N212 R11 dated 5/20/91 onto Figure 11 "Proposed Borings". Borings need to be proposed in these areas to better define the geology and hydrogeology below the CCR units.
Appendix D	Figure 14	267/ 724	N.A.	N.A.	Provide additional Figure that indicates the location of all historical well that have been closed. Provide a copy of all groundwater monitoring optimization plans for the site that reference, discuss or document closure of wells. Provide the 2017 "Geotechnical Field Services for Well Installations and Closures, Groundwater Monitoring Optimization - Phase 3, Cumberland Fossil Plant, Cumberland City, Tennessee" dated February 10.
Appendix D	Figure 15	268/ 724	N.A.	N.A.	Add sediment sampling location in the proximity of the stilling pond discharge at the cooling water discharge channel.
Appendix D	Figure 19	272/ 724	N.A.	N.A.	Include documentation for the seep repair grouting at the Ash Pond referenced memorandum dated 11/20/1990 (B65901120029).
Appendix D	Figure 15 & 20	N.A.	N.A.	N.A.	Surface water and sediment sampling needs to be proposed for the embayment/pond in the northeast corner of the TVA property.
Appendix D	Figure 20	273/ 724	N.A.	N.A.	Add surface stream sampling locations in the proximity of Highway bridge at Wells creek and the cooling water discharge channel.

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Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix E, Section 3.0	Background Soil SAP	3	1	5	Field teams should consist of (at a minimum) an experienced TN licensed professional geologist.
Appendix E 4.0	Sampling Locations	4	2	3	Borings should be logged by a Tennessee licensed professional geologist not a professional engineer.
Appendix E 5.2.1.1	Background Borings	7	1	1	TVA has previously stated in this EIP that borings will be extended until refusal or a depth of 20 feet below encountered groundwater surface, whichever is shallower. The SAP is designating that borings will only be advanced until refusal. Please clarify.
Appendix E, Section 5.2.1.1	Background Soil SAP	7	3	10	Will the mid-point for sampling aliquot be the vertical depth midpoint or the mid-point based on recovery? What is the contingency if recovery is poor? Or is it a composite over the entire 5ft interval?
Appendix E, Section 5.2.1.1	Background Soil SAP	7	4	1	Borehole should be filled with cement-bentonite grout mixture using a tremie pipe to within approximately six inches of the surface. The top six inches should be restored to match the existing surface.
Appendix E, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil color will be determined using a Munsell soil color chart.
Appendix E, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil will be logged following the visual-manual procedures of the American Society of Testing and Materials (ASTM) Standard D2488-09a
Appendix E, Section 5.2.1.2	Background Soil SAP	8	1	5	Soil should be logged to include soil consistency or density, size, shape and angularity of particles, plasticity (for fine-grained soil)
Appendix E, Section 5.2.5	Background Soil SAP	12	Table 4	9	A pH field test kit should be employed to help identify if soil pH is in a range to mobilize CCR contaminants (specifically target sample aliquots and horizon changes). For example several metals are easily leached from acidic soil, however selenium is mobilized under alkaline conditions. Also, due the short hold time, which will create a situation where the analytical result will not be within the 15 min holding time, please consider a field method measurement of pH for comparison.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix E, Section 5.2.7	Background Soil SAP	13	4	1	Some of the requirements in the Background Soil Sampling SAP are written as should. The SAP must be written as what will be done. This indicates the requirements on what will be acceptable. If the procedure cannot be followed, identify in the QAPP or QA/QC section of SAP how things will be documented that don't follow the QAPP /SAP requirements. Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.
Figure 13	NA	NA	NA	NA	Although CUF-210 is listed as being anomalous compared to surrounding wells, what is the background information that supports that decision? If the screen and well are intact and screened in the same location then CUF-210 appears to indicate an area of potential mounding, the flow in this area needs to be further clarified as it appears that groundwater may flow bidirectionally southeastward and northwestward and not necessarily to Wells Creek. Wells Creek pool elevation and Cumberland river elevation should be depicted on potentiometric maps.
Figure 14	NA	NA	NA	NA	Figure 14 shows the Cumberland River stage gauge location but does not depict a staging location in Wells Creek. Please revise to show Wells Creek gauging station location.
Table 1B	NA	NA	NA	NA	CUF-213 has had an unusually high pH (9.77) compared to surrounding wells, is it screened in ash?
Table 1C	NA	NA	NA	NA	CUF-204 and CUF-205 both exhibit a significant change in water levels between November 2016 and January 2017, approximately 10ft and 7ft respectively. Do these elevations reflect higher than normal pool elevations of the Cumberland river?
Appendix F 3.5.1	Field Activities	19	2	2	The paragraph states that 7 borings were installed to the NE of the CCR units and the data will not be considered as part of this assessment. TDEC would like to evaluate the boring locations and associated data
Appendix F	All	All	All	All	General comment - All subsurface and boring logging should be completed by a Tennessee licensed professional geologist only, not a professional engineer.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix F	3.1	6	1	All	Traditional methods of conducting a subsurface geologic investigation utilizing vertical bore- and core holes will probably not produce the data necessary to decipher the bedrock geology of the site. Bedrock exposures in the crater document that the bedding is steeply dipping to near vertical and so is the interpreted geometry of the faults. Drawing accurate cross sections will be difficult using vertical boreholes. Borehole depths may need to be very deep when encountering steeply dipping beds in order to attempt to correlate the geology between boreholes. Furthermore in many places the bedrock is highly fractured to the point of being brecciated, which may make it difficult to obtain bedrock cores.
Appendix G, Section 4.1	Material Quantity SAP	5	2	4	Draft model and discussion as the model is being developed
Appendix G, Section 4.2.1	Material Quantity SAP	5	1	7	Exploratory Drilling SAP should be Appendix H, not Appendix F.
Appendix G, Section 4.2.1	Material Quantity SAP	6	1	1	Is a minimum of 3 month adequate to determine if there is any seasonal fluctuation? Recommend a minimum of 6 months.
Appendix G	4.2.1	6	1	1	TDEC recommends monthly water level monitoring be conducted during a timeframe that is representative of average precipitation at the CUF.
Appendix G, Section 5.2.5	Material Quantity SAP	10	2	1	Discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.
Appendix H	5.2.1.2	9	3	1	TDEC recommends borehole geophysics (gamma logs, etc..) be conducted as part of the exploratory drilling operations.
Appendix H, Section 5.2.9	Exploratory Drilling SAP	14	1	1	Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as to not create a safety hazard.
Appendix H, Section 5.3.2.2	Exploratory Drilling SAP	16	1	11	Why is the target turbidity for development 10 NTU when the groundwater stabilization criteria listed for turbidity in ENV-TI-05.80.42 is less than 5 NTUs?
Appendix I	5.1.3	9	1	1	TDEC recommends monthly data collection be conducted during a timeframe that is representative of average precipitation at the CUF.
Appendix I	5.2	9	1	6	Please define "*statistically significant* "
Appendix K	5.4	8	2	6	Please correct apparent error with word "*Potentially* "
Appendix K, Section 5.5.4	Water Use Survey SAP	11	1	7	The sample ~~should~~ will be collected at the indoor or outdoor tap closest to the wellhead, prior to any water treatment devices.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix L	Hydrogeological Investigation SAP	All	All	All	General comment - TDEC recommends installing monitoring wells within the ash disposal complex to accurately characterize groundwater flow beneath the complex.
Appendix L	Hydrogeological Investigation SAP	All	All	All	Demonstrate how groundwater at the new background well locations are representative of background groundwater quality. This demonstration should include flow rate and direction associated with the aquifer being monitored.
Appendix L	Hydrogeological Investigation SAP	All	All	All	Background well CUF-1001 could potentially be impacted from facility operations from handling the coal and gypsum. How can this well location demonstrate groundwater that has not been impacted by the CCR waste or facility operations?
Appendix L	Hydrogeological Investigation SAP	All	All	All	This SAP is missing a table of the well construction details TVA anticipates for the additional ground water monitoring wells. This includes latitude and longitude, approximate screen interval below ground surface, anticipated depth of groundwater, estimated depth of bedrock.
Appendix L	Hydrogeological Investigation SAP	4	2	1	It is premature to designate background well locations until such time that groundwater flow has been characterized at the CUF. TDEC recommends installing additional groundwater wells in both soil and bedrock to the southwest, northwest, and within the ash pond complex to fully characterize groundwater flow at the CUF.
Appendix L, Section 4.0	Hydrogeological Investigation SAP	4	2	10	Alternative locations need to be indicated on the map.
Appendix L, Section 5.1	Hydrogeological Investigation SAP	6	2	1	Potable water should be used for drilling, installation, and development of all environmental monitoring wells and piezometers. Non potable water may be used for core holes, geotechnical borings, or other boreholes in which monitoring wells are not installed.

Table 1 TVA Cumberland EIP Rev 1
Summary of TDEC Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix L, Section 5.2	Hydrogeological Investigation SAP	6	2	2	The elevation of the established and documented point on the top of each well casing will be correlated to Mean Sea Level
Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	2	1	If the well is intended to be 4" ID and 5.5" OD then a larger than 9" borehole may be required to allow for proper placement of completion materials such as filter sand and bentonite pellets.
Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	2	3	Preference is for 10-ft well screen to be set within the coarser unit above the bedrock.
Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	2	11	The annular grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs./gal shall be used.
Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	5	1	Missing period. *An example installation log is shown in Figure 3 A drawing of the wellhead construction is shown in Figure 4.*
Appendix L, Section 5.2.7.2	Hydrogeological Investigation SAP	11	1	1	Monitoring well development should not begin until a minimum of 24 hours following completion of the well.
Appendix L, Attachment A	Hydrogeological Investigation SAP	NA	Figure 3	NA	Well pump placement should be at the midpoint of the screen, if the screen is fully submerged, otherwise the pump should be placed at the midpoint of the saturated interval. It is unclear by this figure that the pump is placed correctly.
Appendix L, Attachment A	Hydrogeological Investigation SAP	NA	Figure 3	NA	Water encountered during drilling should be shown on stratigraphy log adjacent to monitoring well construction log.
Appendix M	Groundwater Investigation SAP	All	All	All	General comment - TDEC recommends installing monitoring wells within the ash disposal complex to accurately characterize groundwater quality beneath the complex.

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix M	Groundwater Investigation SAP	All	All	All	Groundwater monitoring reports for samples taken should be submitted within 60 days of sampling event to TDEC. If TVA cannot meet the SW Rule requirement TVA should submit justification for an alternate schedule. We understand that Radium 226 and 228 analysis take longer, but those results can be submitted at a later date as an addendum.
Appendix M	Groundwater Investigation SAP	All	All	All	Recent groundwater results submitted by email on August 25, 2017 show an arsenic exceedance at wells CUF-206 (10.5 ug/L), CUF-211 (10.8 ug/L) and CUF-213 (12.8 ug/L). TVA must initiate an assessment of corrective measure as required by SWM Rule 0400-11-01-.04-7. or explain why it is not necessary.
Appendix M	Groundwater Investigation SAP				Statistical methods to be used for evaluating groundwater monitoring data are not developed in this EIP. TVA must include the selection and certification of the statistical procedure to be used in accordance with 40 CFR 257.93. The certification must include a narrative description of the chosen statistical method.
Appendix M, Section 3	Groundwater Investigation SAP	2	1	2&6	The Groundwater Investigation SAP indicates determining direction only, however 40 CFR 257.93 requires the rate and direction of groundwater flow each time groundwater is sampled.
Appendix M	Groundwater Investigation SAP	4	1	3	TVA states that monitoring wells that are being sampled as part of other programs will not be sampled as part of this SAP. TDEC recommends all groundwater monitoring wells be sampled as part of the EIP and the data provided to TDEC for review.
Appendix M, Section 4	Groundwater Investigation SAP	4	5	3	The gauging of the pool elevation of Wells Creek is a critical component to understanding groundwater flow at the site. It needs to be measured as part of the environmental investigation. The location of the gauge needs to be shown on Figure 1.
Appendix M	Groundwater Investigation SAP	4	3	5	It is premature to designate background well locations until such time that groundwater flow has been characterized at the CUF. TDEC recommends installing additional groundwater wells in both soil and bedrock to the southwest, northwest, and beneath the ash pond complex to fully characterize groundwater flow at the CUF.

Table 1 TVA Cumberland EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix M, Section 4	Groundwater Investigation SAP	4	6	1	This statement makes it appear that 93-1, 93-2R, 93-3, 93-4, 96-9, B103, B110, CUF-101, CUF-102, CUF-120, CUF-201, CUF-202 and CUF-205 through CUF-213 will not be sampled but only gauged for water levels. Is this accurate? Please specify which wells are monitoring wells and which are observation wells.
Appendix M, Section 4	Groundwater Investigation SAP	5	1	1	When installing new groundwater monitoring networks, groundwater quality data from at least eight events is needed, in most cases, to fully assess and compare up gradient versus downgradient groundwater quality. Please address justification for sampling frequency.
Appendix M, Section 5.2.2	Groundwater Investigation SAP	7	5	5	If the final turbidity after sample collection is greater than 10NTU is there any additional requirements for resample?
Appendix M, Section 5.2.2	Groundwater Investigation SAP	8	2	1	Will barometric pressure readings be recorded? What will be the frequency and source of the barometric pressure readings? Will ambient air temperature be measured? Will a correlation between a NIST thermometer and the temperature on the multi parameter probe be made and recorded?
Appendix M, Section 5.2.6	Groundwater Investigation SAP	13	Table 5		Field pH meters used for collecting data will have to meet the calibration requirements of Method C , which is 0.05 pH units of the bracketing buffer solution values.
Appendix M, Section 6.2	Groundwater Investigation SAP	15	4	1	If the tubing used to collect the filter blank is not certified clean tubing then a tubing blank would be required at the same rate of collection as a filter blank and for the same analytes.
Appendix M, Section 6.2	Groundwater Investigation SAP	15	6	7	If an analyte is not amenable to the MS/MSD procedure it should be collected as a lab duplicate (e.g., TSS and radium)
Appendix M, Appendix A	Groundwater Investigation SAP	22	Figure 1		Please show location of Wells Creek staff gauge and the second Cumberland River gauge.

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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix N	CCR Material Characteristics SAP	All	All	All	TDEC recommends conducting a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility. This would include not only pore water analysis but LEAF methods (SPLP, TCLP) for solid material. Samples should be collected from multiple depths within the profile of each material located in the ash disposal complex.
Appendix N, Attachment A	CCR Material Characteristics SAP	NA	Figure 1	NA	TDEC recommends additional temporary wells be installed in the retention pond and stilling pond area to accurately assess the presence of ash and leachability characteristics there of.
Appendix O	Sediment SAP	All	All	All	General comments - TDEC recommends analyzing all top six-inch sediment samples for CCR parameters. TDEC recommends running additional analysis on boring samples if CCR constituents are detected in the associated top six-inch sediment sample not only if percent ash >20%. TDEC recommends adjusting sediment sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river bed profile. TDEC recommends implementing Phase 2 sampling if CCR constituents are detected in the associated top six-inch sediment sample.
Appendix P	Seep SAP	All	All	All	How does TVA plan to identify, assess, and sample seeps that may not currently be visible due to mitigation (rip rap)?
Appendix Q	Surface Stream SAP	All	All	All	General comments - TDEC recommends collecting water column samples (top, middle, and bottom) at each sampling location in Wells Creek, the Cumberland River, and the unnamed tributary flowing into Wells Creek. Effort should be made to co-locate water column samples with sediment samples collected as part of the EIP as well as the already identified sampling locations. TDEC recommends adjusting water column sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river profile.

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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix Q	Surface Stream SAP	All	All	All	General comment - Background sample locations in should be upstream of the CUF and ash pond area, outside of any potential influence from site activities and CCR storage/release.
Appendix Q	Surface Stream SAP	All	All	All	General comment - TDEC recommends implementing Phase 2 sampling if CCR constituents are detected in the associated top six-inch sediment sample.
Appendix Q	Surface Stream SAP	All	All	All	General comment - TDEC recommends multiple sampling events to account for seasonal fluctuation of rain fall and water quality conditions.
Appendix R	Fish Tissue SAP				Several species of fish are targeted. The plan should focus on fish that are popular with local fishers.
Appendix R	Fish Tissue SAP				How will sample integrity be maintained?
Appendix R	Fish Tissue SAP				It does not appear that DQOs have been identified in either the SAP or QAPP for the fish tissue sample collection activities. The text should explain relevant DQOs assuming that they would be primarily related to sample handling issues. One exception involves the measurement of sample location surface water pH. DQOs for pH will require that meters are calibrated to a known standard in accordance with manufacturer's specifications.
Appendix R, Section 5.2.1.2	Fish Tissue SAP	8	2	7	The text should explain how why only muscle and ovary sampling was chosen and does not appear to include the following four types of fish tissue: liver, muscle, ovary and testes.
Appendix R, Section 3.0	Fish Tissue SAP	3	1	5	Field teams should consist of (at a minimum) one experienced fisheries biologist, one field technician, and a quality control specialist, all of whom must have experience with the array of fisheries sampling equipment to be used.
Appendix R, Section 5.2.1.2	Fish Tissue SAP	8	2	3	The sampled fish should be of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual
Appendix R, Section 5.2.4.1	Fish Tissue SAP	10	2	6	Since the fish tissue samples are required to be maintained at -10 degrees C, wet ice in resalable bags may not meet that requirement. It is suggested to pack the samples on dry ice, and that the samples arrive at the sample preparation laboratory within less than 24 hours from the time of sample collection.
Appendix R	Fish Tissue SAP	13	Table 5		Please confirm the appropriate method for Mercury analysis (i.e., Method 1631, Revision B with Appendix A or Method 7473)

Appendix B
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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)
1	All	All	NA	NA	NA	General content comment - please give titles to sections that reflect the content of the section - *"TDEC Information Request"* is not an appropriate section title.	Comment is acknowledged and the corresponding change has been made in the document.
2	General Comment	All	NA	NA	NA	TVA has indicated that it plans to close the existing landfill in place, the purpose of the EIP is to determine the proper closure remedy.	Comment is acknowledged. TVA is updating the purpose section of the EIP to match Section VII.A.d of the Order which is to "fully identify the extent of soil, surface water and ground water contamination by CCR". Consideration of remedies does not come until Section VII.A.f of the Order with the CARA Plan.
3	General Administrative	NA	NA	NA	NA	The document lacks a signature page that indicates the document has been read and that the various parties (e.g., QA consultant, Investigation Consultant field personal) understand the relevant requirements.	Comment is acknowledged and the corresponding change has been made in the document.
4	General Administrative	NA	NA	NA	NA	The document lacks an approval page, with all stakeholders listed.	Comment is acknowledged and the corresponding change has been made in the document.
5	General Administrative	NA	NA	NA	NA	The document lacks a revision log.	Comment is acknowledged and the corresponding change has been made in the document.
6	General Administrative	NA	NA	NA	NA	TDEC will be notified immediately by the TVA of any problems related to successful completion of field efforts as outlined in this EIP.	Comment is acknowledged and the corresponding change has been made in the document.
7	Global SAPs	NA	NA	NA	NA	The SAPs lack a list of field equipment and critical spare parts (if applicable) related to the specific tasks described in each SAP.	Comment is acknowledged and the corresponding change has been made in the document. The SAPs have been revised to include a list of field equipment as an Attachment. The QAPP has been revised to state that spare parts will be the responsibility of the contracted equipment provider.
8	Global SAPs	NA	NA	NA	NA	There needs to be a maintenance form created to document the routine checks and both the regular and special maintenance that will occur for each instrument. This form needs to include the nature of the maintenance the qualified person and dates.	Comment is acknowledged and the corresponding change has been made in the document. The QAPP has been revised to state "field equipment will be maintained under service contract for rapid instrument repair or provision of backup instruments in the case of instrument failure". The contracted equipment provider will be responsible for equipment maintenance.
9	General Technical	NA	NA	NA	NA	Is there a plan to look at the data for trends when common leachate indicators are compared to the total amount of CCR metals in contaminated water samples. It is important to determine if there is a relationship because of the expected geochemical relationships between chloride, other leachate indicators, and the presence of CCR metals, otherwise only CCR metals can be used to reliably indicate leachate- groundwater interaction.	Following collection of the leachate data from the proposed work in the EI, the data will be evaluated for trends and additional assessment will be performed as necessary.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)
10	General Technical	NA	NA	NA	NA	Will Piper diagrams be used to compare the hydrochemical facies of EIP groundwater samples? And if so please identify what comparison(s) will be made (e.g., gypsum storage are vs. dry ash stack; contaminated wells versus background wells, etc.)?	Piper diagrams will be used to classify groundwater samples according to their major ionic composition. Groundwater sample results from background and downgradient monitoring wells will be included in the evaluation. Additional Piper diagram comparisons of individual CCR units or geological formations may be included based on the results of the hydrogeological investigation.
11	General Technical	NA	NA	NA	NA	Has there been any comparison or evaluation of wells to determine if they are hydraulically influenced by river stage (both Wells Creek and Cumberland River)? This is an integral part of understanding the hydrogeological setting of the CCR units. The potentiometric map does not show radial flow to the Cumberland River from CUF-101/CUF-120 area.	This is part of the EIP Section 3. Analysis of correlations between groundwater and surface water elevations, seasonal variations and effects on the saturation level in the CCR units will be included in the EAR.
12	2.1	EIP Development and Structure	5	5	1	Please provide a minimum frequency that TVA will be providing progress reports to TDEC.	Monthly progress reports and schedule updates will be provided to TDEC. Change will be made in the document.
13	2.2	Proposed Schedule	6	All	All	The schedule should acknowledge and be in accordance with the February 22, 2017 letter from Chuck Head to Susan Smelley (reference page 140 in Appendix B of this document). Ongoing and planned studies for other programs shall be submitted for TDEC's review and comment and incorporated into the EAR.	Comment is acknowledged.
14	2.2	Proposed Schedule	6	2	All	Monthly schedule updates will be provided to TDEC depicting progress for all EIP activities. TVA should include explanations for lagging or incomplete EIP tasks.	Monthly progress reports and schedule updates will be provided to TDEC. Change will be made in the document.
15	2.3	Quality Assurance Project Plan (CUF Quality Plan)	6	1	1	Suggest using common abbreviations for clarity, Appendix C uses CUF QAPP instead of CUF Quality Plan.	Comment is acknowledged and the corresponding changes have been made in the document.
16	2.3	Quality Assurance Project Plan (CUF Quality Plan)	7	2	4	Please include as an appendix to the EIP the referenced "*Data Management Plan* ".	The Data Management Plan for the TDEC Order environmental investigations will be provided to TDEC under separate cover as a stand-alone document. Site specific updates to the Data Management Plan, if applicable, will be included in each site specific QAPP.
17	3.1.1	A.1 TDEC Information Request	8	2	7	Line reads "*The General Guidelines removed the requirement for hexavalent chromium analysis* ." This is incorrect. TDEC will require both total chromium and hexavalent chromium to be analyzed.	Previous hexavalent chromium sampling events at other TVA sites have shown that quantitation of Cr(VI) is not reliable at trace concentrations. Hexavalent chromium that might occur in soil or in CCR would be expected to quickly be reduced to trivalent chromium as it oxidizes other constituents. A more feasible, phased approach is for TVA to analyze samples for total chromium, the form of chromium listed in the CCR Rule Appendix IV. If total chromium values in soil are at EPA RSL guidelines, TVA will consult with TDEC about how best to perform analyses for hexavalent chromium. All chromium sample results will be in the EAR.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)
18	3.1.1	A.1 TDEC Information Request	8	4	4	Statistics play a major role in determining background concentrations and based on chosen method will effect the sample design and data analysis. Please specify how the background soil will be evaluated and what statistical method will be employed to determine what background levels are for the CCR parameters.	There are multiple statistical methods available to calculate background concentrations. TVA proposes to utilize Background Threshold Values (BTVs) as the method to statistically evaluate and quantify site specific background concentrations for CCR parameters. BTVs are calculated using sampling data collected from un-impacted site-specific reference areas and represent an upper threshold of background concentration(s). The choice of BTV (Upper Confidence Limit, Upper Threshold Limit, Upper Prediction Limits) will be determined based on characteristics of the data (e.g. sample size, statistical distribution). All statistical analyses will be conducted utilizing the latest version of USEPA ProUCL software (currently version 5.1.0) and consistent with ProUCL Technical Guidance Document (USEPA 2015. ProUCL Version 5.1 Technical Guide. Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. EPA/600/R-07/041).
19	3.1.1	A.1 TDEC Information Request	8	4	4	Will a background concentration be determined for each soil type? Please explain how many samples from each soil type will be considered a valid test population for statistical evaluation.	TVA proposes to collect a minimum of 12 background samples from each soil horizon or geographic strata for the purpose of establishing background concentrations of CCR parameters. Twelve samples is consistent with other State's guidance (Ohio) and consistent with the findings presented in Gilbert, 1987. Twelve samples also exceeds the recommended number of samples for other States (n=4 for Wisconsin and Alabama). If TDEC has specific regulatory guidance on the number of samples required, please provide that guidance to TVA.
20	3.1.1	A.1 TDEC Information Request	9	3	4	This refers to the collection of background soil samples for use at the TVA CUF site. Location is provided in Appendix E, the background Soil Sampling and Analysis Plan on page 297 of the EIP Document at Figure 1. Generally the locations seem appropriate with the exception of SB 01 (possible impact by CCR contaminated surface water and ground water). Also, TVA should consider a boring directly east of SB 05 and south of the pond noted on Figure 1.	The location of soil boring SB 01 has been relocated as shown on Figure 1A. TVA considered placing a boring at the location directly east of SB 05, however that property is not owned by TVA and is not accessible to TVA.
21	3.1.1	A.1 TDEC Information Request	9	4	6	Line reads "*Proximity to existing background groundwater monitoring wells ;*". Sample locations can be near existing background monitor well locations, but this should not be used as a criteria to exclude a sample location.	Comment is acknowledged.
22	3.1.1	A.1 TDEC Information Request	9	4	NA	TDEC recommends considering the direction of stormwater and groundwater flow from the CUF ash ponds and potential for historic inundation of sample locations during rain events and river flooding events. Care should be taken not to sample in an area that may have been in contact with CCR constituents during rain events, flood events, or currently being influenced by groundwater flow from CUF.	Comment is acknowledged.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)
23	3.1.1	A.1 TDEC Information Request	10	3	7	It is unclear as to whether or not the sampling is a single grab sample or multiple aliquots that generate one composite sample. Since in the text it states "grab samples". A five foot sample interval seems course in suspected alluvial silts and clays. A 1-2.5 ft. interval, or change in lithology is recommended for silts and clay. Five foot intervals may be appropriate in sands. Also if the soil is fine sand and silt the sample should be biased to sampling the interface between sand lenses and silt since these lenses are of the conduits for contaminant movement. In clays the inorganics will tend to adsorb and samples should be collected from soil fractures or areas that show oxidation.	All proposed background soil samples are grab samples. One grab sample is proposed from the mid point of each five foot soil core, unless there is a change in lithology within a five foot core interval. In the event that a change in lithology occurs within a core interval separate grab samples will be collected from the mid point of both lithologies in the core. Since the purpose of this study is to investigate natural soil chemistry and determine background concentrations of naturally occurring CCR constituents, the biasing of sample collections or collection of additional samples for this purpose is not warranted. The proposed background soil borings are positioned at locations that are not expected to be impacted from stormwater, flooding, or groundwater from CUF and are positioned in areas previously determined to not be impacted by plant activities.
24	3.1.1	A.1 TDEC Information Request	10	3	11	Grab samples are okay. No composites. This should be reinforced on page 284 of the Adobe document in Section 5.2.1.1, 3rd paragraph.	Comment is acknowledged and the corresponding change has been made in the document.
25	3.1.3	A.3 TDEC Information Request	11	3	8	TVA shall sample the spring on the Rye property if at all possible. If TVA cannot get access, then TDEC will assist	TVA has not been granted access by the property owner to sample Rye Spring. Historically, TVA sampled Rye Spring as a background groundwater monitoring site. The last date TVA sampled the spring was on April 15, 2016. After that time, the property owner has decided not to allow TVA access to the spring. To the extent that TDEC wants TVA to sample Rye Spring rather than identify a current well and/or future well as a new background monitoring well, TVA would appreciate TDEC's help in alleviating the landowner's concerns and obtaining from the landowner a signed access agreement granting TDEC and TVA permission to simultaneously enter the property and for TVA to sample Rye Spring. TVA will work with TDEC to draft an agreeable access agreement for TDEC to provide to the landowner to sign.
26	3.1.5	A.5 TDEC Information Request	12	All	All	TVA should highlight and summarize references in the historical documents that provide data that supports the existence of a continuous constructed or natural clay liner between the coal ash and bedrock and water table.	The clay foundation map (Figure 9) will be revised to describe the uppermost foundation soil type (clay, silt, sand, etc.) in each boring. Associated sections of the EIP text will be updated, including references for the historical documents. The foundation soil information will be incorporated into the 3D model of the CCR units and results provided in the EAR.

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27	3.1.6	A.6 TDEC Information Request	14	2	10	The data discussed is relatively old. A clear delineation between the sluiced ash and the gypsum stack is needed. This information is needed is making stability calculations for the gypsum landfill. Should new borings be required to better identify the sluiced ash/gypsum contact.	Additional discussion will be added to the EAR regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are documented and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects as outlined in the EIP. Summary tables of key boring parameters will be provided as part of the EAR. In addition to borings, the permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 81-102-0086. In addition to borings, the permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 81-102-0086. Finally, the EAR will provide explanation that a more accurate delineation of the gypsum/sluiced ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary.
28	3.1.6	A.6 TDEC Information Request	14	5	1	TDEC recommends additional borings to characterize the interface between the gypsum stack and sluiced ash for the Gypsum Landfill. There appears to be little data available from the center of the Gypsum Landfill (Figure 8). Additional fieldwork and boring installation will likely be required to fully characterize the interface in this area	The existing information referenced in the EIP is adequate to support a response to this information request. Additional discussion will be added to the EAR regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are known with reasonable confidence and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value.
29	3.1.7	A.7 TDEC Information Request	14	2	1	TDEC recommends additional borings to characterize the interface between the dry ash stack and sluiced ash for the Fly Ash and Bottom Ash Landfill. There appears to be little data available from the center of the Landfills (Figure 8). Additional fieldwork and boring installation will likely be required to fully characterize the interface in this area.	The existing information referenced in the EIP is adequate to support a response to this information request. Additional discussion will be added to the EIP regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are known with reasonable confidence and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects. Finally, the EAR will explain that a more accurate delineation of the stacked ash/sluiced ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary. Summary tables of key boring parameters will be provided as part of the EAR.

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30	3.1.8	A.8 & A.9 TDEC Information Request	15	All	All	TVA should coordinate this request with Activity ID STN-33070 provided in the CUF EIP Implementation Schedule. As an example, if the Federal rule assessment mandates closure of one or both of the units what final grades are anticipated based on a mandated closure date and waste receipts. Modifications to the storm water design, stability analysis, and closure plan may be required.	Comment is acknowledged and the corresponding change has been made in the document.
31	3.1.8	A.8 TDEC Information Request	15	3	4	TVA shall present both permitted waste cell height and proposed cell height at closure.	Comment is acknowledged and the corresponding change has been made in the document.
32	3.1.10	A.10 TDEC Information Request	16	3	5	TVA discusses submission of a proposed three dimensional model of the CCR materials disposed at the CUF site using existing data. This provides a good starting point for the area of waste disposal. However, TVA should be required to submit a revised three dimensional model of the CCR material disposed at the CUF site in the EAR, based on the findings of the EIP. It is tremendously important for TVA to identify any areas at the CUF site where CCR material is disposed below ground water. For closure in place, TVA has to follow the CCR regulations, specifically 257.102(d)(2)(i and ii) which states: ***"(2) Drainage and stabilization of CCR surface impoundments. The owner or operator of a CCR surface impoundment or any lateral expansion of a CCR surface impoundment must meet the requirements of paragraphs (d)(2)(i) and (ii) of this section prior to installing the final cover system required under paragraph (d)(3) of this section. (i) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.*** ***(ii) Remaining wastes must be stabilized sufficient to support the final cover system."***	The proposed 3-D model is not a preliminary model. It is based on a thorough evaluation of site-specific data regarding the base, sides and surface elevations of CCR. To the extent that information is developed during the environmental investigation that affects CCR volume calculations, revisions to the 3-D model will be included in the EAR. Corrective actions based on this 3-D model or any other data found in the EAR will be found in the CARA Plan according to Part VII.A.f of the Order.
33	3.1.10	A.10 TDEC Information Request	16	1	7	The ERI data has not been provided in the EIP and therefore cannot be evaluated, the transects and interpretation should be included both graphically and with a narrative in the EAR. Were the ERI data correlated with existing borehole data in order to calibrate the apparent resistivity values with bedrock? If so how well did the ERI data match boring data? Were structural features or karst features indicated on the transects? On transects that do not have boring data that indicate the top of rock, a boring should be installed to calibrate the values before inclusion into a 3D model of the site.	The ERI data has recently (August 2017) been provided to TDEC under separate cover. The ERI data were correlated to select borings, but as shown on Figure 10 there are many other borings that can be correlated and interpreted. This evaluation will be presented in text and graphics in the EAR. No new borings will be necessary to perform this evaluation. The ERI results identified one potential bedrock discontinuity which will be further evaluated in the EAR. Otherwise, the ERI did not identify anomalies that would typically be associated with karst topography.

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34	3.1.10	A.10 TDEC Information Request	16	1	7	Were the ERI data collected at a sufficiently close interval as to image small 3-6 ft. wide preferential pathways for groundwater migration along possible fault traces, fracture zones, or joint sets?	Objectives of the ERI were to "...better define the bedrock surface, location potential karstic features and to see if the former Wells Creek channel features can be seen" (AECOM 2016 Attachment B) and to "evaluate subsurface conditions and delineate bedrock fractures, karst topography, gravel layers, and relict stream beds..." (AECOM 2016, Attachment C). Results were used to aid in planning subsequent borings. The scope of work proposed is believed to be appropriate for an initial phase of an environmental investigation. Additional investigations will be proposed if warranted by the results of the initial investigation.
35	3.1.10	A.10 TDEC Information Request	17	2	9	TVA proposes adding additional borings and temporary wells at the TVA should locate additional borings and monitoring wells within the TVA CUF gypsum and ash landfills and between the landfill and the Cumberland River. There is very little subsurface data available in the area between the landfills/sluice ponds and the river (the plant area). Please see the Figure and Adobe page 372 of the EIP.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. The results of the investigation activities will be evaluated to assess if additional monitoring wells are needed to characterize the hydrogeology at the site. Additionally, vibrating wire piezometers have been installed in the Dry Ash Stack and Gypsum Storage Area as part of other ongoing TVA programs. Water level data collected from these piezometers will be used to characterize groundwater flow beneath the units. The proposed scope of work is consistent with an initial phase that is needed is to evaluate groundwater flow. Based on the results of the initial phase of work, additional investigations may be proposed to characterize the extent of CCR constituents, if CCR constituents are detected in groundwater at concentrations indicating impacts from CCR units.
36	3.1.10	A.10 TDEC Information Request	18	2	All	Ongoing and proposed studies for other programs shall be submitted for TDEC's review and comment and incorporate findings into the EAR.	In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.
37	3.1.10	A.10 TDEC Information Request	18	4	4	Along with normal pool elevation, the 3D model should also show maximum and minimum pool elevation of the stilling pond	Comment is acknowledged; the 3D model will include this information.
38	3.1.11	A.11 TDEC Information Request	19	2	1	The Wastewater Characterization Plan did not include a plan for taking analytical results for CCR Parameters.	The Wastewater Characterization Plan was associated with a separate TVA project to evaluate options for potential future wastewater management alternatives and is not associated with this Environmental Investigation. If the need for wastewater characterization develops after completion of the Environmental Investigation, TVA will perform this characterization. Current wastewater monitoring is captured in the site's NPDES permit.
39	3.1.11	A.11 TDEC Information Request	20	7	4	TVA proposes using a rating curve in conjunction with the elevation of the impoundment system to calculate discharge rate. TDEC recommends installing automatic flow meters at the discharge outlet to accurately measure the discharge rate.	TVA will install automatic flow meters at the discharge outlet to accurately measure the discharge rate.
40	3.1.13	A.13 TDEC Information Request	22	All	All	TVA should conduct response to this request with respect to faults/fractures as well as voids/cavities.	Comment is acknowledged.

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41	3.1.13	A.13 TDEC Information Request	24	NA	NA	Stability of bedrock below fill areas - The EIP discusses the installation of 13 borings in the area of the stilling pond and the landfill. Will these borings provide enough additional information to adequately determine the stability of the rock structure below? - see Figure 1 Adobe Page 423	As noted in Section 3 of the EIP, the proposed borings are not, by themselves, intended to assess bedrock stability. Instead, the proposed borings are intended to be used in conjunction with existing geotechnical and hydrogeologic data, surface geophysics, geologic mapping/characterization, and visual inspection reports. The proposed borings, when used as part of this broader data set, are sufficient to respond to the information request.
42	3.1.14	A.14 TDEC Information Request	27	2	6	Need to report river stage (Cumberland and Wells Creek) on potentiometric map and whether it was a high or low during specific sampling events and if any changes in potentiometric water level either in surficial or bedrock aquifer can be attributed to river stage.	This is part of the EIP Section 3. Analysis of correlations between groundwater and surface water elevations, seasonal variations and effects on the saturation level in the CCR units will be included in the EAR. No additional information is needed.
43	3.1.15	A.15 TDEC Information Request	28	All	Last	Ongoing and upcoming studies for other programs shall be submitted for TDEC's review and comment and incorporate findings into the EAR.	In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.
44	3.1.15	A.15 TDEC Information Request	28	6	3	Any documents and data used to help determine soil and CCR sheer strengths should be included in the EAR. TVA shall denote how this data was incorporated with other existing data and new data to make sheer strength calculations	The relevant documents are summarized in Appendix "Evaluation of Existing Geotechnical Data" of the EIP, and many of the documents have been provided to TDEC via the Information Conference data transmittal. The information will also be summarized in the EAR.
45	3.1.16	A.16 TDEC Information Request	31	1	2	Ongoing and upcoming studies for other programs shall be submitted for TDEC's review and comment and incorporate finding into the EAR.	In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.
46	3.1.16	A.16 TDEC Information Request	31	3	6	Are there enough new borings identified on Figure 11 to meet the needs for accurate assessment?	TVA believes that the proposed scope of work is appropriate for an initial investigative phase. If, based on the results of the initial phase of work, data gaps are identified, then TVA will consider additional investigations.
47	3.1.16	A.16 TDEC Information Request	31	4	Last	TVA should conduct observations of outcrops with respect to faults/fractures as well as voids/cavities.	Comment is acknowledged.
48	3.2.2	B.2 TDEC Information Request	35	1	9	All data used to develop the potentiometric surface changes over time shall be included in the EAR.	Comment is acknowledged.
49	3.4	D. Groundwater Monitoring	37	All	All	The permitted landfill was referenced as being in Groundwater Assessment Monitoring, but the Groundwater Quality Assessment Plan was not included in the EIP.	TVA submitted a Groundwater Quality Assessment Plan for the Dry Fly Ash and Gypsum Disposal Areas to TDEC on May 12, 2017. This plan was submitted under separate cover and was not included in the appendices of the EIP submittal.

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50	3.4.1	D.1 TDEC Information Request	37	All	All	TVA shall demonstrate that the groundwater chemistry in background wells is indicative of the groundwater flowing under the CCR units.	Proposed background well locations were discussed and selected during an onsite CUF meeting with TDEC prior to the EIP Rev 1 submittal. During the meeting, the locations of proposed background wells CUF-1000 and CUF-1001 were agreed upon by both TVA and TDEC as locations that would provide groundwater quality that is representative of background conditions. TDEC criteria for background wells are to provide locations to sample groundwater that is representative of the groundwater that flows beneath CCR units. TVA proposes to implement the proposed plan, evaluate the data collected, and then assess the suitability of the proposed background well locations for the initial investigative phase. Additionally, ongoing hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. The results of these investigation activities will be incorporated into the Environmental Investigation.
51	3.4.1	D.1 TDEC Information Request	37	2	11	TDEC will consider the 2 "new" groundwater monitoring wells TVA has installed to determine if they suffice as background groundwater monitoring wells. TVA shall install new wells upon TDEC's request.	TVA believes that the proposed scope of work is appropriate for an initial investigative phase. If, based on the results of the initial phase of work, data gaps are identified, then TVA will proposed additional investigations and entertain TDEC requests.
52	3.4.1	D.1 TDEC Information Request	38	1	8	*"If TVA determines that the new wells are suitable for addition into the TDEC permitted groundwater monitoring network, then TVA will include them in an amended groundwater monitoring network".* This will be with TDEC's approval.	Comment is acknowledged.
53	3.4.1	D.1 TDEC Information Request	38	2	1	Based on currently available monitoring data it appears that the groundwater flow on the eastern side of the Gypsum Storage Area is not fully characterized. The proposed monitoring well location between the CCR units and the main plant northeast of the CCR units may help clarify the groundwater flow, but since CUF-213 also has had arsenic detections greater than the MCL it may be necessary to evaluate an additional well located across Wells Creek south of CUF-213 near the Rye property boundary. This area potentially exhibits highly fractured (brecciated) bedrock or karstic geology.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. In addition, TVA proposes to complete the existing proposed plan for the initial investigative phase and install additional monitoring wells, if needed, based on the results of the Environmental Investigation.
54	3.4.1	D.1 TDEC Information Request	38	2	2	Both "background" wells as outlined in the EIP will be located in the soils above the Stones River Group. However, at least three and possibly four wells in the Gypsum Storage Area are located above the Knox Dolomite. It is recommended that at least one background well be sited above the Knox Dolomite.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. In addition, TVA proposes to complete the existing proposed plan and install additional monitoring wells, if needed, based on the results of the Environmental Investigation. The proposed background well locations were identified with consideration of the geologic formations and agreed upon by TDEC during an onsite meeting. The scope of work proposed is believed to be appropriate for an initial phase of an environmental investigation. Additional investigations will be proposed if warranted by the results of the initial investigation.

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55	3.4.1	D.1 TDEC Information Request	38	2	2	The groundwater is not characterized with respect to the Knox Dolomite. The Knox Dolomite is a highly fractured megabreccia and is mainly limestone and dolomite with lesser shale. CUF-204 is sited in the Stones River Group which is composed of thin bedded limestone with bentonite beds. Preference is for 10-ft well screen in the bedrock within water-bearing fractures. The top of the screen should be at least 5 feet into the bedrock.	Hydrogeological investigation activities are currently in progress to characterize the site-specific hydrogeology at CUF. The results of the investigation activities will be evaluated and incorporated into the EAR. The design for additional monitoring wells proposed to be installed in bedrock will include placement of the screen at least 5 feet into bedrock. The scope of work proposed is believed to be appropriate for an initial phase of an environmental investigation. Additional investigations will be proposed if warranted by the results of the initial investigation.
56	3.4.1	D.1 TDEC Information Request	38	4	1	Are 4 quarterly sampling events sufficient to fully assess and compare up gradient versus downgradient groundwater quality? Please address justification for sampling frequency and why a monthly or bi-monthly sampling interval would not be more prudent to determine fluctuations based on seasonality, river stage or provide a more statistically robust dataset. With only four events it is possible that after an additional year there is still not an adequate background monitoring well.	Quarterly groundwater sampling is consistent with TDEC solid waste regulations for Class II facilities and is an industry accepted frequency for providing information related to seasonal groundwater and river stage fluctuations. Cumberland River and Wells Creek water levels and precipitation data will be monitored prior to conducting each quarterly sampling event to collect samples in a range of seasonal groundwater conditions. Statistically limited data sets are also common in the industry and data can be correlated if sample collection frequency is too short. The purpose of the work proposed in this Environmental Investigation is to investigate and characterize the site-specific hydrogeology at CUF and is not intended to be a groundwater monitoring program. The results of the investigation will be provided in the EAR. If results obtained from this investigation indicate the need for more frequent sampling intervals and additional sampling events, then the sampling schedule may be revised to provide additional groundwater data. Bi-monthly sampling (6 events) for one year is proposed. According to USEPA Project Summary document "Sampling Frequency for Ground-Water Quality Monitoring" dated September 1989, quarterly and bi-monthly groundwater sampling frequencies are sufficient for major, non-reactive chemical constituents. However, more frequent sampling intervals are not recommended due to potential autocorrelation issues.
57	3.4.4	D.4 TDEC Information Request	40	2	10	Need to report river stage (Cumberland and Wells Creek) on potentiometric map and whether it was a high or low during specific sampling events and if any changes in potentiometric water level either in surficial or bedrock aquifer can be attributed to river stage.	This is part of the EIP Section 3. Analysis of correlations between groundwater and surface water elevations, seasonal variations and effects on the saturation level in the CCR units will be included in the EAR.
58	3.4.4	D.4 TDEC Information Request	40	3	8	There may be the need for an interim report and/or presentation as the background and additional wells are installed and water levels gauged. After new monitoring wells have been installed and developed a report with well construction details and initial water levels should be produced. Subsequently water levels should be recorded and reported to TDEC in the form of either a progress report or presentation monthly to determine network adequacy and also aid in determining if seasonality is a factor. Therefore, if additional points need to be added to address groundwater flow directions they can be addressed in a timely manner.	Monthly progress reports and schedule updates will be provided to TDEC. A reference to this change will be made in the EIP.
59	3.5.1	D.1 TDEC Information Request	42	2	1	TDEC recommends considering impacts to groundwater and MCL exceedances as a component of it's assessment of ongoing environmental impacts caused by the 1997 Bypass and/or any	Comment is acknowledged.

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60	3.5.2	D.2 TDEC Information Request	43	1	Last	TVA shall report all groundwater data in tables. One set of tables will consist of all samples taken from each individual well over time. The second set of tables shall compare all groundwater sample results from samples collected during the same sampling event.	Historical groundwater data that meets the requirements of the CUF QAPP will be incorporated with groundwater evaluation in the EAR and presented in the requested table format. Historical groundwater data that does not meet the requirements of the CUF QAPP will remain in the table provided in Appendix J of the EIP for reference purposes.
61	3.5.3	D.3 TDEC Information Request	43			In the explanation for both the hydrogeological investigation and groundwater sampling there do not appear to be sufficient wells to determine if radial flow to the river is occurring north of CUF-101 and 96-9.	The proposed piezometers, observation wells and monitoring wells between the CCR units and plant are designed to characterize groundwater flow in the northeastern part of CUF. Preliminary data suggest that groundwater flow may not be from the CCR units, under the plant to the Cumberland River. TVA proposes to implement the initial plan, evaluate the data collected, and then consider the need for additional monitoring wells north of CUF-101 and 96-9. Additional investigations will be proposed if warranted by the results of the initial investigation.
62	3.5.3	D.3 TDEC Information Request	44	1	All	TDEC recommends additional monitoring well installation outside of the footprint of the ash ponds to the northeast to properly characterize groundwater flow towards the Cumberland River. In addition, TDEC recommends TVA consider installing additional monitoring wells to the south, southwest, and southeast to properly characterize groundwater flow in those areas. These wells should be sampled for CCR constituents as well.	The proposed piezometers, observation wells and monitoring wells between the CCR units and plant are designed to characterize groundwater flow in the northeastern, southern, southwestern and southeastern part of CUF. In addition, hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. TVA proposes to implement the initial plan, evaluate the data collected, and then consider the need for additional wells northeast, south, southwest and southeast of the CCR units. Additional investigations will be proposed if warranted by the results of the initial investigation.
63	3.6.2	E.2 TDEC Information Request	45	1	last	Should TVA be required to collect new data to be used in the seismic and structural stability analysis given the original data collection may have come from borings and tests that were not specifically designed for an analysis of this type. TVA should install multiple borings from the top of each waste cell (gypsum and coal ash) to the original ground surface below the landfill. Samples of the CCR material should be collected at 10' intervals to determine % moisture content, particle size and type of CCR material. This data should be used to determine shear strength of the CCR material from top of fill to the contact point between original ground surface and CCR material. Further, this new data should be used in the stability calculations. If TVA maintains that the water content of the CCR material from this sampling event will decrease with time, thus creating a more stable material for stability analysis, then TVA will need to provide the rationale for their position.	As described in Section 3 of the EIP, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the requested stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The proposed exploratory drilling to install the temporary wells does include borings from the top of each unit to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to the type of index tests described in the comment per the SAP. As discussed in the response, new shear strength testing and new stability analyses are not necessary as current and ongoing analysis for other projects were performed to industry standards. Consistent with conventional practice, additional shearing resistance due to unsaturated soil conditions is neglected in the derivation of strengths and in the analysis performed by TVA.
64	3.6.3	E.3 TDEC Information Request	46	3	2	TVA shall consult with TDEC regarding the use of new data in this analysis. As demonstrated at TVA Kingston, the inefficiency of drainage layers can contribute to structural and seismic stability of the landfilled CCR material.	As noted in Section 3 of the EIP, existing data will be reviewed and new data from proposed borings and other ongoing projects will be incorporated into the response in the EAR. With regard to slope stability, the key issue is whether or not representative (or conservative) pore water pressures in the drainage layer are used in the stability analyses. The existing piezometers and proposed temporary wells and piezometers to be installed as part of other ongoing projects will aid in understanding this issue.

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65	3.6.4	E.4 TDEC Information Request	46	All	Last	Ongoing and upcoming studies for other programs shall be submitted for TDEC's review and comment and incorporate findings into the EAR.	In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.
66	3.6.4	E.4 TDEC Information Request	46	3	1	40 CFR Part 257.53 "Closed" means placement of CCR in a CCR unit has ceased, and the owner or operator has completed closure of the CCR unit in accordance with 40 CFR Part 257.102 and has initiated post-closure care in accordance with 40 CFR Part 257.104. Provide documentation that the surface impoundments on which the existing landfills are constructed are closed by the Federal CCR rule definitions.	Throughout their service life, TVA has constructed and operated the Dry Ash Stack and Gypsum Disposal Complex in compliance with the state and/or federal regulatory frameworks in effect at the time. In 1996, TDEC issued Class II landfill permit IDL 81-102-0086 to allow portions of the existing surface impoundments to be transitioned to the Dry Ash Stack and Gypsum Disposal Complex. Since 1996, TDEC has approved various permit modifications for these CCR units. As discussed in Section 3 of the EIP, the Dry Ash Stack and Gypsum Disposal Complex are existing landfills as defined by the EPA CCR Rule. TVA is actively performing numerous demonstrations to document compliance with the CCR Rule. The CCR Rule became effective in 2015, and does not apply retroactively to the surface impoundments that were transitioned to landfills in compliance with the 1996 TDEC permit.
67	3.6.5 and 3.6.6	E.5 and E.6 TDEC Information Request	47	NA	NA	Stability and seismic calculations should be conducted using the data collected from analysis of CCR material samples from the borings TVA installs into the gypsum and coal ash stacks.	As described in Section 3, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The proposed exploratory drilling to install the temporary wells does include borings from the top of each unit to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to index tests. As discussed in the response, new shear strength testing and new stability analyses are not necessary but could be added if unexpected soil or CCR materials are encountered.
68	3.6.5	E.5 TDEC Information Request	47	1	All	TDEC acknowledges that this request was a duplicate request addressed in Section 3.6.2. This section can be removed from the EIP.	Comment is acknowledged.
69	3.6.6	E.6 TDEC Information Request	48	3	1	The line reads "*Note that certain prior seismic analyses (TVA 2003; Stantec 2011, 2012) are considered superseded by the existing and upcoming analyses summarized in Item A.13* ." TDEC acknowledges additional studies and analyses are being conducted, but does not consider any historical data or reports superseded by current data. All current and historic data/reports should be considered when evaluating current and future site conditions.	Comment is acknowledged. The prior analyses are being considered, and are being supplemented by more recent data and analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.
70	3.6.7	E.7 TDEC Information Request	48	2	2	TVA need to revise/update schedule on the initiation of the construction of the proposed drainage improvements.	Proposed drainage improvements to the Gypsum Disposal Complex and Dry Fly Ash Stack Landfill are documented in TVA's June 20, 2017 Permit #: IDL 81-102-0086 Modification Submittal to TDEC. Since the proposed drainage improvements are being processed according to the permit modification process, the response to this information request has been revised accordingly.

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71	3.6.8	E.8 TDEC Information Request	49	2	2	Provide a site plan locating Section E and F indicated/referenced in the Cumberland Fossil Plant Dry Fly Ash & Gypsum Disposal Complex Grading and Drainage Plan Improvements Work Plan 11 (CUF-110310-WP-11) dated April 4, 2011. Demonstrate that the facility has no existing waste above the vertical limits of the permit drawings. The demonstration is to include conformance with the geometry presented in Section E and F indicated/referenced in the Cumberland Fossil Plant Dry Fly Ash & Gypsum Disposal Complex Grading and Drainage Plan Improvements Work Plan 11 (CUF-110310- WP-11) dated April 4, 2011. Provide a recent topographic map that represents the existing side slope cover grades. Explain discrepancies between the cover grades indicated on Drawing 10W299-05 "Closure Plan Drainage Improvements" R2 dated 8/11/17, Drawing 10W302-17 "Proposed Waste Disposal Facility Proposed Final Contours sheet 2 of 4" R0 dated 10/10/2003, and Drawing 10W551-303 "Grading/Drain Improvements Waste Grading Plan Work Plan 11 (CUF-110310-WP-11)" R3 date 12/14/12.	Proposed drainage improvements to the Gypsum Disposal Complex and Dry Fly Ash Stack Landfill are documented in TVA's June 20, 2017 Permit #: IDL 81-102-0086 Modification Submittal to TDEC. TVA can address comments and information requests regarding the referenced permit modification and existing permit according to the procedures established in Rule 0400-11-01-.02 of TDEC Solid Waste Management and outside of the EIP. All information gathered through this permit modification will be included in the EAR.
72	3.6.9	E.9 TDEC Information Request	49	6	1	The line reads "*The Stantec (2011) seismic analysis, which is the subject of this information request, is considered superseded by the existing and upcoming analyses as discussed in the response to E.6 (Section 3.6.6).* " TDEC acknowledges additional studies and analyses are being conducted, but does not consider any historical data or reports superseded by current data. All current and historic data/reports should be considered when evaluating current and future site conditions.	Concur. The prior analyses are being considered, and are being supplemented by more recent data and analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.
73	3.6.9	E.9 TDEC Information Request	49	6	last	TVA must determine the Factor of Safety using new data. If the factor of safety is less than 1, then it should be reported in the EAR and the Corrective Action Plan shall describe how TVA will address the Factor of Safety issue.	As described in Section 3, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in the Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The prior analyses are being considered, and are being supplemented by more recent data and analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)
74	3.6.12	E.12 TDEC Information Request	51	3	1	The line reads "*The Stantec (2011) seismic analysis, which is the subject of this information request, is considered superseded by the existing and upcoming analyses as discussed in the response to E.6 (Section 3.6.6)* ." TDEC acknowledges additional studies and analyses are being conducted, but does not consider any historical data or reports superseded by current data. All current and historic data/reports should be considered when evaluating current and future site conditions. TVA should conduct a thorough review and justification for the selection of the seismic coefficient (0.083g) in the previous report.	The prior analyses are being considered, and are being supplemented by more recent data and analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance. Regarding the seismic coefficient, additional explanation will be provided in the EIP. Note that the design earthquake return period was 500 years in the referenced 2011 analysis. The more recent seismic analyses consider a more conservative design earthquake return period of 2,500 years.
75	3.6.12	E.12 TDEC Information Request	51	3	4	TVA shall fully explain how the horizontal seismic coefficient was determined previously. TDEC should determine if this should be recalculated based on the results of sampling proposed in this EIP.	Regarding the seismic coefficient, additional explanation will be provided in the EIP. Note that the design earthquake return period was 500 years in the referenced 2011 analysis. The more recent seismic analyses consider a more conservative design earthquake return period of 2,500 years. Note that based on the methods used to derive the seismic coefficient in 2011, the coefficient is independent of any new sampling. The coefficient is purely a function of the seismic hazard analysis.
76	4.1.1	A.1 TDEC Information Request	53	1	2	Line reads "*However, the General Guideline adds the requirement of a map showing the location where soil samples were taken, and clarifies the use of 40 CFR Part 257, Appendices III and IV, in defining the constituents of concern for soil sampling and analytical purposes and further removes the original analytical requirement for hexavalent chromium.* " This is incorrect. TDEC will require both total chromium and hexavalent chromium to be analyzed as well as the Appendix III and IV CCR constituents.	Previous hexavalent chromium sampling events at other TVA sites have shown that quantitation of Cr(VI) is not reliable at trace concentrations. Hexavalent chromium that might occur in soil or in CCR would be expected to quickly be reduced to trivalent chromium as it oxidizes other constituents. A more feasible, phased approach is for TVA to analyze samples for total chromium, the form of chromium listed in the CCR Rule Appendix IV. If total chromium values in soil are at EPA RSL guidelines, TVA will consult with TDEC about how best to perform analyses for hexavalent chromium. All chromium sample results will be in the EAR.

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77	4.1.2	A.2 TDEC Information Request	53	2	All	TVA's approach to obtain representative leaching data did not include CCR waste analysis for SPLP, or samples locations for where the 10 obtained samples were taken. Waste profiles have likely changed over the years from different coal sources and plant operations.	TVA's initial CCR leachability approach in this EIP followed EPA's language in the preamble to the CCR Rule. EPA has stated "The use of pore water data is still considered the most appropriate approach to estimate constituent fluxes to groundwater for CCR surface impoundments." In addition, "EPA agrees that TCLP and SPLP data are less appropriate for CCR disposal scenarios and no longer uses these data in the revised risk assessment." The TCLP leaching method was developed to simulate the potential for leaching of materials intended to be disposed in a municipal landfill. Since TVA's CCR landfills are not municipal landfills, TCLP would not be an appropriate analysis to complete for future modeling of leachate. TVA will obtain pore water samples to provide real-time measurements of constituents in actual conditions for the CCR material in the units. The CCR material at the base of the unit will have had the greatest opportunity for leaching to occur, due to it having the longest duration of time in an aqueous medium reflecting actual conditions, and will be the closest point to the boundary of the unit, nearest any groundwater. Samples of CCR material will be collected from the temporary wells installed to sample pore water. These samples will be analyzed for the CCR parameters according to the most applicable method based on emerging science in the industry which could include the Synthetic Precipitation Leaching Procedure (SPLP). TVA considers the groundwater monitoring well network as the definitive mechanism to determine releases to groundwater which includes protocols for detection, assessment, and corrective action of contaminants in groundwater, through the groundwater monitoring program.

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78	4.1.2	A.2 TDEC Information Request	53	2	3	TDEC recommends conducting a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility. The further referenced 2016 CCR Characterization Report may be sufficient to satisfy the solid material sample analysis if there is adequate vertical and horizontal distribution of samples and meets the data requirements set forth in the EIP.	TVA's initial CCR leachability approach in this EIP followed EPA's language in the preamble to the CCR Rule. EPA has stated "The use of pore water data is still considered the most appropriate approach to estimate constituent fluxes to groundwater for CCR surface impoundments." In addition, "EPA agrees that TCLP and SPLP data are less appropriate for CCR disposal scenarios and no longer uses these data in the revised risk assessment." The TCLP leaching method was developed to simulate the potential for leaching of materials intended to be disposed in a municipal landfill. Since TVA's CCR landfills are not municipal landfills, TCLP would not be an appropriate analysis to complete for future modeling of leachate. TVA will obtain seven pore water samples from the base of the units, and three pore water samples above the drainage layer in the Gypsum Disposal Complex, to provide real-time measurements of constituents in actual conditions for the CCR material in the units. The CCR material at the base of the unit will have had the greatest opportunity for leaching to occur, due to it having the longest duration of time in an aqueous medium reflecting actual conditions, and will be the closest point to the boundary of the unit, nearest any groundwater. Samples of CCR material will be collected from the temporary wells during their construction (that are to be used for sampling pore water). Saturated and unsaturated CCR material samples will be analyzed for the CCR parameters according to the most applicable method based on emerging science in the industry which could include the Synthetic Precipitation Leaching Procedure (SPLP). Taking saturated and unsaturated samples from each temporary well will provide a vertical distribution of the samples. TVA considers the groundwater monitoring well network as the definitive mechanism to determine releases to groundwater which includes protocols for detection, assessment, and corrective action of contaminants in groundwater, through the groundwater monitoring program.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)
79	4.1.2	A.2 TDEC Information Request	55	1	1	The line reads "*TVA will characterize the leachability of the CCR parameters from the CCR material at the base of the CCR units..* ". TDEC recommends characterizing leachability from multiple vertical intervals, not only at the base layer.	TVA's initial CCR leachability approach in this EIP followed EPA's language in the preamble to the CCR Rule. EPA has stated "The use of pore water data is still considered the most appropriate approach to estimate constituent fluxes to groundwater for CCR surface impoundments." In addition, "EPA agrees that TCLP and SPLP data are less appropriate for CCR disposal scenarios and no longer uses these data in the revised risk assessment." The TCLP leaching method was developed to simulate the potential for leaching of materials intended to be disposed in a municipal landfill. Since TVA's CCR landfills are not municipal landfills, TCLP would not be an appropriate analysis to complete for future modeling of leachate. TVA will obtain pore water samples to provide real-time measurements of constituents in actual conditions for the CCR material in the units. The CCR material at the base of the unit will have had the greatest opportunity for leaching to occur, due to it having the longest duration of time in an aqueous medium reflecting actual conditions, and will be the closest point to the boundary of the unit, nearest any groundwater. Samples of CCR material will be collected from the temporary wells installed to sample pore water. These samples will be analyzed for the CCR parameters according to the most applicable method based on emerging science in the industry which could include the Synthetic Precipitation Leaching Procedure (SPLP). TVA considers the groundwater monitoring well network as the definitive mechanism to determine releases to groundwater which includes protocols for detection, assessment, and corrective action of contaminants in groundwater, through the groundwater monitoring program.
80	4.1.2	A.2 TDEC Information Request	55	3	1	The paragraph reads "*The CCR Material Characteristics study is confined to the leachability of CCR parameters from the CCR material (at various locations in the CCR units) into CCR units where the CCR material is deposited. It does not demonstrate the leachability of the CCR parameters (from the CCR material in the CCR units) into the groundwater under the base of the CCR units.* " TDEC requests further explanation from TVA on why the leachability of CCR parameters from CCR materials is not universal and reflective of the leachability into groundwater.	The leachability study in which pore water samples are obtained from the base of the units provides a snapshot of the CCR constituents in the pore water at that time. Although the pore water constituents measured at the base of the unit demonstrate the potential for those constituents to enter the groundwater, it is not indicative of the actual release of those constituents into the groundwater. Any actual releases into the groundwater will be determined by the GWM program, and addressed under the appropriate program protocols. The EIP will be revised with the explanation.
81	4.3.7	C.7 TDEC Information Request	60	2	All	TVA response does not adequately address the TDEC information request. TVA does not discuss how it will define groundwater contaminant plumes and/or how it would scientifically extend the monitoring network if necessary to fully delineate vertical and horizontal impacts to groundwater. TVA should further define methodologies, procedures, and models it will utilize to characterize and assess contamination in groundwater.	The initial phase of the environmental investigation is to characterize the site by assessing current subsurface conditions at CUF. Potential groundwater impacts will be identified by collecting background and downgradient groundwater. TVA will use industry accepted methods for delineating the extent of CCR constituents, if needed, and will install additional wells in appropriate locations based on groundwater flow conditions. Methodologies and procedures for installing monitoring wells are provided in TVA Technical Instruction for Monitoring Well and Piezometer Installation and Development (ENV-TI-05.80.25). New monitoring wells will be monitored bi-monthly for one year. TVA may propose additional methods of evaluation, such as groundwater flow and transport models, as appropriate and guided by sound scientific principles based on the data collected. The proposed investigation is designed to collect groundwater data representative of site conditions that would be needed as input into models. The exact approach will depend on the data collected and will be proposed after evaluation of the data collected during the environmental investigation.

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82	4.4.10	D.10 TDEC Information Request	65	2	All	The line reads "*As noted in Section 3.6.4, none of the CUF CCR units in the Study Area meet the definition of an overfill per the CCR Rule. Therefore, this information request does not apply to CUF.*" TVA previously stated in their response in section 3.6.4that "*Although the Dry Ash Stack and Gypsum Disposal Complex are regulated as "existing landfills" and not "overfills" under the CCR Rule, the CCR Rule still addresses the concern about existing landfills that are constructed over closed CCR surface impoundments. In particular, existing landfills are subject to the "Unstable Areas" location restriction per §257.64. Due to TVA's construction of its CUF landfills on top of a closed CCR surface impoundment, §257.64 will therefore require TVA to demonstrate that "good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.*"" TVA needs to explain why their proposed assessment for section 3.6.4 does not apply to section 4.4.10.	The response will be clarified to state that the proposed assessment outlined in Section 3.6.4 does apply, but it applies in the context of the unstable areas assessment for existing landfills. The information request does not apply within the context of overfills, because these units do not meet the CCR Rule definition of overfills.
83	4.4.11	D.11 TDEC Information Request	65	All	All	TVA response does not adequately address the TDEC information request. TVA does not provide any information regarding historic dam safety analyses that may have been performed and if said analyses were deemed adequate. Given that the perimeter dike system was once included in the TVA Dam Safety Program, this information may be available for review. If these historical analysis were not sufficient for the purpose of the EAR, additional analysis may be required.	Based on verbal clarification from TDEC during the 10/4 meeting, we understand that the intent of TDEC's comment was to make sure the response mentions that the perimeter dike systems in question are including in the stability analyses. The perimeter dikes are indeed evaluated for slope stability. The EIP text will be clarified as such.
84	4.5.2	E.2 TDEC Information Request	70	1	3	TDEC recommends analyzing all top six-inch sediment samples for CCR parameters.	All top six-inch sediment samples (with the exception of the top six-inch sediment samples collected from the pond at the northeast corner of the Plant) will be analyzed for the CCR parameters during Phase I per TDEC recommendation.
85	4.5.2	E.2 TDEC Information Request	70	1	4	Line reads "*Hold remaining composited boring samples for potential future analyses in Phase 2 (if >20% ash).*" TVA previously stated that it will be collecting grab samples, where do the referenced composite samples come from?	All proposed sediment samples are grab samples. References to composited samples have been removed.
86	4.5.2	E.2 TDEC Information Request	70	1	4	Line reads "*Hold remaining composited boring samples for potential future analyses in Phase 2 (if >20% ash).*" TDEC recommends running additional analysis on boring samples if CCR constituents are detected in the associated top six-inch sediment sample.	It is assumed that at least some of the CCR constituents will be detected in samples (including background samples). TVA will evaluate the Phase I CCR constituent results on a sample-by-sample basis to determine whether additional Phase II analyses will be implemented. Rather than using any detections as a trigger for Phase II, TVA will base the decision to implement Phase II at each Phase I sampling location based on PLM results exceeding the 20% ash threshold.
87	4.5.2	E.2 TDEC Information Request	70	4	1	TDEC recommends adjusting sediment sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river bed profile.	TVA has revised the proposed sampling locations to include transects.

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88	4.5.2	E.2 TDEC Information Request	71	1	1	TDEC recommends implementing Phase 2 sampling if CCR constituents are detected in the associated top six-inch sediment sample.	It is assumed that at least some of the CCR constituents will be detected in samples (including background samples). TVA will evaluate the Phase I CCR constituent results on a sample-by-sample basis to determine whether additional Phase II analyses will be implemented. Rather than using any detections as a trigger for Phase II, TVA will base the decision to implement Phase II at each Phase I sampling location based on PLM results exceeding the 20% ash threshold. TVA believes that the proposed scope of work is appropriate for an initial investigative phase. If, based on the results of the initial phase of work, data gaps are identified, then TVA will proposed additional investigations.
89	4.5.2	E.2 TDEC Information Request	71	1	3	Line reads "*Analysis of held composited sediment core sample(s) at sampling locations that exceeded the 20 percent ash content for CCR parameters.*" TVA previously stated that it will be collecting grab samples, where do the referenced composite samples come from?	All proposed sediment samples are grab samples. References to composited samples have been removed.
90	4.5.5	E.5 TDEC Information Request	75	2	3	TDEC recommends collecting water column samples (top, middle, and bottom) at each sampling location in Wells Creek, the Cumberland River, and the unnamed tributary flowing into Wells Creek. Effort should be made to co-locate water column samples with sediment samples collected as part of the EIP as well as the already identified sampling locations. TDEC recommends adjusting water column sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river profile.	The Surface Stream SAP will be revised to include sample transects, instead of point sampling locations. The transects will be evaluated by collection of Hydrolab data initially. If Hydrolab data indicates that the water column is thermally stratified, four samples from the water column (near-bottom (epibenthic) sample 0.5 m above streambed, mid-hypolimnion sample (midway between bottom of thermocline and streambed), mid-epilimnion sample (midway between top of thermocline and water surface, and near-surface (0.5 m depth)) will be collected from the thalweg, right bank, and left bank locations (totaling 12 samples per transect). If there is no thermal stratification, three samples from the water column (bottom, mid-depth, and top) will be collected from the thalweg, right bank, and left bank locations (totaling 9 samples per transect). Language will be included in the SAP to allow the sampling team flexibility if the depth or width of the channel at a sample location is inadequate for collecting multiple samples from the water column or locations along the transect. Surface stream samples will generally be co-located with sediment samples. Where sediment samples are located in close proximity to each other, one representative surface stream sample transect will be collected. Similarly, if a previously proposed surface stream sample location is located in close proximity with a sediment sample, only one sample transect will be evaluated to represent water quality at that location.
91	4.5.5	E.5 TDEC Information Request	76	1	5	Background sample locations in should be upstream of the CUF and ash pond area, outside of any potential influence from site activities and CCR storage/release.	Background samples will be collected from Wells Creek and Cumberland River upstream of CUF. It is also anticipated that some historical surface stream data can be used.
92	4.5.5	E.5 TDEC Information Request	76	3	1	TDEC recommends implementing Phase 2 sampling if CCR constituents are detected in the associated top six-inch sediment sample.	TVA will base the decision to implement Phase II at each Phase I sampling location based on the associated sediment sample PLM results exceeding the 20% ash threshold. TVA believes that the proposed scope of work is appropriate for an initial investigative phase. If, based on the results of the initial phase of work, data gaps are identified, then TVA will propose additional investigations.

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93	4.5.6	E.6 TDEC Information Request	77	2	3	TVA states that to it's knowledge, no public water intakes are located within 1 mile downstream of the TVA site. Please provide justification for this statement and/or an assessment plan to make this determination.	Justification will be provided to demonstrate that no public water intakes are located within 1 mile downstream of the plant.
94	4.5.8	E.8 TDEC Information Request	77	All	All	Is TVA proposing a full aquatic life assessment to satisfy this request?	TVA is not proposing a full aquatic assessment, but rather proposes to evaluate benthic macroinvertebrates and fish as the most relevant indicators of the health of the aquatic ecosystem. The potential impact of CCR materials and/or constituents on fish and/or aquatic life in surface streams will be evaluated based on multiple lines of evidence, specifically: • Concentrations and distribution of CCR constituents in surface water and sediments; • Benthic macroinvertebrate community composition, diversity, and numbers; • CCR constituent concentrations in mayfly nymphs and adults (if sufficient numbers can be collected); and • Concentrations of CCR constituents in representative samples of fish tissue.

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95	4.5.8	E.8 TDEC Information Request	77	2	1	The text should explain how the data will be evaluated to determine whether there is a risk. There should be some explanation as to why six samples of each fish species will be sufficient to address the question. Is there a minimum weight of sample requirement? *Further clarification of this comment was requested and provided by TDEC on October 10 as follows:* The original TDEC comment could be broken into two components. "The text should explain how the data will be evaluated to determine whether there is a risk." The overall objective of the Fish Tissue SAP for the CUF EIP should be to identify potential site contamination in fish tissues and to assess potential risk to human or ecological receptors. There also needs to be a description of the assessment process for both human consumption of recreational sport fish and also if fish and/or wildlife that ingests fish are at risk (e.g., bioaccumulation). One portion of the investigation needs to determine whether measures are needed to reduce fish contaminant concentrations (if found), and/or reduce exposure to people consuming fish from the river depending on the levels of contamination and the amount of consumption. The investigation also needs to determine if fish have been exposed or if bioaccumulation of site contaminants pose unacceptable risk to fish as wells as unacceptable risk to wildlife that ingest fish (birds and larger animals). " There should be some explanation as to why six samples of each fish species will be sufficient to address the question. Is there a minimum weight of sample requirement?" TDEC does not have a specific method that it is requiring of TVA, but the methodology should be in line with similar common practices exercised by the EPA and other state environmental agencies. Generally in the investigations I have read number of samples for a site are generally between 3-5 samples, with each sample being made up of 1-12 fish (depending on size) of the same species. USEPA guidance suggests that the relative difference between the average length of individuals within any composite sample and the average length of all individuals in all composite samples should not exceed 10 percent. If the smallest fish is not 90% of the largest under no circumstances should a composite be made up of fish with a size difference (largest to smallest) greater than 75%. For all sample types, generally the laboratory requires a minimum 150 grams of sample to perform the required analyses.	Data evaluation will be performed as appropriate with existing industry standard guidance documents and protocols. TVA is using six samples of each species following the methods used during the KIF bioaccumulation studies and similar studies completed by EPA. A minimum weight requirement is not included in the SAP. A length requirement has been added. The primary objective of the Fish Tissue SAP is to determine whether tissues from fish in the immediate vicinity and downstream of CUF have higher concentrations of CCR-related contaminants than occur in fish from reference areas upstream of CUF. TVA acknowledges TDEC's comment regarding the importance of the fish tissue analytical results in evaluating potential risks to human health and ecological receptors. The investigative activities described in the EIP are expected to yield multiple lines of evidence that will be considered in evaluating potential risks to human health and ecological receptors. The analytical results of the fish tissue sampling are only one of those many lines of evidence. TVA's approach to evaluating risks will be presented in the EAR. TVA's plan for collecting composite samples consisting of tissues from 6-8 individual fish of the same species is based on EPA guidance on fish tissue monitoring[1] and EPA's recommendations for fish collections for comparison with the fish tissue-based water quality standard for selenium[2]. USEPA's recommendations include the size range requirements described by TDEC above. Per USEPA guidance, "the average of the average lengths of individuals in all composite samples" falls within 10% of the average of the group, and does not include a significantly larger fish in any composite sample. The length of the smallest fish in the composite should not be less than 75% of the length of the longest fish in the composite. TVA collects game fish of legal harvest size (shad are not game fish) and attempts to collect older/larger size classes of individual fish. Clarification of the number of individual fish in a composite has been added to the discussion of fish collection and fish tissue sampling in Section 5.2.1 of the Fish Tissue SAP. 1. U.S. Environmental Protection Agency (USEPA). 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis. Third Edition. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 823-B-00-007. 2. U.S. Environmental Protection Agency (USEPA). 2016. Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion-DRAFT. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 820-F-16-007.

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96	5	Environmental Assessment Report (EAR)	79	1	2	The EAR will address all tasks completed as part of the approved EIP.	Comment is acknowledged.
97	Appendix A	Schedule	NA	NA	NA	General comment - The schedule is considered draft at this time. TDEC will work with TVA to develop a final schedule once the EIP is approved. TDEC will provide a draft schedule for the CUF site for TVA review.	Comment is acknowledged.
98	Appendix C	All	All	All	All	Please make sure the nomenclature for identified positions is consistent throughout the QAPP. There are many errors including: *"TVA Program Manager, TVA Technical Manager"*	Terminology will be updated to "TVA Compliance Lead" and "TVA Technical Lead" throughout the document.
99	Appendix C, Section	QAPP	1	1	6	CUF EIP Revision 1 is May 2017 not April 2017	EIP revision date will be updated.
100	Appendix C, Section 2.1	QAPP	1	2	8	Please provide the Data Management Plan.	The Data Management Plan for the TDEC Order environmental investigations will be provided to TDEC under separate cover as a stand-alone document. Site specific updates to the Data Management Plan, if applicable, will be included in each site specific QAP
101	Appendix C, Section 2.1	QAPP	2	Fig 2-1		There should be an investigation consultant QA leader in the flow chart above the field team leads. This person would have a dashed line to the data manager as the mechanism for submitting field data.	Field data QA review is the responsibility of the Field Team Leader and has been added to the role. A dashed line has been added between the Field Team Leader and the Data Manager as the mechanism for field data submittal.
102	Appendix C, Section 2.1	QAPP	2	Fig 2-1		QA Oversight Manager should read QA Oversight Consultant Manager to be consistent with section 2.2.5	Reference will be updated to "QA Oversight Manager" throughout the document.
103	Appendix C 2.1	Background	1	2	8	Please include as an appendix to the EIP the referenced *"Data Management Plan"*.	The Data Management Plan for the TDEC Order environmental investigations will be provided to TDEC under separate cover as a stand-alone document. Site specific updates to the Data Management Plan, if applicable, will be included in each site specific QAP
104	Appendix C 2.2.1	TVA Compliance Lead	3	2	1	The line references the *"TVA Program Manager"* - is this meant to be the "TVA Compliance Lead"? If not, please provide any pertinent information regarding the TVA Program Manager's duties and how this position fits in the organizational structure. Further, define the TVA Compliance Lead's duties as well.	Reference will be updated to "TVA Compliance Lead."
105	Appendix C 2.2.2	TVA Technical Lead	3	1	2	Please define *"Sampling Contractor"*, this position is not defined in the organizational structure or in the QAPP.	Reference will be updated to "Investigation Consultant Project Manager" throughout the document.
106	Appendix C 2.2.2	TVA Technical Lead	3	1	3	Please define *"Program"*.	Reference will be updated to "TVA CUF EI."
107	Appendix C, Section 2.2.2	QAPP	3	1	2	Is Sampling Contractor equal to Investigation Consultant Project Manager?	Reference will be updated to "Investigation Consultant Project Manager" throughout the document.

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108	Appendix C, Section 2.2.2	QAPP	3	1	2	It appears based on the flow diagram that the TVA Technical Lead also directs the analytical laboratories and the data manager, is this correct?	Correct; laboratory and data manager direction will be added to the responsibilities of the TVA Technical Lead.
109	Appendix C 2.2.3.1	Field Team Leaders	4	1	6	It appears "*Field Personnel* " is being used in place of "*Field Sampling Personnel* " as designated in the organizational chart. Please be consistent throughout with identification of personnel	Reference will be updated to "Field Sampling Personnel" throughout the document.
110	Appendix C, Section 2.2.3.1	QAPP	4	2	5	Field team leaders should submit field data to the investigation contractor QA leader and that person should after completing the QA check of the field data submit it to the Data Manager.	QA review of field data will be performed by Field Team Leaders; QA review has been added as a responsibility under Field Team Leaders role.
111	Appendix C 2.2.4.2	Laboratory Project Manager	7	1	6	The line references the "*TVA Program Manager* " - is this meant to be the "TVA Compliance Lead"? If not, please provide any pertinent information regarding the TVA Program Manager's duties and how this position fits in the organizational structure. Further, define the TVA Compliance Lead's duties as well	Reference will be updated to "TVA Technical Lead."
112	Appendix C, Section 2.2.4	QAPP	5	3	7	Identifying and implementing training certification for laboratory personnel was indicated. How will training be documented?	Section 2.2.4 will be updated to indicate that laboratory personnel training will be conducted and documented in accordance with the laboratory's QA Manual.
113	Appendix C, Section 2.2.5	QAPP	7	7	3	For consistency with Figure 2-1. The QA Oversite Consultant Manager reports directly to the TVA Technical Lead	Reference will be updated to "TVA Technical Lead."
114	Appendix C, Section 2.2.5.2	QAPP	8	1	1	Based on the responsibilities state in Section 2.2.3.1 the Laboratory Coordinator interfaces with the Field Team leaders not the field samplers.	Reference will be updated to "Field Team Leaders."
115	Appendix C, Section 2.2.5.4	QAPP	9	2	3	This implies that a Field Oversight Coordinator will be responsible for training. How will training be documented?	As indicated in Section 5.0, Paragraph 1: Training will be documented by maintaining copies of presentations and sign-in sheets as part of the Project File.
116	Appendix C, Section 2.2.5.4	QAPP	9	2	9	This implies that a Field Oversight Coordinator will be present at every sampling event, is this feasible? And that they will be with every team should the investigation contractor deploy multiple teams. In the case that a field QA oversight coordinator is not at a specific sampling event who will be responsible for checking the COC prior to submittal?	Section 2.2.5.4 describes responsibilities of the Field Oversight Consultant but is not intended to prescribe frequency of oversight. Oversight frequency is addressed in Section 16. Regarding COCs, Field Oversight Coordinators periodically review COCs of samples submitted to laboratories.
117	Appendix C, Section 5.0	QAPP	12	1	6	What certificates are required? What Health and Safety training is required (e.g., site- specific or HAZWOPER 40hr)? How will training be documented?	Section 5.0 updated to indicate that any additional training or certifications required will be presented in the associated Health and Safety Plan and/or investigation-specific SAP.
118	Appendix C 9.1.1	Chain-of-Custody Record	19	3	1	Need to define "*MAGs* "	Method analyte groups (MAGs) are initially defined in Section 6.2.

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119	Appendix C, Section 9.1.2	QAPP	20	2	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done. If multiple coolers are needed, one COC Record should will accompany each cooler that contains the samples identified on the COC.	"Should" will be replaced with "will."
120	Appendix C 9.3.1	Sample Receipt	22	1	4	Line reads " *In the event that aqueous samples for metals analyses are received at pH > 2, acid preservative will be added by the laboratory the samples will equilibrate in the originally received bottle ware for a minimum of 24 hours prior to digestion. Sample preservation and equilibration will be fully documented via laboratory logbooks.* " Will these sampled be flagged as out of compliance with field preservation requirements?	Samples preserved in accordance with QAPP Section 9.3.1 are compliant with 40 CFR Part 136 Methods Update Rule preservation requirements.
121	Appendix C, Section10.0	QAPP	23	1	4	Detectability was not mentioned in the quality objectives and criteria for analytical data	Section 10.0 will be updated to indicate that analytical methods will be selected based on the ability to detect constituents of concern at reporting limits sufficient to meet project requirements and quality objectives for precision, accuracy, and sensitivity.
122	Appendix C, Section 11.1	QAPP	26	4	6	At least 10% of the screening data ~~should~~ will be confirmed using appropriate analytical methods and QA/QC procedures and criteria associated with definitive data.	"Should" will be replaced with "will."
123	Appendix C, Section 11.1	QAPP	27	2	2	Based on the procedure outlined in ENV-TI-05.80.46 (Section 3.3.3, bullet [4]) it appears that the pH instrument will be calibrated to the 25degC certified buffer strength, rather than the temperature-adjusted buffer strength. Is this accurate?	Section 11.1 will be updated to indicate that buffer temperature will be accounted for during pH meter calibration.
124	Appendix C, Section 13.1	QAPP	33	2	2	Based on the QAPP and ENV-TI-05.80.46 the DO calibration is an air saturated water calibration which is time consuming and could introduce error if not done properly. Is this the method the field teams are actually using? Most field applications of DO that are not long-term, continuous monitoring applications utilize the water saturated air calibration method. Please clarify which calibration method the sampling teams will be utilizing.	TVA TI ENV-TI-05.80.46 was drafted to be used by multiple programs within TVA and therefore was not intended to encompass detailed requirements for the wide variety of water quality meters available for use. Section 3.3.4 of ENV-TI-05.80.46 references both air-saturated water and water-saturated air for calibration. Section 13.1 will be updated to indicate that a 1-point water-saturated air method for calibration will be implemented following the manufacturer's recommendations for this procedure.
125	Appendix C, Section 13.1	QAPP	34	1	2	Field pH meters used for collecting data will have to meet the calibration requirements of Method 9040C , which is 0.05 pH units of the bracketing buffer solution values. The QAPP references SESDPROC-100-R3, January 2013 and the TVA TI ENV-TI-05.80.46 which only require calibration to 0.1 SU.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the CUF EI.
126	Appendix C, Section 13.1	QAPP	34	2	4	Maintenance ~~should~~ will be performed when the instrument will not adequately calibrate. Maintenance of field equipment ~~should~~ will be noted in an instrument logbook or field notebook.	"Should" will be replaced with "will."

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127	Appendix C, Section 17.0	QAPP	44	3	3	This audit report ~~should~~ will include a list of observed field activities, a list of reviewed documents, and any observed deficiencies.	"Should" will be replaced with "will."
128	Appendix C, QAPP Appendix A.2	QAPP Appendix A.1	A-3	1	3	In the event that certain required information is not included on a particular form, the laboratory ~~should~~ will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.	"Should" will be replaced with "will."
129	Appendix C, QAPP Appendix A.2	QAPP Appendix A.2	A-15	1	3	In the event that certain required information is not included on a particular form, the laboratory ~~should~~ will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.	"Should" will be replaced with "will."
130	Appendix C, QAPP Appendix D	QAPP Appendix D	D-1	Table A		Sample matrix codes do not have nomenclature for laboratory supplied deionized water.	Table A presents sample nomenclature and includes field QC samples collected using deionized water, which are differentiated for normal samples by "Sample Type". The sample IDs for field QC samples are intentionally reflective of the associated investigatory samples; the matrix code on the COC Record for field QC samples collected using laboratory-supplied deionized water will be "AQ".
131	Appendix C, QAPP Appendix L	QAPP Appendix L	L-5	Table L-3		At RPDs greater than 20%, the data distribution starts to become non-normal and confidence in the representativeness of the sample results diminishes. If the RPD is greater than 20%, re-sampling may, but not necessarily, be required.	Noted. 20% is a standard precision goal for aqueous matrices. Sample data associated with >20% RPD will be qualified during data validation.
132	Appendix D	Figure 1	253/ 724	N.A.	N.A.	Provide proposed background soil sample locations overlaying a USDA soil map.	Comment is acknowledged, the additional figure is included in the EIP.
133	Appendix D	Figure 9	262/ 724	N.A.	N.A.	Additional borings need to be proposed within the CCR unit limits to aid in confirming the presence of a continuous soil liner and soil classification of the liner.	The existing information referenced in the EIP, used in conjunction with new information from borings proposed in the Exploratory Drilling SAP, is adequate to support a response to this information request. The clay foundation map (Figure 9) will be revised to describe the uppermost foundation soil type (clay, silt, sand, etc.) in each boring. Associated sections of the EIP text will be updated, including references for the historical documents. The foundation soil information will be incorporated into the 3D model of the CCR units.

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134	Appendix D	Figure 11	264/ 724	N.A.	N.A.	Provide an additional Figure overlaying Historical Wells Creek alignment and limits of grouting from Drawing 10N212 R11 dated 5/20/91 onto Figure 11 "Proposed Borings". Borings need to be proposed in these areas to better define the geology and hydrogeology below the CCR units.	An additional figure will be added in the Evaluation of Existing Geotechnical Data appendix of the EIP, showing the historical Wells Creek alignment, the grouting alignment, and interior bottom ash berm alignment. The berm was placed in an effort to reduce seepage gradients through the perimeter dike, then grouting was used in an effort to reduce seepage through the foundation soils beneath the perimeter dike. Other mitigation measures were also taken. Also in this appendix, discussion will be added to provide context for the seepage issues observed and the various mitigation measures employed. Perimeter dike design and construction will be discussed, with particular emphasis on the areas where the creek alignment crosses the perimeter dike alignment. The Exploratory Drilling SAP will include two windows of closely spaced CPTs to evaluate the locations where the historical Wells Creek alignment crosses the unit perimeter as well as an area of historical grouting.
135	Appendix D	Figure 14	267/ 724	N.A.	N.A.	Provide additional Figure that indicates the location of all historical well that have been closed. Provide a copy of all groundwater monitoring optimization plans for the site that reference, discuss or document closure of wells. Provide the 2017 "Geotechnical Field Services for Well Installations and Closures, Groundwater Monitoring Optimization - Phase 3, Cumberland Fossil Plant, Cumberland City, Tennessee" dated February 10.	A figure showing the locations of historical wells that have been closed has been added as an appendix to the EIP. A copy of the Geotechnical Field Services for Well Installation and Closures dated February 10, 2017 has also been added as an appendix to the EIP.
136	Appendix D	Figure 15	268/ 724	N.A.	N.A.	Add sediment sampling location in the proximity of the stilling pond discharge at the cooling water discharge channel.	An additional sediment transect has been added at this location in the Benthic SAP.
137	Appendix D	Figure 19	272/ 724	N.A.	N.A.	Include documentation for the seep repair grouting at the Ash Pond referenced memorandum dated 11/20/1990 (B65901120029).	Despite extensive data mining, the referenced memorandum could not be located. However, several construction records of the grouting operations were located and will be provided in an appendix to the EIP.
138	Appendix D	Figure 15 & 20	N.A.	N.A.	N.A.	Surface water and sediment sampling needs to be proposed for the embayment/pond in the northeast corner of the TVA property.	The Benthic SAP will include a sampling transect within the pond in the northeast corner of the TVA property. If PLM analysis of the sediment samples indicate greater than 20% ash is present within the pond sediment, a Phase 2 investigation will be conducted. Surface stream data would be collected from the pond as part of the Phase 2 investigation.
139	Appendix D	Figure 20	273/ 724	N.A.	N.A.	Add surface stream sampling locations in the proximity of Highway bridge at Wells creek and the cooling water discharge channel.	Sample transects have been added at these locations as requested in the Surface Stream SAP.
140	Appendix E, Section 3.0	Background Soil SAP	3	1	5	Field teams should consist of (at a minimum) an experienced TN licensed professional geologist.	TVA proposes that for environmental investigation wells and soil borings, a TN-licensed professional geologist will be present and will log the borings. For geotechnical investigation borings and piezometer installations, a TN-licensed professional geologist or professional engineer will be present and will log the borings. This approach has been used at current investigations at other TVA sites in TN.

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141	Appendix E 4.0	Sampling Locations	4	2	3	Borings should be logged by a Tennessee licensed professional geologist not a professional engineer.	TVA proposes that for environmental investigation wells and soil borings, a TN-licensed professional geologist will be present and will log the borings. For geotechnical investigation borings and piezometer installations, a TN-licensed professional geologist or professional engineer will be present and will log the borings. This approach has been used at current investigations at other TVA sites in TN.
142	Appendix E 5.2.1.1	Background Borings	7	1	1	TVA has previously stated in this EIP that borings will be extended until refusal or a depth of 20 feet below encountered groundwater surface, whichever is shallower. The SAP is designating that borings will only be advanced until refusal. Please clarify.	To clarify, background soil borings will be advanced until refusal or a depth of 20 feet below encountered groundwater surface, whichever is shallower. The SAP will be revised accordingly.
143	Appendix E, Section 5.2.1.1	Background Soil SAP	7	3	10	Will the mid-point for sampling aliquot be the vertical depth midpoint or the mid-point based on recovery? What is the contingency if recovery is poor? Or is it a composite over the entire 5ft interval?	The mid-point for grab samples will be the mid-point based on recovery, except in the situation where a core interval includes a lithology change. In the event that soils are expected to be hard to retain during core retrieval, core catchers will be used to prevent loss of sample material. No composite samples are proposed.
144	Appendix E, Section 5.2.1.1	Background Soil SAP	7	4	1	Borehole should be filled with cement-bentonite grout mixture using a tremie pipe to within approximately six inches of the surface. The top six inches should be restored to match the existing surface.	Comment is acknowledged and the corresponding change has been made in the document.
145	Appendix E, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil color will be determined using a Munsell soil color chart.	The use of the Munsell Color Charts is not included as part of the ASTM Standard D2488. Soils will be logged in compliance with ASTM Standard D2488.
146	Appendix E, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil will be logged following the visual-manual procedures of the American Society of Testing and Materials (ASTM) Standard D2488-09a	Comment is acknowledged and the corresponding change has been made in the document. Soils will be logged using AST) Standard D2488.
147	Appendix E, Section 5.2.1.2	Background Soil SAP	8	1	5	Soil should be logged to include soil consistency or density, size, shape and angularity of particles, plasticity (for fine-grained soil)	Comment is acknowledged and the corresponding change has been made in the document.
148	Appendix E, Section 5.2.5	Background Soil SAP	12	Table 4	9	A pH field test kit should be employed to help identify if soil pH is in a range to mobilize CCR contaminants (specifically target sample aliquots and horizon changes). For example several metals are easily leached from acidic soil, however selenium is mobilized under alkaline conditions. Also, due the short hold time, which will create a situation where the analytical result will not be within the 15 min holding time, please consider a field method measurement of pH for comparison.	The 15 minute holding time for pH testing of soil samples begins from the point that the sample paste is created, prior to taking a pH reading. As such soil samples will be submitted to the laboratory for analysis as opposed to conducting field analysis of soil pH. Additionally, this study is not an investigation to determine the presence of CCR "contaminants" or conduits of contaminant movement. The biasing of sample collections based on pH ranges likely to mobilize CCR contaminants is not warranted.

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149	Appendix E, Section 5.2.7	Background Soil SAP	13	4	1	Some of the requirements in the Background Soil Sampling SAP are written as should. The SAP must be written as what will be done. This indicates the requirements on what will be acceptable. If the procedure cannot be followed, identify in the QAPP or QA/QC section of SAP how things will be documented that don't follow the QAPP /SAP requirements. Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.	Comment is acknowledged and the corresponding change has been made in the document.
150	Figure 13	NA	NA	NA	NA	Although CUF-210 is listed as being anomalous compared to surrounding wells, what is the background information that supports that decision? If the screen and well are intact and screened in the same location then CUF-210 appears to indicate an area of potential mounding, the flow in this area needs to be further clarified as it appears that groundwater may flow bidirectionally southeastward and northwestward and not necessarily to Wells Creek. Wells Creek pool elevation and Cumberland river elevation should be depicted on potentiometric maps.	Figure 13 is based on a limited dataset. TVA proposes to conduct the proposed investigations to provide a dataset for additional site characterization. The Environmental Investigation dataset will be evaluated to develop an understanding of subsurface conditions. If additional groundwater data is needed to characterize subsurface conditions, TVA will communicate to TDEC the proposed plan for additional sampling, measurements, or well installations. Refer to EIP Sections 3.1.14, 3.4.4 and 3.4.5 for additional information related to this request. The Wells Creek and Cumberland River pool elevations will be added to the future groundwater contour maps to represent data collected during the same time interval.
151	Figure 14	NA	NA	NA	NA	Figure 14 shows the Cumberland River stage gauge location but does not depict a staging location in Wells Creek. Please revise to show Wells Creek gauging station location.	An updated figure showing the Wells Creek gauging station has been included in an appendix to the EIP.
152	Table 1B	NA	NA	NA	NA	CUF-213 has had an unusually high pH (9.77) compared to surrounding wells, is it screened in ash?	CUF-213 was not screened in ash. The boring log and well construction log for CUF-213 are included in the February 2017 Geotechnical Field Services for Well Installation and Closures report included in the appendices of the EIP. The proposed investigation activities will provide additional data to characterize the site. After additional groundwater data has been collected, it will be evaluated and conclusions from the evaluation will be incorporated into the EAR. Monitoring well installation activities are proposed in the Hydrogeological Investigation SAP and groundwater gauging and sampling activities are proposed in the Groundwater Investigation SAP.
153	Table 1C	NA	NA	NA	NA	CUF-204 and CUF-205 both exhibit a significant change in water levels between November 2016 and January 2017, approximately 10ft and 7ft respectively. Do these elevations reflect higher than normal pool elevations of the Cumberland river?	The proposed investigation activities will provide additional data, including groundwater and pool elevations, to characterize the site. After additional groundwater and surface water data has been collected, it will be evaluated and conclusions from the evaluation will be incorporated into the EAR. Refer to EIP Sections 3.1.14, 3.4.4 and 3.4.5 for additional information related to this request.
154	Appendix F 3.5.1	Field Activities	19	2	2	The paragraph states that 7 borings were installed to the NE of the CCR units and the data will not be considered as part of this assessment. TDEC would like to evaluate the boring locations and associated data	These 7 borings are located near the middle of the power plant footprint; thus they were not relevant to the CCR units. However, the boring logs are included in Appendix B of TVA (1998), and this report can be provided to TDEC under separate cover.

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155	Appendix F	All	All	All	All	General comment - All subsurface and boring logging should be completed by a Tennessee licensed professional geologist only, not a professional engineer.	TVA proposes that for environmental investigation wells and soil borings, a TN-licensed professional geologist will be present and will log the borings. For geotechnical investigation borings and piezometer installations, a TN-licensed professional geologist or professional engineer will be present and will log the borings. For geotechnical borings, the PG or PE will have suitable experience in geotechnical or geological engineering projects to support the work. This approach has been used at current investigations at other TVA sites in TN.
156	Appendix F	3.1	6	1	All	Traditional methods of conducting a subsurface geologic investigation utilizing vertical bore- and core holes will probably not produce the data necessary to decipher the bedrock geology of the site. Bedrock exposures in the crater document that the bedding is steeply dipping to near vertical and so is the interpreted geometry of the faults. Drawing accurate cross sections will be difficult using vertical boreholes. Borehole depths may need to be very deep when encountering steeply dipping beds in order to attempt to correlate the geology between boreholes. Furthermore in many places the bedrock is highly fractured to the point of being brecciated, which may make it difficult to obtain bedrock cores.	The EIP will be updated to discuss the status of the ongoing Groundwater Conceptual Site Model (CSM), which should address many questions about the hydrogeologic conditions at CUF. The objective of the rock cores in the Exploratory Drilling SAP is not to provide for a site-wide characterization of the deep bedrock. Instead, the objective is to confirm top of rock elevation and the shallow bedrock stratigraphy/condition, to correlate with other existing data. As summarized in Appendix F, there is detailed historical geologic mapping/characterization performed by researchers who worked in this region prior to plant development. This work is being leveraged to develop the CSM.
157	Appendix G, Section 4.1	Material Quantity SAP	5	2	4	Draft model and discussion as the model is being developed	To the extent that information is developed during the environmental investigation that affects CCR volume calculations, revisions to the 3-D model will be included in the EAR.
158	Appendix G, Section 4.2.1	Material Quantity SAP	5	1	7	Exploratory Drilling SAP should be Appendix H, not Appendix F.	Comment is acknowledged and the corresponding change has been made in the document.
159	Appendix G, Section 4.2.1	Material Quantity SAP	6	1	1	Is a minimum of 3 month adequate to determine if there is any seasonal fluctuation? Recommend a minimum of 6 months.	Comment is acknowledged and the corresponding change has been made in the document.
160	Appendix G	4.2.1	6	1	1	TDEC recommends monthly water level monitoring be conducted during a timeframe that is representative of average precipitation at the CUF.	Comment is acknowledged and the corresponding change has been made in the document.
161	Appendix G, Section 5.2.5	Material Quantity SAP	10	2	1	Discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.	Comment is acknowledged and the Material Quantity SAP has been edited to state IDW will be in accordance with ENV-TI-05.80.44 Groundwater Level and Well Depth Measurement. The field work associated with water level monitoring is now addressed in the CCR Material Characteristics SAP. Therefore, investigation derived waste (IDW) associated with water level monitoring is addressed in the CCR Material Characteristics SAP.

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162	Appendix H	5.2.1.2	9	3	1	TDEC recommends borehole geophysics (gamma logs, etc..) be conducted as part of the exploratory drilling operations.	Based on verbal clarification from TDEC during the 10/4 meeting, we understand that the intent of TDEC's comment was to consider borehole geophysics to support hydrogeologic characterization in rock. The proposed monitoring wells do not extend into rock. However, some of the proposed geotechnical borings include rock coring, and borehole geophysics and packer testing will be included in these borings. The EIP will also be updated to discuss the status of the ongoing Groundwater Conceptual Site Model (CSM), which should address many questions about the hydrogeologic conditions at CUF. If the CSM includes performance of borehole geophysics, those results will be leveraged and presented in the EAR.
163	Appendix H, Section 5.2.9	Exploratory Drilling SAP	14	1	1	Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as to not create a safety hazard.	Comment is acknowledged and the corresponding change has been made in the document.
164	Appendix H, Section 5.3.2.2	Exploratory Drilling SAP	16	1	11	Why is the target turbidity for development 10 NTU when the groundwater stabilization criteria listed for turbidity in ENV-TI-05.80.42 is less than 5 NTUs?	The referenced criteria in ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017) is less than or equal to 10 NTU, not 5. It is possible an older version of this TI may have had different criteria.
165	Appendix I	5.1.3	9	1	1	TDEC recommends monthly data collection be conducted during a timeframe that is representative of average precipitation at the CUF.	Precipitation data will be collected in 5-minute intervals for the duration of the water balance study.
166	Appendix I	5.2	9	1	6	Please define "*statistically significant* "	The term "statistically significant" was used here in the wrong context and the text will be revised accordingly.
167	Appendix K	5.4	8	2	6	Please correct apparent error with word "*Potentially* "	The word "potentially" has been removed from the text.
168	Appendix K, Section 5.5.4	Water Use Survey SAP	11	1	7	The sample ~~should~~ will be collected at the indoor or outdoor tap closest to the wellhead, prior to any water treatment devices.	This sentence has been revised to replace "should" with "will".
169	Appendix L	Hydrogeological Investigation SAP	All	All	All	General comment - TDEC recommends installing monitoring wells within the ash disposal complex to accurately characterize groundwater flow beneath the complex.	Piezometers with vibrating wire transducers have been installed within the Dry Ash Stack and Gypsum Storage Area for other ongoing TVA projects. These vibrating wire piezometers are shown on the figure included in the appendix of the EIP. The water level measurements collected from these piezometers will be used to characterize the groundwater flow beneath the units. No additional monitoring wells are proposed to be installed within the units. TVA's understanding is that the compliance boundary per TDEC solid waste regulations is defined as the perimeter of the CCR complex and does not include the areas within the units.

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170	Appendix L	Hydrogeological Investigation SAP	All	All	All	Demonstrate how groundwater at the new background well locations are representative of background groundwater quality. This demonstration should include flow rate and direction associated with the aquifer being monitored.	Proposed background well locations were discussed and selected during an onsite CUF meeting with TDEC prior to the EIP Rev 1 submittal. During the meeting, the locations of proposed background wells CUF-1000 and CUF-1001 were agreed upon by both TVA and TDEC as locations that would provide groundwater quality that is representative of background conditions. TDEC criteria for background wells are to provide locations to sample groundwater that is representative of the groundwater that flows beneath CCR units. TVA proposes to implement the proposed plan, evaluate the data collected, and then assess the suitability of the proposed background well locations for the initial investigative phase. Additionally, ongoing hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. The results of these investigation activities will be incorporated into the Environmental Investigation.
171	Appendix L	Hydrogeological Investigation SAP	All	All	All	Background well CUF-1001 could potentially be impacted from facility operations from handling the coal and gypsum. How can this well location demonstrate groundwater that has not been impacted by the CCR waste or facility operations?	The proposed investigation plan includes collecting background and downgradient groundwater data to be used to assess the suitability of proposed well CUF-1001 as a background well. If groundwater data indicates that the location of CUF-1001 is not suitable as a background sampling location, another existing or new well location will be proposed to TDEC as a background monitoring well.
172	Appendix L	Hydrogeological Investigation SAP	All	All	All	This SAP is missing a table of the well construction details TVA anticipates for the additional ground water monitoring wells. This includes latitude and longitude, approximate screen interval below ground surface, anticipated depth of groundwater, estimated depth of bedrock.	A table will be included with details for existing and proposed wells. Final information including latitude and longitude, approximate screen interval below ground surface, anticipated depth of groundwater, and estimated depth of bedrock will be provided upon completion.
173	Appendix L	Hydrogeological Investigation SAP	4	2	1	It is premature to designate background well locations until such time that groundwater flow has been characterized at the CUF. TDEC recommends installing additional groundwater wells in both soil and bedrock to the southwest, northwest, and within the ash pond complex to fully characterize groundwater flow at the CUF.	Proposed background well locations were discussed and selected during the onsite CUF meeting with TDEC prior to the EIP Rev 1 submittal. During the meeting, the locations of proposed background wells CUF-1000 and CUF-1001 were agreed upon by both TVA and TDEC. In addition, hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. Vibrating wire transducers have been installed within the Dry Ash Stack and Gypsum Storage Area as part of other ongoing TVA projects. After investigation activities have been completed, the results will be evaluated to select appropriate background monitoring well locations. The selected background well locations will be provided to TDEC for review and comment before finalizing these locations. The proposed piezometers, observation wells and monitoring wells between the CCR units and plant are designed to characterize groundwater flow in the northeastern part of CUF. In addition, hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology in the southern, southwestern and southeastern parts of CUF. TVA proposes to implement the initial plan, evaluate the data collected, and then consider the need for additional wells northeast, south, southwest and southeast of the CCR units. Additional investigations will be proposed if warranted by the results of the initial investigation.
174	Appendix L, Section 4.0	Hydrogeological Investigation SAP	4	2	10	Alternative locations need to be indicated on the map.	Alternate locations are provided on the Figure in the Hydrogeological Investigation SAP.

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175	Appendix L, Section 5.1	Hydrogeological Investigation SAP	6	2	1	Potable water should be used for drilling, installation, and development of all environmental monitoring wells and piezometers. Non potable water may be used for core holes, geotechnical borings, or other boreholes in which monitoring wells are not installed.	Potable water will be used for well installation activities. This reference has been added to the text.
176	Appendix L, Section 5.2	Hydrogeological Investigation SAP	6	2	2	The elevation of the established and documented point on the top of each well casing will be correlated to Mean Sea Level	In order to align with existing data, the top of each well casing will be surveyed and correlated to the vertical datum used by the Plant.
177	Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	2	1	If the well is intended to be 4" ID and 5.5" OD then a larger than 9" borehole may be required to allow for proper placement of completion materials such as filter sand and bentonite pellets.	Comment acknowledged.
178	Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	2	3	Preference is for 10-ft well screen to be set within the coarser unit above the bedrock.	Ten-foot well screens are typical, but longer screens may be required to accommodate large groundwater fluctuations in some locations. Screen interval depths will be dependent on the groundwater sampling intervals targeted for the Environmental Investigation.
179	Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	2	11	The annular grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs./gal shall be used.	Comment acknowledged. Cement may or may not be used depending on groundwater conditions due to potential interference with pH readings.
180	Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	5	1	Missing period. *An example installation log is shown in Figure 3 A drawing of the wellhead construction is shown in Figure 4.*	A period has been added after 'Figure 3' in the text.
181	Appendix L, Section 5.2.7.2	Hydrogeological Investigation SAP	11	1	1	Monitoring well development should not begin until a minimum of 24 hours following completion of the well.	TVA TI procedures will be followed and include this requirement.
182	Appendix L, Attachment A	Hydrogeological Investigation SAP	NA	Figure 3	NA	Well pump placement should be at the midpoint of the screen, if the screen is fully submerged, otherwise the pump should be placed at the midpoint of the saturated interval. It is unclear by this figure that the pump is placed correctly.	Figure 3 was revised to show the approximate placement of the well pump to be the midpoint of the screen or saturated interval.
183	Appendix L, Attachment A	Hydrogeological Investigation SAP	NA	Figure 3	NA	Water encountered during drilling should be shown on stratigraphy log adjacent to monitoring well construction log.	A note showing water encountered during drilling has been added to the referenced Figure 3 and will be included on boring logs.
184	Appendix M	Groundwater Investigation SAP	All	All	All	General comment - TDEC recommends installing monitoring wells within the ash disposal complex to accurately characterize groundwater quality beneath the complex.	Piezometers with vibrating wire transducers have been installed within the Dry Ash Stack and Gypsum Storage Area for other ongoing TVA projects. These vibrating wire piezometers are shown on the figure included in the appendix of the EIP. The water level measurements collected from these piezometers will be used to characterize the groundwater flow beneath the units. No additional monitoring wells are proposed to be installed within the units. TVA's understanding is that the compliance boundary per TDEC solid waste regulations is defined as the perimeter of the CCR complex and does not include the areas within the units.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)
185	Appendix M	Groundwater Investigation SAP	All	All	All	Groundwater monitoring reports for samples taken should be submitted within 60 days of sampling event to TDEC. If TVA cannot meet the SW Rule requirement TVA should submit justification for an alternate schedule. We understand that Radium 226 and 228 analysis take longer, but those results can be submitted at a later date as an addendum.	TVA has prepared this EIP and associated plans to conduct an environmental investigation of CUF per the TDEC Order. The reporting requirement for the investigation as stated in the Order is to provide summaries and conclusions in the EAR. If corrective actions or compliance monitoring are required based on the conclusions in the EAR, then those activities will follow the EAR under the CARA Plan as required by the Order. If conditions are detected during the investigation that would warrant more immediate action under the SW rule, the pertinent data and monitoring points would be considered for incorporation into that program and assessment through a minor modification of the permit. However, until the investigation is completed, it is pre-mature to draw conclusions about exceedances and begin assessments or corrective actions, especially for data being collected for other programs. The appropriate place to evaluate data from other programs and develop a path forward is within the requirements and framework of those existing programs. TVA requests that TDEC applies the SWM Rules outside this TDEC Order process.
186	Appendix M	Groundwater Investigation SAP	All	All	All	Recent groundwater results submitted by email on August 25, 2017 show an arsenic exceedance at wells CUF-206 (10.5 ug/L), CUF-211 (10.8 ug/L) and CUF-213 (12.8 ug/L). TVA must initiate an assessment of corrective measure as required by SWM Rule 0400-11-01-.04-7. or explain why it is not necessary.	TVA has prepared this EIP and associated plans to conduct an environmental investigation of CUF per the TDEC Order. The reporting requirement for the investigation as stated in the Order is to provide summaries and conclusions in the EAR. If corrective actions or compliance monitoring are required based on the conclusions in the EAR, then those activities will follow the EAR under the CARA Plan as required by the Order. If conditions are detected during the investigation that would warrant more immediate action under the SW rule, the pertinent data and monitoring points would be considered for incorporation into that program and assessment through a minor modification of the permit. Further, until the investigation is completed, it is pre-mature to draw conclusions about exceedances and begin assessments or corrective actions, especially for data being collected for other programs. The appropriate place to evaluate data from other programs and develop a path forward is within the requirements and framework of those existing programs. TVA requests that TDEC applies the SWM Rules outside this TDEC Order process.
187	Appendix M	Groundwater Investigation SAP				Statistical methods to be used for evaluating groundwater monitoring data are not developed in this EIP. TVA must include the selection and certification of the statistical procedure to be used in accordance with 40 CFR 257.93. The certification must include a narrative description of the chosen statistical method.	TVA will following the statistical procedures listed in 40 CRF 257.93. Because selection of the appropriate statistical method is dependent on the dataset under evaluation, the method cannot be selected a priori. TVA will provide the basis for selection of statistical methods in the EAR.
188	Appendix M, Section 3	Groundwater Investigation SAP	2	1	2&6	The Groundwater Investigation SAP indicates determining direction only, however 40 CFR 257.93 requires the rate and direction of groundwater flow each time groundwater is sampled.	TVA will provide information regarding the direction and rate of groundwater flow each time groundwater is sampled.
189	Appendix M	Groundwater Investigation SAP	4	1	3	TVA states that monitoring wells that are being sampled as part of other programs will not be sampled as part of this SAP. TDEC recommends all groundwater monitoring wells be sampled as part of the EIP and the data provided to TDEC for review.	Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order. However, duplicate samples will not be collected as part of the Environmental Investigation if samples have already been or will be collected as part of another program at the same time as proposed in the EI sampling schedule. The data collected for other programs will be utilized in the EAR.

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190	Appendix M, Section 4	Groundwater Investigation SAP	4	5	3	The gauging of the pool elevation of Wells Creek is a critical component to understanding groundwater flow at the site. It needs to be measured as part of the environmental investigation. The location of the gauge needs to be shown on Figure 1.	Pool elevation data will be collected as part of the Environmental Investigation and provided in the EAR. The Wells Creek gauging location has been added to the Figure in the Groundwater Investigation SAP.
191	Appendix M	Groundwater Investigation SAP	4	3	5	It is premature to designate background well locations until such time that groundwater flow has been characterized at the CUF. TDEC recommends installing additional groundwater wells in both soil and bedrock to the southwest, northwest, and beneath the ash pond complex to fully characterize groundwater flow at the CUF.	Proposed background well locations were discussed and selected during the onsite CUF meeting with TDEC prior to the EIP Rev 1 submittal. During the meeting, the locations of proposed background wells CUF-1000 and CUF-1001 were agreed upon by both TVA and TDEC. In addition, hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. Vibrating wire transducers have been installed within the Dry Ash Stack and Gypsum Storage Area as part of other ongoing TVA projects. After investigation activities have been completed, the results will be evaluated to select appropriate background monitoring well locations. The selected background well locations will be provided to TDEC for review and comment before finalizing these locations.
192	Appendix M, Section 4	Groundwater Investigation SAP	4	6	1	This statement makes it appear that 93-1, 93-2R, 93-3, 93-4, 96-9, B103, B110, CUF- 101, CUF-102, CUF-120, CUF-201, CUF-202 and CUF-205 through CUF-213 will not be sampled but only gauged for water levels. Is this accurate? Please specify which wells are monitoring wells and which are observation wells.	Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order. However, duplicate samples will not be collected as part of the Environmental Investigation if samples have already been or will be collected as part of another program at the same time as proposed in the EI sampling schedule. The data collected for other programs will be utilized in the EAR. Monitoring wells (gauging and analytical sampling) include: 93-1, 93-2R, 93-3, 93-4, B110, CUF-201, CUF-202 and CUF-205 through CUF-213. Observation wells (gauging only) include: 96-9, B103, CUF-101, CUF-102 and CUF-120. Observation wells will only be gauged to collect groundwater elevation data because they were not designed to collect representative groundwater analytical samples.
193	Appendix M, Section 4	Groundwater Investigation SAP	5	1	1	When installing new groundwater monitoring networks, groundwater quality data from at least eight events is needed, in most cases, to fully assess and compare up gradient versus downgradient groundwater quality. Please address justification for sampling frequency.	Quarterly groundwater sampling is consistent with TDEC solid waste regulations for Class II facilities and is an industry accepted frequency for providing information related to seasonal groundwater and river stage fluctuations. Cumberland River and Wells Creek water levels and precipitation data will be monitored prior to conducting each quarterly sampling event to collect samples in a range of seasonal groundwater conditions. Statistically limited data sets are also common in the industry and data can be correlated if sample collection frequency is too short. The purpose of the work proposed in this Environmental Investigation is to investigate and characterize the site-specific hydrogeology at CUF and is not intended to be a groundwater monitoring program. The results of the investigation will be provided in the EAR. If results obtained from this investigation indicate the need for more frequent sampling intervals and additional sampling events, then the sampling schedule may be revised to provide additional groundwater data. Bi-monthly sampling (6 events) for one year is proposed. According to USEPA Project Summary document "Sampling Frequency for Ground-Water Quality Monitoring" dated September 1989, quarterly and bi-monthly groundwater sampling frequencies are sufficient for major, non-reactive chemical constituents. However, more frequent sampling intervals are not recommended due to potential autocorrelation issues.

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194	Appendix M, Section 5.2.2	Groundwater Investigation SAP	7	5	5	If the final turbidity after sample collection is greater than 10NTU is there any additional requirements for resample?	Per the SAP, if final turbidity readings indicate values above 10 NTUs, then filtered (dissolved) inorganic constituent samples will be collected in addition to unfiltered (total) inorganic constituent samples. Dissolved sample collection will be accomplished in accordance with ENV-TI-05.80.42.
195	Appendix M, Section 5.2.2	Groundwater Investigation SAP	8	2	1	Will barometric pressure readings be recorded? What will be the frequency and source of the barometric pressure readings? Will ambient air temperature be measured? Will a correlation between a NIST thermometer and the temperature on the multi parameter probe be made and recorded?	Barometric pressure readings will be recorded daily. TVA plans to use a multi-parameter sensor equipped with an NIST certified temperature sensor.
196	Appendix M, Section 5.2.6	Groundwater Investigation SAP	13	Table 5		Field pH meters used for collecting data will have to meet the calibration requirements of Method C , which is 0.05 pH units of the bracketing buffer solution values.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the CUF EIP.
197	Appendix M, Section 6.2	Groundwater Investigation SAP	15	4	1	If the tubing used to collect the filter blank is not certified clean tubing then a tubing blank would be required at the same rate of collection as a filter blank and for the same analytes.	Tubing blanks have been collected on a frequency of 1 per lot in other GW monitoring programs.
198	Appendix M, Section 6.2	Groundwater Investigation SAP	15	6	7	If an analyte is not amenable to the MS/MSD procedure it should be collected as a lab duplicate (e.g., TSS and radium)	Comment acknowledged. The QAPP indicates that additional volume is collected for laboratory duplicate analysis for parameters not amenable to spiking.
199	Appendix M, Appendix A	Groundwater Investigation SAP	22	Figure 1		Please show location of Wells Creek staff gauge and the second Cumberland River gauge.	There will be only one gauge in the Cumberland River and one in Wells Creek. The Wells Creek gauge has been added to the Figure in the Groundwater Investigation SAP.

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200	Appendix N	CCR Material Characteristics SAP	All	All	All	TDEC recommends conducting a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility. This would include not only pore water analysis but LEAF methods (SPLP, TCLP) for solid material. Samples should be collected from multiple depths within the profile of each material located in the ash disposal complex.	TVA's initial CCR leachability approach in this EIP followed EPA's language in the preamble to the CCR Rule. EPA has stated "The use of pore water data is still considered the most appropriate approach to estimate constituent fluxes to groundwater for CCR surface impoundments." In addition, "EPA agrees that TCLP and SPLP data are less appropriate for CCR disposal scenarios and no longer uses these data in the revised risk assessment." The TCLP leaching method was developed to simulate the potential for leaching of materials intended to be disposed in a municipal landfill. Since TVA's CCR landfills are not municipal landfills, TCLP would not be an appropriate analysis to complete for future modeling of leachate. TVA will obtain seven pore water samples from the base of the units, and three pore water samples above the drainage layer in the Gypsum Disposal Complex, to provide real-time measurements of constituents in actual conditions for the CCR material in the units. The CCR material at the base of the unit will have had the greatest opportunity for leaching to occur, due to it having the longest duration of time in an aqueous medium reflecting actual conditions, and will be the closest point to the boundary of the unit, nearest any groundwater. Samples of CCR material will be collected from the temporary wells during their construction (that are to be used for sampling pore water). Saturated and unsaturated CCR material samples will be analyzed for the CCR parameters according to the most applicable method based on emerging science in the industry which could include the Synthetic Precipitation Leaching Procedure (SPLP). Taking saturated and unsaturated samples from each temporary well will provide a vertical distribution of the samples. TVA considers the groundwater monitoring well network as the definitive mechanism to determine releases to groundwater which includes protocols for detection, assessment, and corrective action of contaminants in groundwater, through the groundwater monitoring program.
201	Appendix N, Attachment A	CCR Material Characteristics SAP	NA	Figure 1	NA	TDEC recommends additional temporary wells be installed in the retention pond and stilling pond area to accurately assess the presence of ash and leachability characteristics there of.	The temporary well proposed in the Ash Pond is located on a dike extending into the ponds. There is very little room to include additional wells spatially throughout the ponds since they are filled with water. Access to drilling locations is difficult and the plan does not include drilling over open ponded areas due to safety concerns.
202	Appendix O	Sediment SAP	All	All	All	General comments - TDEC recommends analyzing all top six-inch sediment samples for CCR parameters. TDEC recommends running additional analysis on boring samples if CCR constituents are detected in the associated top six-inch sediment sample not only if percent ash >20%. TDEC recommends adjusting sediment sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river bed profile. TDEC recommends implementing Phase 2 sampling if CCR constituents are detected in the associated top six-inch sediment sample.	All top six-inch sediment samples (with the exception of the top six-inch sediment samples collected from the pond at the northeast corner of the Plant) will be analyzed for the CCR parameters during Phase I per TDEC recommendation. It is assumed that at least some of the CCR constituents will be detected in samples (including background samples). TVA will evaluate the Phase I CCR constituent results on a sample-by-sample basis to determine whether additional Phase II analyses will be implemented. Rather than using any detections as a trigger for Phase II, TVA will base the decision to implement Phase II at each Phase I sampling location based on PLM results exceeding the 20% ash threshold. TVA has revised the proposed sampling locations to include transects. TVA believes that the proposed scope of work is appropriate for an initial investigative phase. If, based on the results of the initial phase of work, data gaps are identified, TVA will propose additional investigation.

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203	Appendix P	Seep SAP	All	All	All	How does TVA plan to identify, assess, and sample seeps that may not currently be visible due to mitigation (rip rap)?	The site investigation will use a boat to evaluate areas along the creek bank, which would otherwise be inaccessible due to the extent of mitigation riprap in those areas. The investigation will include an examination of the bank at the base of the riprap to determine if there are continuing water discharges at those locations. Should active seeps be discovered during the investigation, a seep sampling location map will be finalized, and the Seep SAP will be implemented. This procedure will identify flowing seeps not otherwise visible due to riprap coverage, and allow for their subsequent sampling and analysis under the procedures of this Seep SAP.
204	Appendix Q	Surface Stream SAP	All	All	All	General comments - TDEC recommends collecting water column samples (top, middle, and bottom) at each sampling location in Wells Creek, the Cumberland River, and the unnamed tributary flowing into Wells Creek. Effort should be made to co-locate water column samples with sediment samples collected as part of the EIP as well as the already identified sampling locations. TDEC recommends adjusting water column sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river profile.	The Surface Stream SAP will be revised to include sample transects, instead of point sampling locations. The transects will be evaluated by collection of Hydrolab data initially. If Hydrolab data indicates that the water column is thermally stratified, four samples from the water column (near-bottom (epibenthic) sample 0.5 m above streambed, mid-hypolimnion sample (midway between bottom of thermocline and streambed), mid-epilimnion sample (midway between top of thermocline and water surface, and near-surface (0.5 m depth)) will be collected from the thalweg, right bank, and left bank locations (totaling 12 samples per transect). If there is no thermal stratification, three samples from the water column (bottom, mid-depth, and top) will be collected from the thalweg, right bank, and left bank locations (totaling 9 samples per transect). Language will be included in the SAP to allow the sampling team flexibility if the depth or width of the channel at a sample location is inadequate for collecting multiple samples from the water column or locations along the transect. Surface stream samples will generally be co-located with sediment samples. Where sediment samples are located in close proximity to each other, one representative surface stream sample transect will be collected. Similarly, if a previously proposed surface stream sample location is located in close proximity with a sediment sample, only one sample transect will be evaluated to represent water quality at that location.
205	Appendix Q	Surface Stream SAP	All	All	All	General comment - Background sample locations in should be upstream of the CUF and ash pond area, outside of any potential influence from site activities and CCR storage/release.	Background samples will be collected from Wells Creek and Cumberland River upstream of CUF. It is also anticipated that additional surface stream data collected previously by TVA can be used.
206	Appendix Q	Surface Stream SAP	All	All	All	General comment - TDEC recommends implementing Phase 2 sampling if CCR constituents are detected in the associated top six-inch sediment sample.	TVA will base the decision to implement Phase II at each Phase I sampling location based on the associated sediment sample PLM results exceeding the 20% ash threshold. TVA believes that the proposed scope of work is appropriate for an initial investigative phase. If, based on the results of the initial phase of work, data gaps are identified, then TVA will propose additional investigations.
207	Appendix Q	Surface Stream SAP	All	All	All	General comment - TDEC recommends multiple sampling events to account for seasonal fluctuation of rain fall and water quality conditions.	The Surface Stream SAP as written allows for multiple sampling events. TVA proposes to implement the SAP twice during the investigation period to capture seasonal fluctuations (e.g., between 4-8 months), as requested.

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208	Appendix R	Fish Tissue SAP				Several species of fish are targeted. The plan should focus on fish that are popular with local fishers.	Per Sections 3.5.1 and 4.5.8 of the EIP, the fish SAP was developed to assess the impact of CCR materials on fish populations, such as mortality, number of species, deformities, etc., not on human health. A human health risk assessment would constitute a separate study/SAP and would possibly include assessing impacts from surface water ingestion by humans, dermal contact and consumption of several animals, including fish, mussels, crayfish, and turtles. The species being collected (bluegill, redear sunfish, largemouth bass, and catfish) are sportfish that are popular with fishermen throughout the Tennessee and Cumberland River Valleys (and the entire southeastern US). They also span a range of trophic guilds which is beneficial in evaluating ecological risks as well as human health risks. In addition, numerous published papers indicate that bluegill and redear sunfish have a tendency to bioaccumulate selenium to a greater extent than most other species; therefore, collecting those species provides a worst-case scenario for fish bioaccumulation of selenium. While selenium is an essential nutrient (and even is touted in over-the-counter human health supplements as a key antioxidant ingredient), at high levels of bioaccumulation it causes reproductive failure in fishes. That's why EPA's water quality criterion for selenium is a fish-tissue-based criterion, instead of a water concentration.
209	Appendix R	Fish Tissue SAP				How will sample integrity be maintained?	QA/QC procedures for the fish sampling activities are included in the referenced TVA SOPs and Tis. Additional language will be added to the SAP, referencing the QA/QC procedures.
210	Appendix R	Fish Tissue SAP				It does not appear that DQOs have been identified in either the SAP or QAPP for the fish tissue sample collection activities. The text should explain relevant DQOs assuming that they would be primarily related to sample handling issues. One exception involves the measurement of sample location surface water pH. DQOs for pH will require that meters are calibrated to a known standard in accordance with manufacturer's specifications.	Relevant DQOs for collection, preparation, and transfer of fish tissue samples to the analytical laboratory have been addressed in the Fish Tissue SAP and QAPP.
211	Appendix R, Section 5.2.1.2	Fish Tissue SAP	8	2	7	The text should explain how why only muscle and ovary sampling was chosen and does not appear to include the following four types of fish tissue: liver, muscle, ovary and testes.	TVA will add liver sampling to the Fish Tissue SAP for the sampled species except shad which are being processed as whole body. Testes are not being included because the objective is to sample tissues where CCR constituents will accumulate and to assess potential transfer of CCR constituents maternally. TVA proposes to follow relevant portions of the fish tissue sampling protocols implemented following the Kingston ash release. Except for gizzard shad (which are very small fish), muscle, liver, and ovaries will be collected from composites of representative trophic level fish. Testes will not be collected.
212	Appendix R, Section 3.0	Fish Tissue SAP	3	1	5	Field teams should consist of (at a minimum) one experienced fisheries biologist, one field technician, and a quality control specialist, all of whom must have experience with the array of fisheries sampling equipment to be used.	TVA will add a requirement for the suggested team to be made up of a fisheries biologist, field technician and quality control specialist with fish sampling experience to the Fish Tissue SAP. TVA will specify in the SAP that the team will consist of personnel with expertise in fish sampling techniques and who have experience with the quality control requirements of the sampling protocols specified herein. The QAPP (Section 5) provides for training of field personnel to reinforce the procedures to be followed during the sampling activities.

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213	Appendix R, Section 5.2.1.2	Fish Tissue SAP	8	2	3	The sampled fish should be of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual	Comment is acknowledged and the corresponding change has been made in the document.
214	Appendix R, Section 5.2.4.1	Fish Tissue SAP	10	2	6	Since the fish tissue samples are required to be maintained at -10 degrees C, wet ice in resalable bags may not meet that requirement. It is suggested to pack the samples on dry ice, and that the samples arrive at the sample preparation laboratory within less than 24 hours from the time of sample collection.	Using dry ice in the field is difficult and can be hazardous. The analytical laboratory confirmed that the samples should be maintained at 6o Celsius and can be stored and shipped to the laboratory on wet ice. The samples will be frozen once received at the laboratory.
215	Appendix R	Fish Tissue SAP	13	Table 5		Please confirm the appropriate method for Mercury analysis (i.e., Method 1631, Revision B with Appendix A or Method 7473)	Comment is acknowledged and the corresponding change has been made in the document.

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Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

December 11, 2017

M. Susan Smelley
Director
Environmental Compliance and Operations
Tennessee Valley Authority
1101 Market Street, MR 4K
Chattanooga, TN 37402

RE: TDEC Commissioner's Order OGC 15-1077
TVA Cumberland Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Revision 2 Comments

Dear Ms. Smelley:

The Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order OGC 15-0177 (the Order) to the Tennessee Valley Authority (TVA) that required TVA action at seven TVA Coal Fired Fossil Power Plants (active and inactive) located in Tennessee. The Order was signed on August 6, 2015 and included information about TVA's right to appeal the Order. TVA did not appeal the Order and it is now final.

The Order required TVA to perform environmental investigations and to take appropriate corrective action at seven TVA Coal Fossil Power Plants (CCR sites) in Tennessee. The Order is specific to Coal Combustion Residual (CCR) material. Paragraph VII. of the Order provides the sequence of events for environmental investigation at a TVA CCR site as presented below.

1. TVA and TDEC are required to schedule and conduct an initial meeting to discuss each CCR site. At each CCR site meeting, TVA provides the operational history of the CCR site, all geological and hydrogeological information currently available, results of environmental investigations and sampling, etc. This is basically a summary of TVA's current understanding of each CCR site.

2. TDEC reviews the information provided by TVA (historical information, geophysical properties of the site, operational history, etc.) at the on-site meeting and historical CCR site information provided by TVA. After review of the information provided by TVA, TDEC sends a letter to TVA that sets the date for submission of the draft CCR site Environmental Investigation Plan (EIP) and informs TVA of any additional environmental activities it believes are necessary to complete the CCR site environmental investigation.

3. TVA submits a draft Environmental Investigation Plan for the CCR site. TDEC reviews the draft CCR site EIP and provides TVA with comments that identify opportunities to improve the environmental investigation of the CCR site EIP. This letter also sets a due date for submission of the revised CCR site EIP.

4. TVA submits a revised EIP for the CCR site to TDEC, with a schedule of onsite activities such as installation of ground water monitoring wells, installing soil/rock borings to determine subsurface geological features, methods that will be used to determine the location and amount of disposed CCR material, surface water and ground water monitoring, etc.

5. TDEC provides TVA with its response to the revised EIP. When TDEC finds the CCR site EIP to be complete, TDEC notifies TVA via letter.

6. TVA is required to issue a public notice for the CCR site EIP before it is implemented. The public has 30 days to submit its EIP comments to TDEC. If EIP comments are submitted to TDEC, then TDEC has 30 days to respond to the comments.

7. Once the public comment period has ended, TDEC may provide TVA with CCR site EIP comments as a result of the review of the public comments submitted to TDEC. TVA submits and TDEC approves/disapproves the schedule of activities for environmental investigation at the CCR site. Unless TDEC disapproves the CCR site EIP schedule of activities, TVA proceeds with the environmental investigation, collects and generates data, then prepares an Environmental Assessment Report (EAR).

8. The EAR is submitted to TDEC. TDEC evaluates the EAR and decides if TVA has generated enough environmental investigation data to:

    a. Determine the impact of CCR materials to public health and the environment.
    b. Provide a comprehensive picture of the areas where CCR material disposed.
    c. Assess the structural and seismic stability of the CCR disposal areas.
    d. Determine the extent of CCR constituents in ground water and discharges to surface water.
    e. Determine if CCR material is disposed below the ground water table.

TDEC also determines if there is enough information generated to prepare a comprehensive corrective action plan.

If TDEC determines the EAR is incomplete or deficient, then TDEC informs TVA of its concerns. TVA is then required to further investigate the CCR site, beginning with item 4. above.

<u>Cumberland CCR site EIP Rev 2 Comments</u>

TVA submitted the EIP Rev 2 for TVA Cumberland Coal Fired Fossil Power Plant (TVA CUF) on November 9, 2017. TDEC has completed its review of EIP Rev 2 and is providing comments listed in the attached **Table 1 TVA Cumberland EIP Rev 2 Summary of TDEC Comments**.

Please address the attached comments and submit a revised plan (EIP Rev 3) with a cover letter summarizing TVA’s response to each comment and subsequent modifications to TDEC by **January 26, 2018**.

TVA has agreed to conduct an environmental investigation at the TVA CUF as required in the Order it received and did not appeal. It is TVA's responsibility to submit an EIP for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discusstheir concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA CUF site is complete, accurate and timely. Should you have any questions, please do not hesitate to contact me via email at Robert.S.Wilkinson@tn.gov or phone at (615) 253-0689.

Sincerely,

Robert Wilkinson, PG, CHMM

CC:

Paul Pearman	Britton Dotson	James Clark
Pat Flood	Scotty Sorrells	Rob Burnette
Tisha Calabrese Benton	Angela Adams	Joseph E. Sanders
Chuck Head	Peter Lemiszki	Jason Repsher
Alan Spear	Shawn Rudder	Taylor Korth
Anna Fisher		

Table 1
TVA Cumberland EIP Rev 2 Summary of TDEC Comments

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
NEW	General Comment	NA	NA	NA	NA	NA	NA	TVA has agreed to conduct an environmental investigation at the TVA Cumberland Fossil Plant as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.
NEW	General Comment	NA	NA	NA	NA	NA	NA	All water and ground water sample results shall be reported in Parts per Billion (µg/L). The analytical results for all soil, CCR material or other solid samples shall be reported in Parts per Million (mg/kg)
NEW	General Comment	NA	NA	NA	NA	NA	NA	All figures that provide liquid and solid results shall be presented on individual pages unless two tables use the same units in presenting data. As an example if 2 tables provide analytical results for the concentration of two metals in 10 mg/kg intervals, then the 2 tables may be on 1 page. However, if 2 tables have different concentration ranges, one in 1 µg/L intervals and the other at 100 µg/l intervals, then the two tables shall be on different pages.
NEW	3.1	Site Info	9	4	7	NA	NA	Background soil samples for CCR parameters boron, sulfate and radium were not included in the potential background wells (CUF-201 & CUF202). Why not?
NEW	3.4	D. GW Monitoring	37	All	ALL	NA	NA	The May 12, 2017 GW Quality Assessment Plan should be included in the EIP.
NEW	Appendix D	Figure 10	340/1241	N.A.	N.A.			Additional borings need to be proposed along the center line of the original ash dike between CPT 07 and CPT 08. These borings are needed to better define the geology and hydrogeology at the perimeter of the CCR unit in the area of the pressure grouting performed in 1991.

Table 1
TVA Cumberland EIP Rev 2 Summary of TDEC Comments

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
NEW	Appendix D	Figure 12	342/1241	N.A.	N.A.			Provide an overlaying Historical Wells Creek alignment and limits of grouting from Drawing 10N212 R11 dated 5/20/91 onto Figure 12 "Proposed Geotechnical Borings". Borings need to be proposed along the natural/original alignment of Wells creek to better define the geology, hydrogeology and presence of a continuous below the CCR units.
NEW	Appendix D	Figure 14	344/1241	N.A.	N.A.			Additional borings need to be proposed along the natural/original alignment of Wells creek to aid in confirming the presence of a continuous soil liner and soil classification of the liner.
NEW	Appendix F	A.4 TDEC Site Information Request No. 4	467/1241	1	6 thru 8			Additional borings need to be proposed along the center line of the original ash dike between CPT 07 and CPT 08. These borings are needed to better define the geology and hydrogeology at the perimeter of the CCR unit in the area of the pressure grouting performed in 1991.
NEW	Appendix F	Attachment A Exhibit 3	473/1241	N.A.	N.A.			Additional borings need to be proposed along the center line of the original ash dike between CPT 07 and CPT 08. These borings are needed to better define the geology and hydrogeology at the perimeter of the CCR unit in the area of the pressure grouting performed in 1991.
17	3.1.1	A.1 TDEC Information Request	8	2	7	Line reads "*The General Guidelines removed the requirement for hexavalent chromium analysis* ." This is incorrect. TDEC will require both total chromium and hexavalent chromium to be analyzed.	Previous hexavalent chromium sampling events at other TVA sites have shown that quantitation of Cr(VI) is not reliable at trace concentrations. Hexavalent chromium that might occur in soil or in CCR would be expected to quickly be reduced to trivalent chromium as it oxidizes other constituents. A more feasible, phased approach is for TVA to analyze samples for total chromium, the form of chromium listed in the CCR Rule Appendix IV. If total chromium values in soil are at EPA RSL guidelines, TVA will consult with TDEC about how best to perform analyses for hexavalent chromium. All chromium sample results will be in the EAR.	TDEC will not require TVA to analyze for Hexavalent Chromium at the TVA CUF site. Our earlier work with TVA and SELC led to the discovery that Hexavalent Chromium analysis at low levels (< .1 parts per billion) did not produce consistent and accurate analytical results.
19	3.1.1	A.1 TDEC Information Request	8	4	4	Will a background concentration be determined for each soil type? Please explain how many samples from each soil type will be considered a valid test population for statistical evaluation.	TVA proposes to collect a minimum of 12 background samples from each soil horizon or geographic strata for the purpose of establishing background concentrations of CCR parameters. Twelve samples is consistent with other State's guidance (Ohio) and consistent with the findings presented in Gilbert, 1987. Twelve samples also exceeds the recommended number of samples for other States (n=4 for Wisconsin and Alabama). If TDEC has specific regulatory guidance on the number of samples required, please provide that guidance to TVA.	TVA should only develop background levels of constituents by totaling analytical results from soil samples from the same soil horizon. There should always be a minimum of 10 soil samples from the same soil horizon used to calculate the background levels of constituents. This may lead to different multiple background levels for a constituent within the profile of one boring.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
23	3.1.1	A.1 TDEC Information Request	10	3	7	It is unclear as to whether or not the sampling is a single grab sample or multiple aliquots that generate one composite sample. Since in the text it states "grab samples". A five foot sample interval seems course in suspected alluvial silts and clays. A 1-2.5 ft. interval, or change in lithology is recommended for silts and clay. Five foot intervals may be appropriate in sands. Also if the soil is fine sand and silt the sample should be biased to sampling the interface between sand lenses and silt since these lenses are of the conduits for contaminant movement. In clays the inorganics will tend to adsorb and samples should be collected from soil fractures or areas that show oxidation.	All proposed background soil samples are grab samples. One grab sample is proposed from the mid point of each five foot soil core, unless there is a change in lithology within a five foot core interval. In the event that a change in lithology occurs within a core interval separate grab samples will be collected from the mid point of both lithology in the core. Since the purpose of this study is to investigate natural soil chemistry and determine background concentrations of naturally occurring CCR constituents, the biasing of sample collections or collection of additional samples for this purpose is not warranted. The proposed background soil borings are positioned at locations that are not expected to be impacted from storm water, flooding, or groundwater from CUF and are positioned in areas previously determined to not be impacted by plant activities.	TVA respond's to TDEC's comment by stating the soil samples will not be collected in areas that have not been impacted by storm water runoff. How will TVA determine if proposed sampling locations have not been impacted by surface water runoff, especially soil samples near Wells Creek?
25	3.1.3	A.3 TDEC Information Request	11	3	8	TVA shall sample the spring on the Rye property if at all possible. If TVA cannot get access, then TDEC will assist	TVA has not been granted access by the property owner to sample Rye Spring. Historically, TVA sampled Rye Spring as a background groundwater monitoring site. The last date TVA sampled the spring was on April 15, 2016. After that time, the property owner has decided not to allow TVA access to the spring. To the extent that TDEC wants TVA to sample Rye Spring rather than identify a current well and/or future well as a new background monitoring well, TVA would appreciate TDEC's help in alleviating the landowner's concerns and obtaining from the landowner a signed access agreement granting TDEC and TVA permission to simultaneously enter the property and for TVA to sample Rye Spring. TVA will work with TDEC to draft an agreeable access agreement for TDEC to provide to the landowner to sign.	TVA shall sample Rye Spring , unless TVA provides written documentation that the owner of Rye Spring will not allow TVA to collect samples from the spring. If the property owner does not cooperate TDEC shall help with access to Rye Spring.
27	3.1.6	A.6 TDEC Information Request	14	2	10	The data discussed is relatively old. A clear delineation between the sluiced ash and the gypsum stack is needed. This information is needed is making stability calculations for the gypsum landfill. Should new borings be required to better identify the sluiced ash/gypsum contact.	Additional discussion will be added to the EAR regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are documented and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects as outlined in the EIP. Summary tables of key boring parameters will be provided as part of the EAR. In addition to borings, the permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC- approved permit application for Class II Landfill No. IDL 81-102-0086. In addition to borings, the permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 81-102-0086. Finally, the EAR will provide explanation that a more accurate delineation of the gypsum/sluiced ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary.	TVA states it does not believe that additional soil borings are needed for stability analysis. TDEC believes additional borings are need in the Gypsum Storage area and the Dry Ash stack. Samples from new borings in these areas will help ensure the type of material from top of ground to refusal, relative moisture content and material sheer strength. TVA shall install eight additional borings in locations identified by TDEC and collect moisture content, material type and material sheer strength from top to bottom of each boring.
28	3.1.6	A.6 TDEC Information Request	14	5	1	TDEC recommends additional borings to characterize the interface between the gypsum stack and sluiced ash for the Gypsum Landfill. There appears to be little data available from the center of the Gypsum Landfill (Figure 8). Additional fieldwork and boring installation will likely be required to fully characterize the interface in this area	The existing information referenced in the EIP is adequate to support a response to this information request. Additional discussion will be added to the EAR regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are known with reasonable confidence and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value.	See response to Comment 27
29	3.1.7	A.7 TDEC Information Request	14	2	1	TDEC recommends additional borings to characterize the interface between the dry ash stack and sluiced ash for the Fly Ash and Bottom Ash Landfill. There appears to be little data available from the center of the Landfills (Figure 8). Additional fieldwork and boring installation will likely be required to fully characterize the interface in this area.	The existing information referenced in the EIP is adequate to support a response to this information request. Additional discussion will be added to the EIP regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are known with reasonable confidence and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects. Finally, the EAR will explain that a more accurate delineation of the stacked ash/sluiced ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary. Summary tables of key boring parameters will be provided as part of the EAR.	See response to Comment 27

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
32	3.1.10	A.10 TDEC Information Request	16	3	5	TVA discusses submission of a proposed three dimensional model of the CCR materials disposed at the CUF site using existing data. This provides a good starting point for the area of waste disposal. However, TVA should be required to submit a revised three dimensional model of the CCR material disposed at the CUF site in the EAR, based on the findings of the EIP. It is tremendously important for TVA to identify any areas at the CUF site where CCR material is disposed below ground water. For closure in place, TVA has to follow the CCR regulations, specifically 257.102(d)(2)(i and ii) which states: ***"(2) Drainage and stabilization of CCR surface impoundments. The owner or operator of a CCR surface impoundment or any lateral expansion of a CCR surface impoundment must meet the requirements of paragraphs (d)(2)(i) and (ii) of this section prior to installing the final cover system required under paragraph (d)(3) of this section. (i) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.*** ***(ii) Remaining wastes must be stabilized sufficient to support the final cover system."***	The proposed 3-D model is not a preliminary model. It is based on a thorough evaluation of site- specific data regarding the base, sides and surface elevations of CCR. To the extent that information is developed during the environmental investigation that affects CCR volume calculations, revisions to the 3-D model will be included in the EAR. Corrective actions based on this 3-D model or any other data found in the EAR will be found in the CARA Plan according to Part VII.A.f of the Order.	The goal of 3.1.10 in the EIP is to collect data to accurately depict a three dimensional model of the CCR materials disposed at the TVA CUF site. This model should be presented in its final form in the Environmental Assessment Report. A major problem with TVA's proposal to collect data for the three dimensional model is it appears TVA plans to only use existing site data and does not plan to install borings and monitoring wells within the CCR landfill area. While using existing data is acceptable for developing the three dimensional model, it is important to have data from within the landfill itself. TDEC made this comment earlier and reiterates the importance of additional data from within the landfill area. TVA shall install after TDEC's approval, a minimum of 8 new borings within the footprint of the current landfill.
33	3.1.10	A.10 TDEC Information Request	16	1	7	The ERI data has not been provided in the EIP and therefore cannot be evaluated, the transects and interpretation should be included both graphically and with a narrative in the EAR. Were the ERI data correlated with existing borehole data in order to calibrate the apparent resistivity values with bedrock? If so how well did the ERI data match boring data? Were structural features or karst features indicated on the transects? On transects that do not have boring data that indicate the top of rock, a boring should be installed to calibrate the values before inclusion into a 3D model of the site.	The ERI data has recently (August 2017) been provided to TDEC under separate cover. The ERI data were correlated to select borings, but as shown on Figure 10 there are many other borings that can be correlated and interpreted. This evaluation will be presented in text and graphics in the EAR. No new borings will be necessary to perform this evaluation. The ERI results identified one potential bedrock discontinuity which will be further evaluated in the EAR. Otherwise, the ERI did not identify anomalies that would typically be associated with karst topography.	TVA indicates that the ERI results identified one potential bedrock discontinuity which will be further evaluated in the EAR. It is unclear what further investigation of this feature is planned since there are no proposed borings or surface geophysical methods planned in the area. TDEC requests that the feature be further explored using noninvasive methods (additional ERI, MASW or other technologies) within the gypsum storage area to identify the orientation of and soil and rock structure within the footprint of the ERI feature and in the immediate area of the ERI feature. If the surface methods indicate the potential for a karst feature, then TVA shall investigate the area around and below this feature with the installation of borings.
35	3.1.10	A.10 TDEC Information Request	17	2	9	TVA proposes adding additional borings and temporary wells at the TVA should locate additional borings and monitoring wells within the TVA CUF gypsum and ash landfills and between the landfill and the Cumberland River. There is very little subsurface data available in the area between the landfills/sluice ponds and the river (the plant area). Please see the Figure and Adobe page 372 of the EIP.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. The results of the investigation activities will be evaluated to assess if additional monitoring wells are needed to characterize the hydrogeology at the site. Additionally, vibrating wire piezometers have been installed in the Dry Ash Stack and Gypsum Storage Area as part of other ongoing TVA programs. Water level data collected from these piezometers will be used to characterize groundwater flow beneath the units. The proposed scope of work is consistent with an initial phase that is needed is to evaluate groundwater flow. Based on the results of the initial phase of work, additional investigations may be proposed to characterize the extent of CCR constituents, if CCR constituents are detected in groundwater at concentrations indicating impacts from CCR units.	TDEC believes that additional borings and monitoring wells are needed as stated in Comment 35; "TVA should locate additional borings and monitoring wells within the TVA CUF gypsum and ash landfills and between the landfill and the Cumberland River. There is very little subsurface data available in the area between the landfills/sluice ponds and the river (the plant area). Please see the Figure and Adobe page 372 of the EIP."" TVA shall provide TDEC with locations for the soils and borings described above as part of the EIP.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
38	3.1.11	A.11 TDEC Information Request	19	2	1	The Wastewater Characterization Plan did not include a plan for taking analytical results for CCR Parameters.	The Wastewater Characterization Plan was associated with a separate TVA project to evaluate options for potential future wastewater management alternatives and is not associated with this Environmental Investigation. If the need for wastewater characterization develops after completion of the Environmental Investigation, TVA will perform this characterization. Current wastewater monitoring is captured in the site's NPDES permit.	While the Wastewater Characterization Plan is a part of the TVA CUF NPDES permit, TDEC should understand the level of CCR constituents in the wastewater discharged to the Cumberland River Without data reporting the levels of CCR constituents discharged into the Cumberland River, it is difficult to determine the amount of CCR material release from the TVA CUF Plant into the Cumberland. TVA shall either collect water samples for CCR analyses when it collects samples for NPDES monitoring or collect and analyze water samples from the NPDES discharge point quarterly
41	3.1.13	A.13 TDEC Information Request	24	NA	NA	Stability of bedrock below fill areas - The EIP discusses the installation of 13 borings in the area of the stilling pond and the landfill. Will these borings provide enough additional information to adequately determine the stability of the rock structure below? - see Figure 1 Adobe Page 423	As noted in Section 3 of the EIP, the proposed borings are not, by themselves, intended to assess bedrock stability. Instead, the proposed borings are intended to be used in conjunction with existing geotechnical and hydrogeologic data, surface geophysics, geologic mapping/characterization, and visual inspection reports. The proposed borings, when used as part of this broader data set, are sufficient to respond to the information request.	TVA shall collect sufficient data during the installation of the 13 borings described in Section 3.1.13 that it can be used in the calculations of bedrock stability.
53	3.4.1	D.1 TDEC Information Request	38	2	1	Based on currently available monitoring data it appears that the groundwater flow on the eastern side of the Gypsum Storage Area is not fully characterized. The proposed monitoring well location between the CCR units and the main plant northeast of the CCR units may help clarify the groundwater flow, but since CUF-213 also has had arsenic detections greater than the MCL it may be necessary to evaluate an additional well located across Wells Creek south of CUF-213 near the Rye property boundary. This area potentially exhibits highly fractured (brecciated) bedrock or karstic geology.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. In addition, TVA proposes to complete the existing proposed plan for the initial investigative phase and install additional monitoring wells, if needed, based on the results of the Environmental Investigation.	TVA's response does not adequately resolve TDEC's concern. Groundwater flow on the eastern side of the Gypsum Storage Area is not fully characterized and requires at a minimum one eastern boundary well.
54	3.4.1	D.1 TDEC Information Request	38	2	2	Both "background" wells as outlined in the EIP will be located in the soils above the Stones River Group. However, at least three and possibly four wells in the Gypsum Storage Area are located above the Knox Dolomite. It is recommended that at least one background well be sited above the Knox Dolomite.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. In addition, TVA proposes to complete the existing proposed plan and install additional monitoring wells, if needed, based on the results of the Environmental Investigation. The proposed background well locations were identified with consideration of the geologic formations and agreed upon by TDEC during an onsite meeting. The scope of work proposed is believed to be appropriate for an initial phase of an environmental investigation. Additional investigations will be proposed if warranted by the results of the initial investigation.	TVA shall install the additional well in the Knox Dolomite with the details of well location, construction and development included in the revised EIP
55	3.4.1	D.1 TDEC Information Request	38	2	2	The groundwater is not characterized with respect to the Knox Dolomite. The Knox Dolomite is a highly fractured megabreccia and is mainly limestone and dolomite with lesser shale. CUF-204 is sited in the Stones River Group which is composed of thin bedded limestone with bentonite beds. Preference is for 10-ft well screen in the bedrock within water-bearing fractures. The top of the screen should be at least 5 feet into the bedrock.	Hydrogeological investigation activities are currently in progress to characterize the site-specific hydrogeology at CUF. The results of the investigation activities will be evaluated and incorporated into the EAR. The design for additional monitoring wells proposed to be installed in bedrock will include placement of the screen at least 5 feet into bedrock. The scope of work proposed is believed to be appropriate for an initial phase of an environmental investigation. Additional investigations will be proposed if warranted by the results of the initial investigation.	See TDEC response to Comment 54.

Table 1

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
56	3.4.1	D.1 TDEC Information Request	38	4	1	Are 4 quarterly sampling events sufficient to fully assess and compare up gradient versus downgradient groundwater quality? Please address justification for sampling frequency and why a monthly or bi-monthly sampling interval would not be more prudent to determine fluctuations based on seasonality, river stage or provide a more statistically robust dataset. With only four events it is possible that after an additional year there is still not an adequate background monitoring well.	Quarterly groundwater sampling is consistent with TDEC solid waste regulations for Class II facilities and is an industry accepted frequency for providing information related to seasonal groundwater and river stage fluctuations. Cumberland River and Wells Creek water levels and precipitation data will be monitored prior to conducting each quarterly sampling event to collect samples in a range of seasonal groundwater conditions. Statistically limited data sets are also common in the industry and data can be correlated if sample collection frequency is too short. The purpose of the work proposed in this Environmental Investigation is to investigate and characterize the site- specific hydrogeology at CUF and is not intended to be a groundwater monitoring program. The results of the investigation will be provided in the EAR. If results obtained from this investigation indicate the need for more frequent sampling intervals and additional sampling events, then the sampling schedule may be revised to provide additional groundwater data. Bi-monthly sampling (6 events) for one year is proposed. According to USEPA Project Summary document "Sampling Frequency for Ground-Water Quality Monitoring" dated September 1989, quarterly and bi-monthly groundwater sampling frequencies are sufficient for major, non-reactive chemical constituents. However, more frequent sampling intervals are not recommended due to potential autocorrelation issues.	SWM GW Monitoring rules are in place for release detection. The monitoring wells in the EIP are to fully investigation the extent of CCR contamination in ground water at TVA CUF. Sampling once every two months will provide site data more quickly. The last paragraph of the TVA response to comment 56 indicates TVA will sample the TVA CUF CCR monitoring wells bi-monthly. This is acceptable
60	3.5.2	D.2 TDEC Information Request	43	1	Last	TVA shall report all groundwater data in tables. One set of tables will consist of all samples taken from each individual well over time. The second set of tables shall compare all groundwater sample results from samples collected during the same sampling event.	Historical groundwater data that meets the requirements of the CUF QAPP will be incorporated with groundwater evaluation in the EAR and presented in the requested table format. Historical groundwater data that does not meet the requirements of the CUF QAPP will remain in the table provided in Appendix J of the EIP for reference purposes.	TDEC agrees that ground water data should be presented in a table. TVA shall develop a Ground Water table with all ground water monitoring results. This will provide a comprehensive view of all ground water at the TAA CUF site. This includes ground water monitoring wells that are not part of the EIP and the results from those wells. This includes ground water monitoring performed under the USWAG Program, the SWM Landfill ground water monitoring wells and the EPA CCR regulatory program.
61	3.5.3	D.3 TDEC Information Request	43	NA	NA	In the explanation for both the hydrogeological investigation and groundwater sampling there do not appear to be sufficient wells to determine if radial flow to the river is occurring north of CUF-101 and 96-9.	The proposed piezometers, observation wells and monitoring wells between the CCR units and plant are designed to characterize groundwater flow in the northeastern part of CUF. Preliminary data suggest that groundwater flow may not be from the CCR units, under the plant to the Cumberland River. TVA proposes to implement the initial plan, evaluate the data collected, and then consider the need for additional monitoring wells north of CUF-101 and 96-9. Additional investigations will be proposed if warranted by the results of the initial investigation.	TVA's response does not adequately resolve TDEC's concern. Evaluation of data as TVA has suggested will not fill this data gap, since there will be no monitoring point to be evaluated with respect of flow towards the Cumberland River or to the east. Additional monitoring wells will need to be proposed in the revised EIP.
62	3.5.3	D.3 TDEC Information Request	44	1	All	TDEC recommends additional monitoring well installation outside of the footprint of the ash ponds to the northeast to properly characterize groundwater flow towards the Cumberland River. In addition, TDEC recommends TVA consider installing additional monitoring wells to the south, southwest, and southeast to properly characterize groundwater flow in those areas. These wells should be sampled for CCR constituents as well.	The proposed piezometers, observation wells and monitoring wells between the CCR units and plant are designed to characterize groundwater flow in the northeastern, southern, southwestern and southeastern part of CUF. In addition, hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. TVA proposes to implement the initial plan, evaluate the data collected, and then consider the need for additional wells northeast, south, southwest and southeast of the CCR units. Additional investigations will be proposed if warranted by the results of the initial investigation.	TVA's response does not adequately resolve TDEC's concern. Evaluation of data as TVA has suggested will not fill this data gap, since there will be no monitoring point to be evaluated. The groundwater flow beneath the CCR units and the plant site need to be fully characterized in accordance with the order. Additional monitoring wells will need to be proposed in the revised EIP.
63	3.6.2	E.2 TDEC Information Request	45	1	last	Should TVA be required to collect new data to be used in the seismic and structural stability analysis given the original data collection may have come from borings and tests that were not specifically designed for an analysis of this type. TVA should install multiple borings from the top of each waste cell (gypsum and coal ash) to the original ground surface below the landfill. Samples of the CCR material should be collected at 10' intervals to determine % moisture content, particle size and type of CCR material. This data should be used to determine shear strength of the CCR material from top of fill to the contact point between original ground surface and CCR material. Further, this new data should be used in the stability calculations. If TVA maintains that the water content of the CCR material from this sampling event will decrease with time, thus creating a more stable material for stability analysis, then TVA will need to provide the rationale for their position.	As described in Section 3 of the EIP, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the requested stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The proposed exploratory drilling to install the temporary wells does include borings from the top of each unit to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to the type of index tests described in the comment per the SAP. As discussed in the response, new shear strength testing and new stability analyses are not necessary as current and ongoing analysis for other projects were performed to industry standards. Consistent with conventional practice, additional shearing resistance due to unsaturated soil conditions is neglected in the derivation of strengths and in the analysis performed by TVA.	TVA shall conduct shear strength,% moisture content, particle size and type of CCR material/soil material from new borings installed within the footprint of the current SWM Landfills.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
64	3.6.3	E.3 TDEC Information Request	46	3	2	TVA shall consult with TDEC regarding the use of new data in this analysis. As demonstrated at TVA Kingston, the inefficiency of drainage layers can contribute to structural and seismic stability of the landfilled CCR material.	As noted in Section 3 of the EIP, existing data will be reviewed and new data from proposed borings and other ongoing projects will be incorporated into the response in the EAR. With regard to slope stability, the key issue is whether or not representative (or conservative) pore water pressures in the drainage layer are used in the stability analyses. The existing piezometers and proposed temporary wells and piezometers to be installed as part of other ongoing projects will aid in understanding this issue.	Specifically the request is to clarify the discharge of the drainage layer to the perimeter ditch. Drawing 10W302-25 included as part of the TVA (2003) 10W302 series drawings, provides a detail that illustrates a drainage system for the Dry Ash Stack drainage layer to the perimeter ditch. Further, the recommendations provided in Law Engineering's January 27, 1992 report references in Appendix A's Figures 9 & 10 providing a detail intended to provide for the discharge of water from the drainage layer to the perimeter ditch. This ash dewatering recommendation is made to reduce liquefaction potential.
66	3.6.4	E.4 TDEC Information Request	46	3	1	40 CFR Part 257.53 "Closed" means placement of CCR in a CCR unit has ceased, and the owner or operator has completed closure of the CCR unit in accordance with 40 CFR Part 257.102 and has initiated post-closure care in accordance with 40 CFR Part 257.104. Provide documentation that the surface impoundments on which the existing landfills are constructed are closed by the Federal CCR rule definitions.	Throughout their service life, TVA has constructed and operated the Dry Ash Stack and Gypsum Disposal Complex in compliance with the state and/or federal regulatory frameworks in effect at the time. In 1996, TDEC issued Class II landfill permit IDL 81-102-0086 to allow portions of the existing surface impoundments to be transitioned to the Dry Ash Stack and Gypsum Disposal Complex. Since 1996, TDEC has approved various permit modifications for these CCR units. As discussed in Section 3 of the EIP, the Dry Ash Stack and Gypsum Disposal Complex are existing landfills as defined by the EPA CCR Rule. TVA is actively performing numerous demonstrations to document compliance with the CCR Rule. The CCR Rule became effective in 2015, and does not apply retroactively to the surface impoundments that were transitioned to landfills in compliance with the 1996 TDEC permit.	TDEC is in agreement that areas of historic surface impoundments that have been permitted as solid waste landfills are not part any currently NPDES permitted surface impoundment and subject to the SWM regulations including repair of areas along the contours of the landfill(s) where seeps occur or there is sloughing of material along the landfill slopes
67	3.6.5 and 3.6.6	E.5 and E.6 TDEC Information Request	47	NA	NA	Stability and seismic calculations should be conducted using the data collected from analysis of CCR material samples from the borings TVA installs into the gypsum and coal ash stacks.	As described in Section 3, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The proposed exploratory drilling to install the temporary wells does include borings from the top of each unit to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to index tests. As discussed in the response, new shear strength testing and new stability analyses are not necessary but could be added if unexpected soil or CCR materials are encountered.	TDEC understands TVA's desire to perform stability and seismic analysis using existing data. However, site conditions change and unless the existing data was collected following the protocols for collection of samples to determine structural and seismic stability, the analyses may be incorrect due to data quality.
69	3.6.6	E.6 TDEC Information Request	48	3	1	The line reads "*Note that certain prior seismic analyses (TVA 2003; Stantec 2011, 2012) are considered superseded by the existing and upcoming analyses summarized in Item A.13* ." TDEC acknowledges additional studies and analyses are being conducted, but does not consider any historical data or reports superseded by current data. All current and historic data/reports should be considered when evaluating current and future site conditions.	Comment is acknowledged. The prior analyses are being considered, and are being supplemented by more recent data and analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.	See response to Comment 67
73	3.6.9	E.9 TDEC Information Request	49	6	last	TVA must determine the Factor of Safety using new data. If the factor of safety is less than 1, then it should be reported in the EAR and the Corrective Action Plan shall describe how TVA will address the Factor of Safety issue.	As described in Section 3, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in the Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The prior analyses are being considered, and are being supplemented by more recent data and analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.	See response to Comment 67

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
76	4.1.1	A.1 TDEC Information Request	53	1	2	Line reads "*However, the General Guideline adds the requirement of a map showing the location where soil samples were taken, and clarifies the use of 40 CFR Part 257, Appendices III and IV, in defining the constituents of concern for soil sampling and analytical purposes and further removes the original analytical requirement for hexavalent chromium.* " This is incorrect. TDEC will require both total chromium and hexavalent chromium to be analyzed as well as the Appendix III and IV CCR constituents.	Previous hexavalent chromium sampling events at other TVA sites have shown that quantitation of Cr(VI) is not reliable at trace concentrations. Hexavalent chromium that might occur in soil or in CCR would be expected to quickly be reduced to trivalent chromium as it oxidizes other constituents. A more feasible, phased approach is for TVA to analyze samples for total chromium, the form of chromium listed in the CCR Rule Appendix IV. If total chromium values in soil are at EPA RSL guidelines, TVA will consult with TDEC about how best to perform analyses for hexavalent chromium. All chromium sample results will be in the EAR.	Hexavalent Chromium analysis is not needed
79	4.1.2	A.2 TDEC Information Request	55	1	1	The line reads "*TVA will characterize the leachability of the CCR parameters from the CCR material at the base of the CCR units..* ". TDEC recommends characterizing leachability from multiple vertical intervals, not only at the base layer.	TVA's initial CCR leachability approach in this EIP followed EPA's language in the preamble to the CCR Rule. EPA has stated "The use of pore water data is still considered the most appropriate approach to estimate constituent fluxes to groundwater for CCR surface impoundments." In addition, "EPA agrees that TCLP and SPLP data are less appropriate for CCR disposal scenarios and no longer uses these data in the revised risk assessment." The TCLP leaching method was developed to simulate the potential for leaching of materials intended to be disposed in a municipal landfill. Since TVA's CCR landfills are not municipal landfills, TCLP would not be an appropriate analysis to complete for future modeling of leachate. TVA will obtain pore water samples to provide real-time measurements of constituents in actual conditions for the CCR material in the units. The CCR material at the base of the unit will have had the greatest opportunity for leaching to occur, due to it having the longest duration of time in an aqueous medium reflecting actual conditions, and will be the closest point to the boundary of the unit, nearest any groundwater. Samples of CCR material will be collected from the temporary wells installed to sample pore water. These samples will be analyzed for the CCR parameters according to the most applicable method based on emerging science in the industry which could include the Synthetic Precipitation Leaching Procedure (SPLP). TVA considers the groundwater monitoring well network as the definitive mechanism to determine releases to groundwater which includes protocols for detection, assessment, and corrective action of contaminants in groundwater, through the groundwater monitoring program.	Pore water samples indicate the amount of CCR material that has leached into water over time and is dependent upon the time the CCR material has been in contact with ground water. Determining the leachability of CCR material provides the best data for the amount of CCR material that will leach into ground water because CCR material at the upper levels of the landfill have had less exposure to ground water than CCR material at depth in the landfill. Further pore water samples do not take into account that as water moves through the CCR material downward it carries all CCR material that it has adsorbed from top to bottom. TVA shall describe the location of new soil borings to conduct leachability tests and the how frequently samples will be taken as borings are completed, i.e. 5 ft. intervals
80	4.1.2	A.2 TDEC Information Request	55	3	1	The paragraph reads "*The CCR Material Characteristics study is confined to the leachability of CCR parameters from the CCR material (at various locations in the CCR units) into CCR units where the CCR material is deposited. It does not demonstrate the leachability of the CCR parameters (from the CCR material in the CCR units) into the groundwater under the base of the CCR units.* " TDEC requests further explanation from TVA on why the leachability of CCR parameters from CCR materials is not universal and reflective of the leachability into groundwater.	The leachability study in which pore water samples are obtained from the base of the units provides a snapshot of the CCR constituents in the pore water at that time. Although the pore water constituents measured at the base of the unit demonstrate the potential for those constituents to enter the groundwater, it is not indicative of the actual release of those constituents into the groundwater. Any actual releases into the groundwater will be determined by the GWM program, and addressed under the appropriate program protocols. The EIP will be revised with the explanation.	See response in Comment 79 above
81	4.3.7	C.7 TDEC Information Request	60	2	All	TVA response does not adequately address the TDEC information request. TVA does not discuss how it will define groundwater contaminant plumes and/or how it would scientifically extend the monitoring network if necessary to fully delineate vertical and horizontal impacts to groundwater. TVA should further define methodologies, procedures, and models it will utilize to characterize and assess contamination in groundwater.	The initial phase of the environmental investigation is to characterize the site by assessing current subsurface conditions at CUF. Potential groundwater impacts will be identified by collecting background and downgradient groundwater. TVA will use industry accepted methods for delineating the extent of CCR constituents, if needed, and will install additional wells in appropriate locations based on groundwater flow conditions. Methodologies and procedures for installing monitoring wells are provided in TVA Technical Instruction for Monitoring Well and Piezometer Installation and Development (ENV-TI-05.80.25). New monitoring wells will be monitored bi-monthly for one year. TVA may propose additional methods of evaluation, such as groundwater flow and transport models, as appropriate and guided by sound scientific principles based on the data collected. The proposed investigation is designed to collect groundwater data representative of site conditions that would be needed as input into models. The exact approach will depend on the data collected and will be proposed after evaluation of the data collected during the environmental investigation.	TVA shall describe in the EIP how it will model ground water contaminant plumes and contaminant migration within the ground water plumes. TDEC must review and agree with the ground water model(s) TVA will use for this work so it may be determined if the proposed ground water model is acceptable.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
82	4.4.10	D.10 TDEC Information Request	65	2	All	The line reads "*As noted in Section 3.6.4, none of the CUF CCR units in the Study Area meet the definition of an overfill per the CCR Rule. Therefore, this information request does not apply to CUF.* " TVA previously stated in their response in section 3.6.4that "*Although the Dry Ash Stack and Gypsum Disposal Complex are regulated as "existing landfills" and not "overfills" under the CCR Rule, the CCR Rule still addresses the concern about existing landfills that are constructed over closed CCR surface impoundments. In particular, existing landfills are subject to the "Unstable Areas" location restriction per §257.64. Due to TVA's construction of its CUF landfills on top of a closed CCR surface impoundment, §257.64 will therefore require TVA to demonstrate that "good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."* " TVA needs to explain why their proposed assessment for section 3.6.4 does not apply to section 4.4.10.	The response will be clarified to state that the proposed assessment outlined in Section 3.6.4 does apply, but it applies in the context of the unstable areas assessment for existing landfills. The information request does not apply within the context of overfills, because these units do not meet the CCR Rule definition of overfills.	TVA has been issued a Commissioner's Order that requires TVA to investigate all areas where CCR material has been disposed. Areas where CCR material was used by TVA as fill material are subject to the Order. The impact of CCR material on the environment does not change whether it is "disposed" or "used as fill material". The TDEC Commissioner's Order is broader in scope than the EPA CCR regulations. TVA shall conduct the TVA CUF investigation as required under the Consent Order.
119	Appendix C, Section 9.1.2	QAPP	20	2	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done. If multiple coolers are needed, one COC Record should will accompany each cooler that contains the samples identified on the COC.	"Should" will be replaced with "will."	The word shall will be used in the EIP when any task, action, activity, etc. is required by TDEC. This is a universal requirement.
122	Appendix C, Section 11.1	QAPP	26	4	6	At least 10% of the screening data ~~should will be confirmed using appropriate analytical methods and QA/QC pr ocedures and criteria associated with definitive data.~~	"Should" will be replaced with "will."	See comment 119
125	Appendix C, Section 13.1	QAPP	34	1	2	Field pH meters used for collecting data will have to meet the calibration requirements of Method 9040C , which is 0.05 pH units of the bracketing buffer solution values. The QAPP references SESDPROC-100-R3, January 2013 and the TVA TI ENV-TI-05.80.46 which only require calibration to 0.1 SU.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the CUF EI.	TVA will calibrate field pH meters to meet the requirements of 9040C.
133	Appendix D	Figure 9	262/ 724	N.A.	N.A.	Additional borings need to be proposed within the CCR unit limits to aid in confirming the presence of a continuous soil liner and soil classification of the liner.	The existing information referenced in the EIP, used in conjunction with new information from borings proposed in the Exploratory Drilling SAP, is adequate to support a response to this information request. The clay foundation map (Figure 9) will be revised to describe the uppermost foundation soil type (clay, silt, sand, etc.) in each boring. Associated sections of the EIP text will be updated, including references for the historical documents. The foundation soil information will be incorporated into the 3D model of the CCR units.	TVA shall install soil borings as required by TDEC. New data is needed to supplement old data to fully investigate the site. New borings will be proposed and installed.
134	Appendix D	Figure 11	264/ 724	N.A.	N.A.	Provide an additional Figure overlaying Historical Wells Creek alignment and limits of grouting from Drawing 10N212 R11 dated 5/20/91 onto Figure 11 "Proposed Borings". Borings need to be proposed in these areas to better define the geology and hydrogeology below the CCR units.	An additional figure will be added in the Evaluation of Existing Geotechnical Data appendix of the EIP, showing the historical Wells Creek alignment, the grouting alignment, and interior bottom ash berm alignment. The berm was placed in an effort to reduce seepage gradients through the perimeter dike, then grouting was used in an effort to reduce seepage through the foundation soils beneath the perimeter dike. Other mitigation measures were also taken. Also in this appendix, discussion will be added to provide context for the seepage issues observed and the various mitigation measures employed. Perimeter dike design and construction will be discussed, with particular emphasis on the areas where the creek alignment crosses the perimeter dike alignment. The Exploratory Drilling SAP will include two windows of closely spaced CPTs to evaluate the locations where the historical Wells Creek alignment crosses the unit perimeter as well as an area of historical grouting.	Additional borings will be proposed along the center line of the original ash dike between CPT 07 and CPT 08. These borings are needed to better define the geology and hydrogeology at the perimeter of the CCR unit in the area of the pressure grouting performed in 1991.
145	Appendix E, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil color will be determined using a Munsell soil color chart.	The use of the Munsell Color Charts is not included as part of the ASTM Standard D2488. Soils will be logged in compliance with ASTM Standard D2488.	Munsell color chart is industry standard and will need to be followed.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
148	Appendix E, Section 5.2.5	Background Soil SAP	12	Table 4	9	A pH field test kit should be employed to help identify if soil pH is in a range to mobilize CCR contaminants (specifically target sample aliquots and horizon changes). For example several metals are easily leached from acidic soil, however selenium is mobilized under alkaline conditions. Also, due the short hold time, which will create a situation where the analytical result will not be within the 15 min holding time, please consider a field method measurement of pH for comparison.	The 15 minute holding time for pH testing of soil samples begins from the point that the sample paste is created, prior to taking a pH reading. As such soil samples will be submitted to the laboratory for analysis as opposed to conducting field analysis of soil pH. Additionally, this study is not an investigation to determine the presence of CCR "contaminants" or conduits of contaminant movement. The biasing of sample collections based on pH ranges likely to mobilize CCR contaminants is not warranted.	Field analysis of pH will be required.
178	Appendix L, Section 5.2.7.1	Hydrogeological Investigation SAP	10	2	3	Preference is for 10-ft well screen to be set within the coarser unit above the bedrock.	Ten-foot well screens are typical, but longer screens may be required to accommodate large groundwater fluctuations in some locations. Screen interval depths will be dependent on the groundwater sampling intervals targeted for the Environmental Investigation.	Before any screen greater than 10ft is used an explanation as to how the alternate well construction procedures ensure groundwater samples and groundwater-level measurements will be representative of the water-bearing zone or aquifer to be monitored.
182	Appendix L, Attachment A	Hydrogeological Investigation SAP	NA	Figure 3	NA	Well pump placement should be at the midpoint of the screen, if the screen is fully submerged, otherwise the pump should be placed at the midpoint of the saturated interval. It is unclear by this figure that the pump is placed correctly.	Figure 3 was revised to show the approximate placement of the well pump to be the midpoint of the screen or saturated interval.	The midpoint of the saturated screen is the optimum depth for the pump intake. Figure 3 (although a schematic still shows the pump intake less than 2 ft from sump). Pump intakes must not be so close to the static water surface that the water level may be pulled below the intake; however, the pump intake should also be at least two feet above the bottom of the well to preclude excess turbidity from the well bottom. In the Figure 3 example assuming static water level was above 401.5ft then the pump inlet should be approximately 396.3ft. If the pump intake will be placed in a location other than the midpoint of the saturated interval TVA must provide detailed information outlining why and how each pump intake depth was selected.
184	Appendix M	Groundwater Investigation SAP	All	All	All	General comment - TDEC recommends installing monitoring wells within the ash disposal complex to accurately characterize groundwater quality beneath the complex.	Piezometers with vibrating wire transducers have been installed within the Dry Ash Stack and Gypsum Storage Area for other ongoing TVA projects. These vibrating wire piezometers are shown on the figure included in the appendix of the EIP. The water level measurements collected from these piezometers will be used to characterize the groundwater flow beneath the units. No additional monitoring wells are proposed to be installed within the units. TVA's understanding is that the compliance boundary per TDEC solid waste regulations is defined as the perimeter of the CCR complex and does not include the areas within the units.	New monitoring wells within the ash disposal complex footprint will be proposed in the revised EIP.
196	Appendix M, Section 5.2.6	Groundwater Investigation SAP	13	Table 5		Field pH meters used for collecting data will have to meet the calibration requirements of Method C , which is 0.05 pH units of the bracketing buffer solution values.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the CUF EIP.	TVA will calibrate field pH meters to meet the requirements of 9040C.
201	Appendix N, Attachment A	CCR Material Characteristics SAP	NA	Figure 1	NA	TDEC recommends additional temporary wells be installed in the retention pond and stilling pond area to accurately assess the presence of ash and leachability characteristics there of.	The temporary well proposed in the Ash Pond is located on a dike extending into the ponds. There is very little room to include additional wells spatially throughout the ponds since they are filled with water. Access to drilling locations is difficult and the plan does not include drilling over open ponded areas due to safety concerns.	TVA shall conduct the sampling stated in Comment 201 with the exception that TVA shall conduct the sampling required when the ponds are emptied.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)
203	Appendix P	Seep SAP	All	All	All	How does TVA plan to identify, assess, and sample seeps that may not currently be visible due to mitigation (rip rap)?	The site investigation will use a boat to evaluate areas along the creek bank, which would otherwise be inaccessible due to the extent of mitigation riprap in those areas. The investigation will include an examination of the bank at the base of the riprap to determine if there are continuing water discharges at those locations. Should active seeps be discovered during the investigation, a seep sampling location map will be finalized, and the Seep SAP will be implemented. This procedure will identify flowing seeps not otherwise visible due to riprap coverage, and allow for their subsequent sampling and analysis under the procedures of this Seep SAP.	TVA's proposal for seep identification is unacceptable. TVA shall take the following actions to examine seeps potentially discharging into surface streams; 1. TVA shall conduct field testing at the point where water from a seep(s) most likely enters a stream. TVA shall monitor the stream channel and surface water at the waters edge. TVA shall conduct field tests for pH, temperature, dissolved oxygen and conductivity. 2. If field testing indicates a significant difference between stream channel samples and samples adjacent to the stream bank, then TVA shall determine if there is a flow from the seep. If the seep is covered with rock or other material, the material shall be removed to determine if there is flow from the seep. If there is flow from the seep, then the seep shall be sampled for CCR constituents. If the seep is flowing then TVA has three options to choose from to address the seep; (1) repair the seep and eliminate the flow, (2) modify its NPDES permit and add the seep as a permitted outfall or (3) collect flow from the seep and return it to the NPDES permitted surface impoundment.

Table TVA Cumberland EIP Rev 2
Responses to TDEC Comments (December 8, 2017)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)	TVA Response (January 26, 2018)
NEW (216)	General Comment	NA	NA	NA	NA	NA	NA	TVA has agreed to conduct an environmental investigation at the TVA Cumberland Fossil Plant as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are, questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.	Comment noted.
NEW (217)	General Comment	NA	NA	NA	NA	NA	NA	All water and ground water sample results shall be reported in Parts per Billion (µg/L). The analytical results for all soil, CCR material or other solid samples shall be reported in Parts per Million (mg/kg)	Comment acknowledged. The document will be revised as necessary to address this comment.
NEW (218)	General Comment	NA	NA	NA	NA	NA	NA	All figures that provide liquid and solid results shall be presented on individual pages unless two tables use the same units in presenting data. As an example, if 2 tables provide analytical results for the concentration of two metals in 10 mg/kg intervals, then the 2 tables may be on 1 page. However, if 2 tables have different concentration ranges, one in 1 µg/L intervals and the other at 100 µg/l intervals, then the two tables shall be on different pages.	Comment acknowledged. The documents will be completed in the requested format and provided in the EAR to address this comment.
NEW (219)	3.1	Site Info	9	4	7	NA	NA	Background soil samples for CCR parameters boron, sulfate and radium were not included in the potential background wells (CUF-201 & CUF202). Why not?	TVA will investigate the prior project scope and determine if these analytes were analyzed. If results are available, the findings will be included in the EAR.

Table TVA Cumberland EIP Rev 2
Responses to TDEC Comments (December 8, 2017)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)	TVA Response (January 26, 2018)
NEW (220)	3.4	D. GW Monitoring	37	ALL	ALL	NA	NA	The May 12, 2017 GW Quality Assessment Plan should be included in the EIP.	The latest version of the Groundwater Quality Plan (dated December 11, 2017) will be incorporated into the EIP as a new appendix.
NEW (221)	Appendix D	Figure 10	340/1241	NA	NA			Additional borings need to be proposed along the center line of the original ash dike between CPT 07 and CPT 08. These borings are needed to better define the geology and hydrogeology at the perimeter of the CCR unit in the area of the pressure grouting performed in 1991.	See response to Comment 134.
NEW (222)	Appendix D	Figure 12	342/1241	NA	NA			Provide an overlaying Historical Wells Creek alignment and limits of grouting from Drawing 10N212 R11 dated 5/20/91 onto Figure 12 "Proposed Geotechnical Borings". Borings need to be proposed along the natural/original alignment of Wells creek to better define the geology, hydrogeology, and presence of a continuous below the CCR units.	Figure 12 will be updated to add the Wells Creek alignment and limits of grouting as requested. The scope of the Exploratory Drilling SAP and Figure 12 will be updated to shift 1 previously proposed boring (within the Dry Stack) and add 4 more proposed borings, evenly distributed (in plan view) along the historical Wells Creek alignment within the interior of the Dry Ash Stack. These 5 borings will provide additional information on the foundation soils within the historical Wells Creek alignment, to support the 3-D model and the hydrogeologic understanding of this vicinity. Refer to the updated Exploratory Drilling SAP for additional details of each boring. The foundation conditions will be characterized using historical data and data gathered from the 19 proposed borings and 26 proposed CPTs during the Investigation, and interpretations provided in the EAR as it may relate to the hydrogeologic setting. Mapping of the uppermost foundation soil types (Figure 14) will be updated in the EAR to include the results of proposed borings.

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NEW (223)	Appendix D	Figure 14	344/1241	NA	NA			Additional borings need to be proposed along the natural/original alignment of Wells creek to aid in confirming the presence of a continuous soil liner and soil classification of the liner.	See response to Comment 222.
NEW (224)	Appendix F	A.4 TDEC Site Information Request No. 4	467/1241	1	6 THRU 8			Additional borings need to be proposed along the center line of the original ash dike between CPT 07 and CPT 08. These borings are needed to better define the geology and hydrogeology at the perimeter of the CCR unit in the area of the pressure grouting performed in 1991.	See response to Comment 134.
NEW (225)	Appendix F	Attachment A Exhibit 3	473/1241	NA	NA			Additional borings need to be proposed along the center line of the original ash dike between CPT 07 and CPT 08. These borings are needed to better define the geology and hydrogeology at the perimeter of the CCR unit in the area of the pressure grouting performed in 1991.	See response to Comment 134.
17	3.1.1	A.1 TDEC Information Request	8	2	7	Line reads "*The General Guidelines removed the requirement for hexavalent chromium analysis.*" This is incorrect. TDEC will require both total chromium and hexavalent chromium to be analyzed.	Previous hexavalent chromium sampling events at other TVA sites have shown that quantitation of Cr(VI) is not reliable at trace concentrations. Hexavalent chromium that might occur in soil or in CCR would be expected to quickly be reduced to trivalent chromium as it oxidizes other constituents. A more feasible, phased approach is for TVA to analyze samples for total chromium, the form of chromium listed in the CCR Rule Appendix IV. If total chromium values in soil are at EPA RSL guidelines, TVA will consult with TDEC about how best to perform analyses for hexavalent chromium. All chromium sample results will be in the EAR.	TDEC will not require TVA to analyze for Hexavalent Chromium at the TVA CUF site. Our earlier work with TVA and SELC led to the discovery that Hexavalent Chromium analysis at low levels (< .1 parts per billion) did not produce consistent and accurate analytical results	Comment acknowledged. The document has been revised as necessary to address this comment.

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19	3.1.1	A.1 TDEC Information Request	8	4	4	Will a background concentration be determined for each soil type? Please explain how many samples from each soil type will be considered a valid test population for statistical evaluation.	TVA proposes to collect a minimum of 12 background samples from each soil horizon or geographic strata for the purpose of establishing background concentrations of CCR parameters. Twelve samples are consistent with other State's guidance (Ohio) and consistent with the findings presented in Gilbert, 1987. Twelve samples also exceed the recommended number of samples for other States (n=4 for Wisconsin and Alabama). If TDEC has specific regulatory guidance on the number of samples required, please provide that guidance to TVA.	TVA should only develop background levels of constituents by totaling analytical results from soil samples from the same soil horizon. There should always be a minimum of 10 soil samples from the same soil horizon used to calculate the background levels of constituents. This may lead to different multiple background levels for a constituent within the profile of one boring	Comment acknowledged. If a particular horizon or geologic unit is under represented in the statistical population, additional borings in excess of those currently proposed will be installed.
23	3.1.1	A.1 TDEC Information Request	10	3	7	It is unclear as to whether or not the sampling is a single grab sample or multiple aliquots that generate one composite sample. Since in the text it states, "grab samples". A five-foot sample interval seems course in suspected alluvial silts and clays. A 1-2.5 ft. interval, or change in lithology is recommended for silts and clay. Five-foot intervals may be appropriate in sands. Also, if the soil is fine sand and silt the sample should be biased to sampling the interface between sand lenses and silt since these lenses are of the conduits for contaminant movement. In clays the inorganics will tend to adsorb, and samples should be collected from soil fractures or areas that show oxidation.	All proposed background soil samples are grab samples. One grab sample is proposed from the midpoint of each five-foot soil core, unless there is a change in lithology within a five-foot core interval. In the event that a change in lithology occurs within a core interval separate grab samples will be collected from the midpoint of both lithologies in the core. Since the purpose of this study is to investigate natural soil chemistry and determine background concentrations of naturally occurring CCR constituents, the biasing of sample collections or collection of additional samples for this purpose is not warranted. The proposed background soil borings are positioned at locations that are not expected to be impacted from stormwater, flooding, or groundwater from CUF and are positioned in areas previously determined to not be impacted by plant activities.	TVA respond's to TDEC's comment by stating the soil samples will not be collected in areas that have not been impacted by storm water runoff. How will TVA determine if proposed sampling locations have not been impacted by surface water runoff, especially soil samples near Wells Creek?	The four proposed locations closest to Wells Creek, BG-6, BG-7, BG-8, and BG-9 are all located on the opposite side of the surface water body from the Plant. Consequently, surface water runoff originating from CUF would not cross over the locations as it flows toward the creek. Additionally, each of these proposed locations are at ground surface elevations above the summer pool elevation. A review of historical aerial photographs has been conducted to verify that these locations are not typically covered during high summer pool conditions. Based on our review, BG-6, BG-7, BG-8, and BG-9 are not typically covered by known/expected summer pool elevations.

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25	3.1.3	A.3 TDEC Information Request	11	3	8	TVA shall sample the spring on the Rye property if at all possible. If TVA cannot get access, then TDEC will assist	TVA has not been granted access by the property owner to sample Rye Spring. Historically, TVA sampled Rye Spring as a background groundwater monitoring site. The last date TVA sampled the spring was on April 15, 2016. After that time, the property owner has decided not to allow TVA access to the spring. To the extent that TDEC wants TVA to sample Rye Spring rather than identify a current well and/or future well as a new background monitoring well, TVA would appreciate TDEC's help in alleviating the landowner's concerns and obtaining from the landowner a signed access agreement granting TDEC and TVA permission to simultaneously enter the property and for TVA to sample Rye Spring. TVA will work with TDEC to draft an agreeable access agreement for TDEC to provide to the landowner to sign.	TVA shall sample Rye Spring, unless TVA provides written documentation that the owner of Rye Spring will not allow TVA to collect samples from the spring. If the property owner does not cooperate TDEC shall help with access to Rye Spring.	TVA's Groundwater Quality Assessment Plan (December 12, 2017) will be attached to Revision 3 of the Cumberland EIP. This document includes information regarding the Rye Spring access issue and serves as written documentation as requested. TVA is currently working with the TDEC field office to identify an alternative background monitoring point to replace the Rye Spring sampling location. Upon agreement with the TDEC field office, that alternative monitoring point will be incorporated into the EIP scope. If an alternative sampling location cannot be identified, TVA will request assistance from TDEC in regaining access to the Rye Spring property.

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27	3.1.6	A.6 TDEC Information Request	14	2	10	The data discussed is relatively old. A clear delineation between the sluiced ash and the gypsum stack is needed. This information is needed is making stability calculations for the gypsum landfill. Should new borings be required to better identify the sluiced ash/gypsum contact.	Additional discussion will be added to the EAR regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are documented, and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects as outlined in the EIP. Summary tables of key boring parameters will be provided as part of the EAR. In addition to borings, the permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 81-102-0086. In addition to borings, the permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 81-102-0086. Finally, the EAR will provide explanation that a more accurate delineation of the gypsum/sluiced ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary. The existing information referenced in the EIP is adequate to support a response to this information request.	TVA states it does not believe that additional soil borings are needed for stability analysis. TDEC believes additional borings are need in the Gypsum Storage area and the Dry Ash stack. Samples from new borings in these areas will help ensure the type of material from top of ground to refusal, relative moisture content and material sheer strength. TVA shall install eight additional borings in locations identified by TDEC and collect moisture content, material type and material sheer strength from top to bottom of each boring	TVA is currently performing additional borings, laboratory testing, and subsurface characterization within the interiors of the Dry Ash Stack and the Gypsum Storage Area, in part to support slope stability analyses for other ongoing programs. These boring locations are included on Figure 12. The data gathered from this ongoing work will be presented in the EAR and will be used to supplement existing data and existing slope stability analyses. Additional borings are proposed in the interior of the Dry Ash Stack and Gypsum Storage Area (see Exploratory Drilling SAP Figure 12, and response to Comment 222). If the results of the ongoing efforts described in the previous paragraph identify remaining data gaps, these additional proposed borings can also be used to gather supplemental data.

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28	3.1.6	A.6 TDEC Information Request	14	5	1	TDEC recommends additional borings to characterize the interface between the gypsum stack and sluiced ash for the Gypsum Landfill. There appears to be little data available from the center of the Gypsum Landfill (Figure 8). Additional fieldwork and boring installation will likely be required to fully characterize the interface in this area	The existing information referenced in the EIP is adequate to support a response to this information request. Additional discussion will be added to the EAR regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are known with reasonable confidence and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects. Finally, the EAR will explain that a more accurate delineation of the gypsum/sluiced ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary. Summary tables of key boring parameters will be provided as part of the EAR. In addition to borings, the permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 81-102-0086. In addition to borings, the permit drawings (10W302 series, dated 1992 and updated 2003) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 81-102-0086.	See response to Comment 27	See response to Comment 27.

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							Also, Figure 8 shows existing instrumentation and is not intended to represent all borings that provide data about the gypsum/sluiced ash interface.		
29	3.1.7	A.7 TDEC Information Request	14	2	1	TDEC recommends additional borings to characterize the interface between the dry ash stack and sluiced ash for the Fly Ash and Bottom Ash Landfill. There appears to be little data available from the center of the Landfills (Figure 8). Additional fieldwork and boring installation will likely be required to fully characterize the interface in this area.	The existing information referenced in the EIP is adequate to support a response to this information request. Additional discussion will be added to the EIP regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are known with reasonable confidence and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects. Finally, the EAR will explain that a more accurate delineation of the stacked ash/sluiced ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary. Summary tables of key boring parameters will be provided as part of the EAR.	See response to Comment 27	See response to Comment 27.

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32	3.1.10	A.10 TDEC Information Request	16	3	5	TVA discusses submission of a proposed three-dimensional model of the CCR materials disposed at the CUF site using existing data. This provides a good starting point for the area of waste disposal. However, TVA should be required to submit a revised three- d i m e n s i o n a l model of the CCR material disposed at the CUF site in the EAR, based on the findings of the EIP. It is tremendously important for TVA to identify any areas at the CUF site where CCR material is disposed below ground water. For closure in place, TVA has to follow the CCR regulations, specifically 257.102(d)(2) (i and ii) which states: ***"(2) Drainage and stabilization of CCR surface impoundments. The owner or operator of a CCR surface impoundment or any lateral expansion of a CCR surface impoundment must meet the requirements of paragraphs (d)(2)(i) and (ii) of this section prior to installing the final cover system required under paragraph (d)(3) of this section. (i) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.*** ***(ii) Remaining wastes must be stabilized sufficient to support the final cover system."***	The proposed 3-D model is not a preliminary model. It is based on a thorough evaluation of site-specific data regarding the base, sides, and surface elevations of CCR. To the extent that information is developed during the environmental investigation that affects CCR volume calculations, revisions to the 3-D model will be included in the EAR. Corrective actions based on this 3-D model or any other data found in the EAR will be found in the CARA Plan according to Part VII.A.f of the Order.	The goal of 3.1.10 in the EIP is to collect data to accurately depict a three-dimensional model of the CCR materials disposed at the TVA CUF site. This model should be presented in its final form in the Environmental Assessment Report. A major problem with TVA's proposal to collect data for the three-dimensional model is it appears TVA plans to only use existing site data and does not plan to install borings and monitoring wells within the CCR landfill area. While using existing data is acceptable for developing the three-dimensional model, it is important to have data from within the landfill itself. TDEC made this comment earlier and reiterates the importance of additional data from within the landfill area. TVA shall install after TDEC's approval, a minimum of 8 new borings within the footprint of the current landfill.	Consistent with Section 3.1.10 of the EIP and the Material Quantity SAP, the proposed 3-D model will be developed utilizing both existing and proposed borings, as well as historical drawings. Several of the existing and proposed borings are on the interior of the CCR units, as shown in Figures 11 and 12. As noted in the response to Comment 27, several borings within the CCR units have recently been completed as part of ongoing CCR Rule and closure design projects (see Figure 12). These borings and laboratory data should address the intent of the December 8, 2017, TDEC Comment. In response to Comments 222 and 223, the scope of the Exploratory Drilling SAP has been revised to add borings within the CCR unit, along the historical Wells Creek alignment. The existing, ongoing, and proposed borings will be used to supplement the 3-D model, per the Material Quantity SAP.

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33	3.1.10	A.10 TDEC Information Request	16	1	7	The ERI data has not been provided in the EIP and therefore cannot be evaluated, the transects and interpretation should be included both graphically and with a narrative in the EAR. Were the ERI data correlated with existing borehole data in order to calibrate the apparent resistivity values with bedrock? If so how well did the ERI data match boring data? Were structural features or karst features indicated on the transects? On transects that do not have boring data that indicate the top of rock, a boring should be installed to calibrate the values before inclusion into a 3D model of the site.	The ERI data has recently (August 2017) been provided to TDEC under separate cover. The ERI data were correlated to select borings, but as shown on Figure 10 there are many other borings that can be correlated and interpreted. This evaluation will be presented in text and graphics in the EAR. No new borings will be necessary to perform this evaluation. The ERI results identified one potential bedrock discontinuity which will be further evaluated in the EAR. Otherwise, the ERI did not identify anomalies that would typically be associated with karst topography.	TVA indicates that the ERI results identified one potential bedrock discontinuity which will be further evaluated in the EAR. It is unclear what further investigation of this feature is planned since there are no proposed borings or surface geophysical methods planned in the area. TDEC requests that the feature be further explored using noninvasive methods (additional ERI, MASW or other technologies) within the gypsum storage area to identify the orientation of and soil and rock structure within the footprint of the ERI feature and in the immediate area of the ERI feature. If the surface methods indicate the potential for a karst feature, then TVA shall investigate the area around and below this feature with the installation of borings.	The scope of the Exploratory Drilling SAP will be revised to include two additional borings with rock coring and downhole testing. The borings will be located along the ERI alignment at the location of the potential bedrock feature. The intent of these borings is to intercept the interpreted location of the potential feature based on the ERI results. The borings proposed are believed to be appropriate for an initial phase of investigation. Additional investigations will be proposed if warranted, based on the results of the initial investigation.
35	3.1.10	A.10 TDEC Information Request	17	2	9	TVA proposes adding additional borings and temporary wells at the TVA should locate additional borings and monitoring wells within the TVA CUF gypsum and ash landfills and between the landfill and the Cumberland River. There is very little subsurface data available in the area between the landfills/sluice ponds and the river (the plant area). Please see the Figure and Adobe page 372 of the EIP.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. The results of the investigation activities will be evaluated to assess if additional monitoring wells are needed to characterize the hydrogeology at the site. Additionally, vibrating wire piezometers have been installed in the Dry Ash Stack and Gypsum Storage Area as part of other ongoing TVA programs. Water level data collected from these piezometers will be used to characterize groundwater flow beneath the units. The proposed scope of work is consistent with an initial phase that is needed is to evaluate groundwater flow. Based on the results of the initial phase of work, additional investigations may be proposed to characterize the extent of CCR constituents, if CCR constituents are detected in groundwater at concentrations indicating impacts from CCR units.	TDEC believes that additional borings and monitoring wells are needed as stated in Comment 35; "TVA should locate additional borings and monitoring wells within the TVA CUF gypsum and ash landfills and between the landfill and the Cumberland River. There is very little subsurface data available in the area between the landfills/sluice ponds and the river (the plant area). Please see the Figure and Adobe page 372 of the EIP."" TVA shall provide TDEC with locations for the soils and borings described above as part of the EIP.	TVA has developed an approach to define the hydrogeological characterization around the gypsum and ash landfills. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA would prefer to complete the initial phase of the investigation and jointly review the results with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. This may include installing groundwater monitoring wells within the CUF landfill units. See response to Comment 61 for specific information on additional wells to be installed for determined groundwater flow between the landfills and the Cumberland River.

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38	3.1.11	A.11 TDEC Information Request	19	2	1	The Wastewater Characterization Plan did not include a plan for taking analytical results for CCR Parameters.	The Wastewater Characterization Plan was associated with a separate TVA project to evaluate options for potential future wastewater management alternatives and is not associated with this Environmental Investigation. If the need for wastewater characterization develops after completion of the Environmental Investigation, TVA will perform this characterization. Current wastewater monitoring is captured in the site's NPDES permit.	While the Wastewater Characterization Plan is a part of the TVA CUF NPDES permit, TDEC should understand the level of CCR constituents in the wastewater discharged to the Cumberland River Without data reporting the levels of CCR constituents discharged into the Cumberland River, it is difficult to determine the amount of CCR material release from the TVA CUF Plant into the Cumberland. TVA shall either collect water samples for CCR analyses when it collects samples for NPDES monitoring or collect and analyze water samples from the NPDES discharge point quarterly	TVA has included NPDES outfall sampling information, as well as detailed constituent information in its NPDES permit applications of 2009 and 2016. The NPDES data previously submitted to TDEC will be included in the revised EIP as an appendix. If after reviewing the existing data, TDEC desires additional NPDES data as part of the investigation, TDEC and TVA can jointly determine a path forward.
41	3.1.13	A.13 TDEC Information Request	24	NA	NA	Stability of bedrock below fill areas - The EIP discusses the installation of 13 borings in the area of the stilling pond and the landfill. Will these borings provide enough additional information to adequately determine the stability of the rock structure below? - see Figure 1 Adobe Page 423	As noted in Section 3 of the EIP, the proposed borings are not, by themselves, intended to assess bedrock stability. Instead, the proposed borings are intended to be used in conjunction with existing geotechnical and hydrogeologic data, surface geophysics, geologic mapping/characterization, and visual inspection reports. The proposed borings, when used as part of this broader data set, are sufficient to respond to the information request.	TVA shall collect sufficient data during the installation of the 13 borings described in Section 3.1.13 that it can be used in the calculations of bedrock stability.	Comment acknowledged.
53	3.4.1	D.1 TDEC Information Request	38	2	1	Based on currently available monitoring data it appears that the groundwater flow on the eastern side of the Gypsum Storage Area is not fully characterized. The proposed monitoring well location between the CCR units and the main plant northeast of the C C R units may help clarify the groundwater flow, but since CUF-213 also has had arsenic detections greater than the MCL it may be necessary to evaluate an additional well located across Wells Creek south of CUF-213 near the Rye property boundary. This area potentially exhibits highly fractured (brecciated) bedrock or karstic geology.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. In addition, TVA proposes to complete the existing proposed plan for the initial investigative phase and install additional monitoring wells, if needed, based on the results of the Environmental Investigation.	TVA's response does not adequately resolve TDEC's concern. Groundwater flow on the eastern side of the Gypsum Storage Area is not fully characterized and requires at a minimum one eastern boundary well.	TVA is currently reviewing data from CUF-213 and nearby wells to develop a plan to more accurately characterize groundwater quality near the location of CUF-213. TVA proposes to install one monitoring well along the eastern boundary of the Gypsum Storage Area to satisfy this request. The screened interval and sand pack will be placed below CCR materials, if observed during drilling.

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54	3.4.1	D.1 TDEC Information Request	38	2	2	Both "background" wells as outlined in the EIP will be located in the soils above the Stones River Group. However, at least three and possibly four wells in the Gypsum Storage are located above the Knox Dolomite. It is recommended that at least one background well be sited above the Knox Dolomite.	Hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. In addition, TVA proposes to complete the existing proposed plan and install additional monitoring wells, if needed, based on the results of the Environmental Investigation. The proposed background well locations were identified with consideration of the geologic formations and agreed upon by TDEC during an onsite meeting. The scope of work proposed is believed to be appropriate for an initial phase of an environmental investigation. Additional investigations will be proposed if warranted by the results of the initial investigation.	TVA shall install the additional well in the Knox Dolomite with the details of well location, construction and development included in the revised EIP	TVA will install an additional background monitoring well to characterize groundwater quality above the Knox Dolomite if saturated unconsolidated materials exist. The existing monitoring well network for the CCR units is in unconsolidated materials.
55	3.4.1	D.1 TDEC Information Request	38	2	2	The groundwater is not characterized with respect to the Knox Dolomite. The Knox Dolomite is a highly fractured megabreccia and is mainly limestone and dolomite with lesser shale. CUF-204 is sited in the Stones River Group which is composed of thin bedded limestone with bentonite beds. Preference is for 10-ft well screen in the bedrock within water-bearing fractures. The top of the screen should be at least 5 feet into the bedrock.	Hydrogeological investigation activities are currently in progress to characterize the site-specific hydrogeology at CUF. The results of the investigation activities will be evaluated and incorporated into the EAR. The design for additional monitoring wells proposed to be installed in bedrock will include placement of the screen at least 5 feet into bedrock. The scope of work proposed is believed to be appropriate for an initial phase of an environmental investigation. Additional investigations will be proposed if warranted by the results of the initial investigation.	See TDEC response to Comment 54.	Same as above (see Comment 54)

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56	3.4.1	D.1 TDEC Information Request	38	4	1	Are 4 quarterly sampling events sufficient to fully assess and compare up gradient versus downgradient groundwater quality? Please address justification for sampling frequency and why a monthly or bi-monthly sampling interval would not be more prudent to determine fluctuations based on seasonality, river stage or provide a more statistically robust dataset. With only four events it is possible that after an additional year there is still not an adequate background monitoring well.	Quarterly groundwater sampling is consistent with TDEC solid waste regulations for Class II facilities and is an industry accepted frequency for providing information related to seasonal groundwater and river stage fluctuations. Cumberland River and Wells Creek water levels and precipitation data will be monitored prior to conducting each quarterly sampling event to collect samples in a range of seasonal groundwater conditions. Statistically limited data sets are also common in the industry and data can be correlated if sample collection frequency is too short. The purpose of the work proposed in this Environmental Investigation is to investigate and characterize the site-specific hydrogeology at CUF and is not intended to be a groundwater monitoring program. The results of the investigation will be provided in the EAR. If results obtained from this investigation indicate the need for more frequent sampling intervals and additional sampling events, then the sampling schedule may be revised to provide additional groundwater data. Bi-monthly sampling (6 events) for one year is proposed. According to USEPA Project Summary document "Sampling Frequency for Ground-Water Quality Monitoring" dated September 1989, quarterly and bi-monthly groundwater sampling frequencies are sufficient for major, non-reactive chemical constituents. However, more frequent sampling intervals are not recommended due to potential autocorrelation issues.	SWM GW Monitoring rules are in place for release detection. The monitoring wells in the EIP are to fully investigation the extent of CCR contamination in ground water at TVA CUF. Sampling once every two months will provide site data more quickly. The last paragraph of the TVA response to comment 56 indicates TVA will sample the TVA CUF CCR monitoring wells bi-monthly. This is acceptable	Comment is acknowledged. TVA will sample monitoring wells installed as part of the EIP bimonthly for one year. Other monitoring wells will continue to be sampled per the requirements of the program for which they were installed.

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60	3.5.2	D.2 TDEC Information Request	43	1	Last	TVA shall report all groundwater data in tables. One set of tables will consist of all samples taken from each individual well over time. The second set of tables shall compare all groundwater sample results from samples collected during the same sampling event.	Historical groundwater data that meets the requirements of the CUF QAPP will be incorporated with groundwater evaluation in the EAR and presented in the requested table format. Historical groundwater data that does not meet the requirements of the CUF QAPP will remain in the table provided in Appendix J of the EIP for reference purposes.	TDEC agrees that ground water data should be presented in a table. TVA shall develop a Ground Water table with all ground water monitoring results. This will provide a comprehensive view of all ground water at the TAA CUF site. This includes ground water monitoring wells that are not part of the EIP and the results from those wells. This includes ground water monitoring performed under the USWAG Program, the SWM Landfill ground water monitoring wells and the EPA CCR regulatory program.	Comment acknowledged. The documents will be completed in the requested format and provided in the EAR to address this comment.
61	3.5.3	D.3 TDEC Information Request	43			In the explanation for both the hydrogeological investigation and groundwater sampling there do not appear to be sufficient wells to determine if radial flow to the river is occurring north of CUF-101 and 96-9.	The proposed piezometers, observation wells and monitoring wells between the CCR units and plant are designed to characterize groundwater flow in the northeastern part of CUF. Preliminary data suggest that groundwater flow may not be from the CCR units, under the plant to the Cumberland River. TVA proposes to implement the initial plan, evaluate the data collected, and then consider the need for additional monitoring wells north of CUF-101 and 96-9. Additional investigations will be proposed if warranted by the results of the initial investigation.	TVA's response does not adequately resolve TDEC's concern. Evaluation of data as TVA has suggested will not fill this data gap, since there will be no monitoring point to be evaluated with respect of flow towards the Cumberland River or to the east. Additional monitoring wells will need to be proposed in the revised EIP.	Site data indicates that groundwater flows from the area of well CUF-120 toward the CCR units. Based on this information, there is no indication that groundwater flows from the CCR units to the area north of CUF-101 and 96-9. Because the existing dataset indicates flow from areas of the plant toward the CCR units, TVA has proposed monitoring wells CUF-1002 and CUF-1003 as an initial step to characterize groundwater flow direction and quality in the unconsolidated materials between the CCR units and the Cumberland River. After groundwater levels are collected from these monitoring wells and groundwater flow between the CCR units and the plant is better understood, TVA will develop a plan, in collaboration with TDEC, to install monitoring wells in other locations, if necessary.
62	3.5.3	D.3 TDEC Information Request	44	1	All	TDEC recommends additional monitoring well installation outside of the footprint of the ash ponds to the northeast to properly characterize groundwater flow towards the Cumberland River. In addition, TDEC recommends TVA consider installing additional monitoring wells to the south, southwest, and southeast to properly characterize groundwater flow in those areas. These wells should be sampled for CCR constituents as well.	The proposed piezometers, observation wells and monitoring wells between the CCR units and plant are designed to characterize groundwater flow in the northeastern, southern, southwestern, and southeastern part of CUF. In addition, hydrogeological investigation activities are in progress to characterize the site-specific hydrogeology at CUF. TVA proposes to implement the initial plan, evaluate the data collected, and then consider the need for additional wells northeast, south, southwest, and southeast of the CCR units. Additional investigations will be proposed if warranted by the results of the initial investigation.	TVA's response does not adequately resolve TDEC's concern. Evaluation of data as TVA has suggested will not fill this data gap, since there will be no monitoring point to be evaluated. The groundwater flow beneath the CCR units and the plant site need to be fully characterized in accordance with the order. Additional monitoring wells will need to be proposed in the revised EIP.	Same as above (see Comments 53, 54 and 61)

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63	3.6.2	E.2 TDEC Information Request	45	1	last	Should TVA be required to collect new data to be used in the seismic and structural stability analysis given the original data collection may have come from borings and tests that were not specifically designed for an analysis of this type. TVA should install multiple borings from the top of each waste cell (gypsum and coal ash) to the original ground surface below the landfill. Samples of the CCR material should be collected at 10' intervals to determine % moisture content, particle size and type of CCR material. This data should be used to determine shear strength of the CCR material from top of fill to the contact point between original ground surface and CCR material. Further, this new data should be used in the stability calculations. If TVA maintains that the water content of the CCR material from this sampling event will decrease with time, thus creating a more stable material for stability analysis, then TVA will need to provide the rationale for their position.	As described in Section 3 of the EIP, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the requested stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The proposed exploratory drilling to install the temporary wells does include borings from the top of each unit to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to the type of index tests described in the comment per the SAP. As discussed in the response, new shear strength testing and new stability analyses are not necessary as current and ongoing analysis for other projects were performed to industry standards. Consistent with conventional practice, additional shearing resistance due to unsaturated soil conditions is neglected in the derivation of strengths and in the analysis performed by TVA.	TVA shall conduct shear strength, % moisture content, particle size and type of CCR material/soil material from new borings installed within the footprint of the current SWM Landfills.	TVA is currently gathering additional data within the internal areas of each landfill as described in the EIP, and if any data gaps still exist, TDEC's proposed additional borings will be used to gather additional data.

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64	3.6.3	E.3 TDEC Information Request	46	3	2	TVA shall consult with TDEC regarding the use of new data in this analysis. As demonstrated at TVA Kingston, the inefficiency of drainage layers can contribute to structural and seismic stability of the landfilled CCR material.	As noted in Section 3 of the EIP, existing data will be reviewed and new data from proposed borings and other ongoing projects will be incorporated into the response in the EAR. With regard to slope stability, the key issue is whether or not representative (or conservative) pore water pressures in the drainage layer are used in the stability analyses. The existing piezometers and proposed temporary wells and piezometers to be installed as part of other ongoing projects will aid in understanding this issue.	Specifically, the request is to clarify the discharge of the drainage layer to the perimeter ditch. Drawing 10W302-25 included as part of the TVA (2003) 10W302 series drawings, provides a detail that illustrates a drainage system for the Dry Ash Stack drainage layer to the perimeter ditch. Further, the recommendations provided in Law Engineering's January 27, 1992 report references in Appendix A's Figures 9 & 10 providing a detail intended to provide for the discharge of water from the drainage layer to the perimeter ditch. This ash dewatering recommendation is made to reduce liquefaction potential.	A more detailed discussion regarding the underdrain system in the Dry Ash Stack and Gypsum Storage Area has been added in the Evaluation of Existing Geotechnical Data (Section 4.2 of Appendix F). Discussion will be added to the EAR regarding how the findings of the geotechnical borings compare to the interface geometry shown on the referenced drawings. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects as outlined in the EIP. The functionality of the bottom ash blanket drain will be evaluated by reviewing piezometer data from within the Dry Ash Stack. This evaluation will be documented in the EAR. Note that the recent liquefaction triggering analyses and seismic slope stability analyses are based on as-built conditions and observed performance of the unit, not on design assumptions from the 2003 drawings.
66	3.6.4	E.4 TDEC Information Request	46	3	1	40 CFR Part 257.53 "Closed" means placement of CCR in a CCR unit has ceased, and the owner or operator has completed closure of the CCR unit in accordance with 40 CFR Part 257.102 and has initiated post-closure care in accordance with 40 CFR Part 257.104. Provide documentation that the surface impoundments on which the existing landfills are constructed are closed by the Federal CCR rule definitions.	Throughout their service life, TVA has constructed and operated the Dry Ash Stack and Gypsum Disposal Complex in compliance with the state and/or federal regulatory frameworks in effect at the time. In 1996, TDEC issued Class II landfill permit IDL 81-102-0086 to allow portions of the existing surface impoundments to be transitioned to the Dry Ash Stack and Gypsum Disposal Complex. Since 1996, TDEC has approved various permit modifications for these CCR units. As discussed in Section 3 of the EIP, the Dry Ash Stack and Gypsum Disposal Complex are existing landfills as defined by the EPA CCR Rule. TVA is actively performing numerous demonstrations to document compliance with the CCR Rule. The CCR Rule became effective in 2015, and does not apply retroactively to the surface impoundments that were	TDEC is in agreement that areas of historic surface impoundments that have been permitted as solid waste landfills are not part any currently NPDES permitted surface impoundment and subject to the SWM regulations including repair of areas along the contours of the landfill(s) where seeps occur or there is sloughing of material along the landfill slopes	Comment is acknowledged.

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							transitioned to landfills in compliance with the 1996 TDEC permit.		
67	3.6.5 and 3.6.6	E.5 and E.6 TDEC Information Request	47	NA	NA	Stability and seismic calculations should be conducted using the data collected from analysis of CCR material samples from the borings TVA installs into the gypsum and coal ash stacks.	As described in Section 3, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The proposed exploratory drilling to install the temporary wells does include borings from the top of each unit to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to index tests. As discussed in the response, new shear strength testing and new stability analyses are not necessary but could be added if unexpected soil or CCR materials are encountered.	TDEC understands TVA's desire to perform stability and seismic analysis using existing data. However, site conditions change and unless the existing data was collected following the protocols for collection of samples to determine structural and seismic stability, the analyses may be incorrect due to data quality.	See response to Comment 27.
69	3.6.6	E.6 TDEC Information Request	48	3	1	The line reads "*Note that certain prior seismic analyses (TVA 2003; Stantec 2011, 2012) are considered superseded by the existing and upcoming analyses summarized in Item A.13.*" TDEC acknowledges additional studies and analyses are being conducted, but does not consider any historical data or reports superseded by current data. All current and historic data/reports should be considered when evaluating current and future site conditions.	Comment is acknowledged. The prior analyses are being considered, and are being supplemented by more recent data and analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.	See response to Comment 67	See response to Comment 67.

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73	3.6.9	E.9 TDEC Information Request	49	6	last	TVA must determine the Factor of Safety using new data. If the factor of safety is less than 1, then it should be reported in the EAR and the Corrective Action Plan shall describe how TVA will address the Factor of Safety issue.	As described in Section 3, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in the Appendix "Evaluation of Existing Geotechnical Data" demonstrate that existing data is representative and suitable to support the stability analyses. In addition, upcoming analysis (as part of the CCR Rule Unstable Areas demonstration) of existing geometry is still representative for the final permitted geometry. The prior analyses are being considered, and are being supplemented by more recent data and analyses. The newer information (used in conjunction with historic information) can account for current site conditions. Newer analyses (performed in the context of the historic analyses) can account for updates to the state of practice and provide an improved understanding of expected performance.	See response to Comment 67	See response to Comment 67.
76	4.1.1	A.1 TDEC Information Request	53	1	2	Line reads "*However, the General Guideline adds the requirement of a map showing the location where soil samples were taken, and clarifies the use of 40 CFR Part 257, Appendices III and IV, in defining the constituents of concern for soil sampling and analytical purposes and further removes the original analytical requirement for hexavalent chromium.* " This is incorrect. TDEC will require both total chromium and hexavalent chromium to be analyzed as well as the Appendix III and IV CCR constituents.	Previous hexavalent chromium sampling events at other TVA sites have shown that quantitation of Cr(VI) is not reliable at trace concentrations. Hexavalent chromium that might occur in soil or in CCR would be expected to quickly be reduced to trivalent chromium as it oxidizes other constituents. A more feasible, phased approach is for TVA to analyze samples for total chromium, the form of chromium listed in the CCR Rule Appendix IV. If total chromium values in soil are at EPA RSL guidelines, TVA will consult with TDEC about how best to perform analyses for hexavalent chromium. All chromium sample results will be in the EAR.	Hexavalent Chromium analysis is not needed	Comment is acknowledged.

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79	4.1.2	A.2 TDEC Information Request	55	1	1	The line reads "*TVA will characterize the leachability of the CCR parameters from the CCR material at the base of the CCR units.* ". TDEC recommends characterizing leachability from multiple vertical intervals, not only at the base layer.	Obtaining pore water samples will provide real-time leaching data for the CCR material in the units, and samples obtained from the base of the units will be representative of the CCR constituents most likely to have an impact on groundwater. The CCR material at the base of the unit will have had the greatest opportunity for leaching to occur, due to it having the longest duration of time in an aqueous medium, and will be the closest point to the boundary of the unit, nearest any groundwater. By sampling pore water, real-time constituent measurements are obtained, versus using a predictive leachate model to estimate constituent levels. EPA has stated in the preamble to the CCR Rule that "The use of pore water data is still considered the most appropriate approach to estimate constituent fluxes to groundwater for CCR surface impoundments." In addition, "EPA agrees that TCLP and SPLP data are less appropriate for CCR disposal scenarios and no longer uses these data in the revised risk assessment." In commenting upon its update of the risk assessment for the final rule, "EPA relied on surface impoundment pore water data and impoundment wastewater data, including the data submitted by commenters." Finally, the way to determine releases to groundwater would be through the groundwater monitoring (GWM) network surrounding the units, and the protocols in place for detection, assessment, and corrective action of contaminants in groundwater, through the existing GWM program.	Pore water samples indicate the amount of CCR material that has leached into water over time and is dependent upon the time the CCR material has been in contact with ground water. Determining the leachability of CCR material provides the best data for the amount of CCR material that will leach into ground water because CCR material at the upper levels of the landfill have had less exposure to ground water than CCR material at depth in the landfill. Further pore water samples do not take into account that as water moves through the CCR material downward it carries all CCR material that it has adsorbed from top to bottom. TVA shall describe the location of new soil borings to conduct leachability tests and the how frequently samples will be taken as borings are completed, i.e. 5 ft. intervals	The CCR Material Characteristics SAP has been revised to state that during construction and installation of temporary wells for collecting soil samples from both the phreatic and non-phreatic zones at an active, unclosed unit, grab samples will be taken from each 5-foot core boring, from the top of the unit to its base.

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80	4.1.2	A.2 TDEC Information Request	55	3	1	The paragraph reads "*The CCR Material Characteristics study is confined to the leachability of CCR parameters from the CCR material (at various locations in the CCR units) into CCR units where the CCR material is deposited. It does not demonstrate the leachability of the CCR parameters (from the CCR material in the CCR units) into the groundwater under the base of the CCR units.*" TDEC requests further explanation from TVA on why the leachability of CCR parameters from CCR materials is not universal and reflective of the leachability into groundwater.	The leachability study in which pore water samples are obtained from the base of the units provides a snapshot of the CCR constituents in the pore water at that time. Although the pore water constituents measured at the base of the unit demonstrate the potential for those constituents to enter the groundwater, it is not indicative of the actual release of those constituents into the groundwater. Any actual releases into the groundwater will be determined by the GWM program, and addressed under the appropriate program protocols. The EIP will be revised with the explanation.	See response in Comment 79 above	Samples of CCR material will be collected from the temporary wells during their installation. Grab samples will be taken from each 5-foot core boring, from the top of the unit to its base. These samples will be analyzed for the CCR parameters, after application of the most applicable method based on emerging science in the industry, which could include the Synthetic Precipitation Leaching Procedure (SPLP) method.
81	4.3.7	C.7 TDEC Information Request	60	2	All	TVA response does not adequately address the TDEC information request. TVA does not discuss how it will define groundwater contaminant plumes and/or how it would scientifically extend the monitoring network if necessary to fully delineate vertical and horizontal impacts to groundwater. TVA should further define methodologies, procedures, and models it will utilize to characterize and assess contamination in groundwater.	The initial phase of the environmental investigation is to characterize the site by assessing current subsurface conditions at CUF. Potential groundwater impacts will be identified by collecting background and downgradient groundwater. TVA will use industry accepted methods for delineating the extent of CCR constituents, if needed, and will install additional wells in appropriate locations based on groundwater flow conditions. Methodologies and procedures for installing monitoring wells are provided in TVA Technical Instruction for Monitoring Well and Piezometer Installation and Development (ENV-TI-05.80.25). New monitoring wells will be monitored bi-monthly for one year. TVA may propose additional methods of evaluation, such as groundwater flow and transport models, as appropriate and guided by sound scientific principles based on the data collected. The proposed investigation is designed to collect groundwater data representative of site conditions that would be needed as input into models. The exact approach will depend on the data collected and will be proposed after evaluation of the data collected during the environmental investigation.	TVA shall describe in the EIP how it will model ground water contaminant plumes and contaminant migration within the ground water plumes. TDEC must review and agree with the ground water model(s) TVA will use for this work so it may be determined if the proposed ground water model is acceptable.	Groundwater data collected during the environmental investigation will be evaluated to determine an appropriate modeling method. After the data set has been developed, TVA will collaborate with TDEC to agree on the most appropriate model.

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82	4.4.10	D.10 TDEC Information Request	65	2	All	The line reads "*As noted in Section 3.6.4, none of the CUF CCR units in the Study Area meet the definition of an overfill per the CCR Rule. Therefore, this information request does not apply to CUF.* " TVA previously stated in their response in section 3.6.4that "*Although the Dry Ash Stack and Gypsum Disposal Complex are regulated as "existing landfills" and not "overfills" under the CCR Rule, the CCR Rule still addresses the concern about existing landfills that are constructed over closed CCR surface impoundments. In particular, existing landfills are subject to the "Unstable Areas" location restriction per §257.64. Due to TVA's construction of its CUF landfills on top of a closed CCR surface impoundment, §257.64 will therefore require TVA to demonstrate that "good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.*" " TVA needs to explain why their proposed assessment for section 3.6.4 does not apply to section 4.4.10	The response will be clarified to state that the proposed assessment outlined in Section 3.6.4 does apply, but it applies in the context of the unstable areas assessment for existing landfills. The information request does not apply within the context of overfills, because these units do not meet the CCR Rule definition of overfills.	TVA has been issued a Commissioner's Order that requires TVA to investigate all areas where CCR material has been disposed. Areas where CCR material was used by TVA as fill material are subject to the Order. The impact of CCR material on the environment does not change whether it is "disposed" or "used as fill material". The TDEC Commissioner's Order is broader in scope than the EPA CCR regulations. TVA shall conduct the TVA CUF investigation as required under the Consent Order.	See revised EIP in Section 4.4.10.
119	Appendix C, Section 9.1.2	QAPP	20	2	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done. If multiple coolers are needed, one COC Record should will accompany each cooler that contains the samples identified on the COC.	"Should" will be replaced with "will."	The word shall will be used in the EIP when any task, action, activity, etc. is required by TDEC. This is a universal requirement.	The word "will" will be replaced with "shall" where a TDEC regulation, rule or the Order is explicitly referenced. In all other uses, the word "will" can be interpreted by TDEC as having the same meaning as "shall" and reflect TVA's commitment to performing the specified task, action, activity, etc.
122	Appendix C, Section 11.1	QAPP	26	4	6	At least 10% of the screening data ~~should~~ will be confirmed using appropriate analytical methods and QA/QC procedures and criteria associated with definitive data.	"Should" will be replaced with "will."	See comment 119	Same as above (see Comment 119)

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125	Appendix C, Section 13.1	QAPP	34	1	2	Field pH meters used for collecting data will have to meet the calibration requirements of Method 9040C, which is 0.05 pH units of the bracketing buffer solution values. The QAPP references SESDPROC-100-R3, January 2013 and the TVA TI ENV-TI-05.80.46 which only require calibration to 0.1 SU.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the CUF EI.	TVA will calibrate field pH meters to meet the requirements of 9040C.	Comment acknowledged. The document will be revised as necessary to address this comment.
133	Appendix D	Figure 9	262/ 724	N.A.	N.A.	Additional borings need to be proposed within the CCR unit limits to aid in confirming the presence of a continuous soil liner and soil classification of the liner.	The existing information referenced in the EIP, used in conjunction with new information from borings proposed in the Exploratory Drilling SAP, is adequate to support a response to this information request. The clay foundation map (Figure 9) will be revised to describe the uppermost foundation soil type (clay, silt, sand, etc.) in each boring. Associated sections of the EIP text will be updated, including references for the historical documents. The foundation soil information will be incorporated into the 3D model of the CCR units.	TVA shall install soil borings as required by TDEC. New data is needed to supplement old data to fully investigate the site. New borings will be proposed and installed.	See responses to comments 27, 32, and 222.

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134	Appendix D	Figure 11	264/ 724	N.A.	N.A.	Provide an additional Figure overlaying Historical Wells Creek alignment and limits of grouting from Drawing 10N212 R11 dated 5/20/91 onto Figure 11 "Proposed Borings". Borings need to be proposed in these areas to better define the geology and hydrogeology below the CCR units.	An additional figure will be added in the Evaluation of Existing Geotechnical Data appendix of the EIP, showing the historical Wells Creek alignment, the grouting alignment, and interior bottom ash berm alignment. The berm was placed in an effort to reduce seepage gradients through the perimeter dike, then grouting was used in an effort to reduce seepage through the foundation soils beneath the perimeter dike. Other mitigation measures were also taken. Also in this appendix, discussion will be added to provide context for the seepage issues observed and the various mitigation measures employed. Perimeter dike design and construction will be discussed, with particular emphasis on the areas where the creek alignment crosses the perimeter dike alignment. The Exploratory Drilling SAP will include two windows of closely spaced CPTs to evaluate the locations where the historical Wells Creek alignment crosses the unit perimeter as well as an area of historical grouting.	Additional borings will be proposed along the center line of the original ash dike between CPT 07 and CPT 08. These borings are needed to better define the geology and hydrogeology at the perimeter of the CCR unit in the area of the pressure grouting performed in 1991.	Based on recent discussions with TDEC, we understand that the intent of the December 8, 2017, TDEC Comment is related to understanding the possible beneficial effects of the pressure grouting with respect to perimeter seepage. As stated in the November 9, 2017, response and text included in Section 4 of Appendix F, pressure grouting was performed in 1991 to address seepage along a pervious soil foundation layer. Grout holes were not advanced into rock, as treatment of the rock was not an objective of the 1991 work. Since 1991, 29 borings and 3 CPTs have been advanced along the perimeter dike to characterize the foundation soils between the proposed locations of CPT07 and CPT08 (see Exhibit 1 in Appendix F). Sixteen of these borings were advanced to the top of rock, one of which included rock coring (see Figure 15). Seven piezometers have been installed in the foundation soils along this same reach of the perimeter dike (see Figure 13). In addition, TVA is currently performing additional borings and installing additional piezometers in this vicinity to support other ongoing programs (see Figure 12). The information gathered from historical and ongoing explorations, historical observations of seepage, grouting data, piezometer data, and changes in site operations (i.e., conversion from surface impoundments to landfills) will be used to develop an improved understanding of the seepage characteristics along the area of pressure grouting. Results will be presented in the EAR. No other new field data is considered necessary to support a response to the December 8, 2017, comment. If the results of these efforts identify remaining data gaps, additional field efforts will be designed and implemented in communication with TDEC.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)	TVA Response (January 26, 2018)
145	Appendix E, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil color will be determined using a Munsell soil color chart.	The use of the Munsell Color Charts is not included as part of the ASTM Standard D2488. Soils will be logged in compliance with ASTM Standard D2488.	Munsell color chart is industry standard and will need to be followed.	Comment is acknowledged, and the requested change has been made in the applicable SAPs.
148	Appendix E, Section 5.2.5	Background Soil SAP	12	Table 4	9	A pH field test kit should be employed to help identify if soil pH is in a range to mobilize CCR contaminants (specifically target sample aliquots and horizon changes). For example, several metals are easily leached from acidic soil, however selenium is mobilized under alkaline conditions. Also, due the short hold time, which will create a situation where the analytical result will not be within the 15-min holding time, please consider a field method measurement of pH for comparison.	The 15-minute holding time for pH testing of soil samples begins from the point that the sample paste is created, prior to taking a pH reading. As such soil samples will be submitted to the laboratory for analysis as opposed to conducting field analysis of soil pH. Additionally, this study is not an investigation to determine the presence of CCR "contaminants" or conduits of contaminant movement. The biasing of sample collections based on pH ranges likely to mobilize CCR contaminants is not warranted.	Field analysis of pH will be required.	Comment is acknowledged, and the corresponding change has been made in the document. Background soil samples will be tested using pH field test kits. Ten percent of the samples will have confirmation samples submitted for laboratory analysis of pH.
178	Appendix L, Section 5.2.7.1	Hydrogeolo gical Investigation SAP	10	2	3	Preference is for 10-ft well screen to be set within the coarser unit above the bedrock.	Ten-foot well screens are typical, but longer screens may be required to accommodate large groundwater fluctuations in some locations. Screen interval depths will be dependent on the groundwater sampling intervals targeted for the Environmental Investigation.	Before any screen greater than 10ft is used an explanation as to how the alternate well construction procedures ensure groundwater samples and groundwater-level measurements will be representative of the water-bearing zone or aquifer to be monitored.	TVA will restrict the maximum well screen length to 10 feet which may cause screens to be fully submerged during part of the year in settings where groundwater level fluctuations are greater than 10 feet.
182	Appendix L, Attachment A	Hydrogeolo gical Investigation SAP	NA	Figure 3	NA	Well pump placement should be at the midpoint of the screen, if the screen is fully submerged, otherwise the pump should be placed at the midpoint of the saturated interval. It is unclear by this figure that the pump is placed correctly.	Figure 3 was revised to show the approximate placement of the well pump to be the midpoint of the screen or saturated interval.	The midpoint of the saturated screen is the optimum depth for the pump intake. Figure 3 (although a schematic still shows the pump intake less than 2 ft. from sump). Pump intakes must not be so close to the static water surface that the water level may be pulled below the intake; however, the pump intake should also be at least two feet above the bottom of the well to preclude excess turbidity from the well bottom. In the Figure 3 example assuming static water level was above 401.5ft then the pump inlet should be approximately 396.3ft. If the pump intake will be placed in a location other than the midpoint of the saturated interval TVA must provide detailed information outlining why and how each pump intake depth was selected.	Comment acknowledged. The schematic has been revised to indicate placement of the intake at the midpoint of the saturated screen.

Table TVA Cumberland EIP Rev 2
Responses to TDEC Comments (December 8, 2017)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)	TVA Response (January 26, 2018)
184	Appendix M	Groundwater Investigation SAP	All	All	All	General comment - TDEC recommends installing monitoring wells within the ash disposal complex to accurately characterize groundwater quality beneath the complex.	Piezometers with vibrating wire transducers have been installed within the Dry Ash Stack and Gypsum Storage Area for other ongoing TVA projects. These vibrating wire piezometers are shown on the figure included in the appendix of the EIP. The water level measurements collected from these piezometers will be used to characterize the groundwater flow beneath the units. No additional monitoring wells are proposed to be installed within the units. TVA's understanding is that the compliance boundary per TDEC solid waste regulations is defined as the perimeter of the CCR complex and does not include the areas within the units.	New monitoring wells within the ash disposal complex footprint will be proposed in the revised EIP.	See responses to comment 35.
196	Appendix M, Section 5.2.6	Groundwater Investigation SAP	13	Table 5		Field pH meters used for collecting data will have to meet the calibration requirements of Method C, which is 0.05 pH units of the bracketing buffer solution values.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the CUF EIP.	TVA will calibrate field pH meters to meet the requirements of 9040C.	Comment acknowledged. The document will be revised as necessary to address this comment.
201	Appendix N, Attachment A	CCR Material Characteristics SAP	NA	Figure 1	NA	TDEC recommends additional temporary wells be installed in the retention pond and stilling pond area to accurately assess the presence of ash and leachability characteristics thereof.	The temporary well proposed in the Ash Pond is located on a dike extending into the ponds. There is very little room to include additional wells spatially throughout the ponds since they are filled with water. Access to drilling locations is difficult and the plan does not include drilling over open ponded areas due to safety concerns.	TVA shall conduct the sampling stated in Comment 201 with the exception that TVA shall conduct the sampling required when the ponds are emptied.	Comment is acknowledged.

Table TVA Cumberland EIP Rev 2
Responses to TDEC Comments (December 8, 2017)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (August 31, 2017)	TVA Response (November 9, 2017)	TDEC Comment (December 8, 2017)	TVA Response (January 26, 2018)
203	Appendix P	Seep SAP	All	All	All	How does TVA plan to identify, assess, and sample seeps that may not currently be visible due to mitigation (rip rap)?	The site investigation will use a boat to evaluate areas along the creek bank, which would otherwise be inaccessible due to the extent of mitigation riprap in those areas. The investigation will include an examination of the bank at the base of the riprap to determine if there are continuing water discharges at those locations. Should active seeps be discovered during the investigation, a seep sampling location map will be finalized, and the Seep SAP will be implemented. This procedure will identify flowing seeps not otherwise visible due to riprap coverage, and allow for their subsequent sampling and analysis under the procedures of this Seep SAP.	TVA's proposal for seep identification is unacceptable. TVA shall take the following actions to examine seeps potentially discharging into surface streams; 1. TVA shall conduct field testing at the point where water from a seep(s) most likely enters a stream. TVA shall monitor the stream channel and surface water at the water's edge. TVA shall conduct field tests for pH, temperature, dissolved oxygen, and conductivity. 2. If field testing indicates a significant difference between stream channel samples and samples adjacent to the stream bank, then TVA shall determine if there is a flow from the seep. If the seep is covered with rock or other material, the material shall be removed to determine if there is flow from the seep. If there is flow from the seep, then the seep shall be sampled for CCR constituents. If the seep is flowing then TVA has three options to choose from to address the seep; (1) repair the seep and eliminate the flow, (2) modify its NPDES permit and add the seep as a permitted outfall or (3) collect flow from the seep and return it to the NPDES permitted surface impoundment.	The Seep SAP has been revised to include the new seep identification protocol as provided by TDEC. After the EAR has been completed and approved, the options provided by TDEC for addressing any flowing seeps will be evaluated and chosen during the CARA phase of the TDEC Order. A seep history summary will be included in the revised document an appendix.

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Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

March 8, 2018

Angela Garrone
Southern Alliance for Clean Energy
P.O. Box 1842
Knoxville, Tennessee 37901

RE: TDEC Commissioner's Order OGC 15-1077
TVA Cumberland Coal Fired Fossil Fuel Plant
All Interested Parties Meeting

Dear Ms. Garrone:

The Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order OGC 15-0177 (the Order) to the Tennessee Valley Authority (TVA) that required TVA action at seven TVA Coal Fired Fossil Power Plants (active and inactive) located in Tennessee. The Order was signed on August 6, 2015 and included information about TVA's right to appeal the Order. TVA did not appeal the Order and it is now final. The Order required TVA to perform environmental investigations and to take appropriate corrective action at seven TVA Coal Fossil Power Plants in Tennessee. The Order is specific to Coal Combustion Residual (CCR) material.

TVA submitted the Environmental Investigation Plan (EIP) Revision 3 for the TVA Cumberland Coal Fired Fossil Power Plant (TVA CUF) located in Cumberland City, TN on January 26, 2018. TDEC has completed its review of the submittal and found it to be acceptable.

In a letter dated September 28, 2015 from TDEC to the Southern Alliance for Clean Energy (SACE), TDEC added an additional opportunity for public involvement prior to the public notice and comment period stipulated in Section 7 of the Order.

This letter is to notify your organization that TDEC will hold an All Interested Parties (AIP) meeting to discuss the TVA CUF EIP Revision 3 on March 27, 2018, 9:00 am CST at the TDEC Central Office located at W.R. Snodgrass Building, 312 Rosa L. Parks Avenue Nashville, TN 37243.

If your organization will be attending the AIP meeting, please respond no later than March 20, 2018. TDEC requests that each organization limit attendees to no more than three personnel. Please provide at least one valid email address, if you have not already done so, to allow for file sharing of a digital copy of the TVA CUF EIP Revision 3 to review prior to the AIP meeting.

TDEC appreciates your continued interest in this issue and looks forward to meeting with you. Should you have any questions, please do not hesitate to contact me via email at Robert.S.Wilkinson@tn.gov or phone at (615) 253-0689.

Sincerely,

Robert Wilkinson

Robert Wilkinson, P.G., CHMM
TDEC CCR Technical Program Manager

CC:	Robert J. Martineau, Jr.	Shari Meghreblian	James Clark
	Tisha Calabrese-Benton	Chuck Head	Pat Flood
	Brooke Barrett	Britton Dotson	Rob Burnette
	Jenny Howard	Angela Adams	Joseph E. Sanders
	Taylor Korth	Susan Smelley	Shawn Rudder
	Christina Treglia		

APPENDIX C
QUALITY ASSURANCE PROJECT PLAN

ENVIRONMENTAL STANDARDS
Setting the Standards for Innovative Environmental Solutions

QUALITY ASSURANCE PROJECT PLAN
FOR THE TENNESSEE VALLEY AUTHORITY
CUMBERLAND FOSSIL PLANT ENVIRONMENTAL INVESTIGATION

Revision 2

January 2018

Prepared by:

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Prepared for:

TENNESSEE VALLEY AUTHORITY
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Chattanooga, TN 34702-2801

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2.0 QUALITY ASSURANCE PROJECT PLAN DESCRIPTION

2.1 Background

The primary goal of this Tennessee Valley Authority (TVA) Cumberland Fossil Plant (CUF) Environmental Investigation Quality Assurance Project Plan (CUF QAPP) is to confirm that the CUF environmental investigation objectives are met by TVA consultants and contractors generating documented, high-quality, reliable investigative/analytical data. This document describes the quality assurance (QA) requirements for work performed under the *TVA Cumberland Fossil Plant Environmental Investigation Plan*, *Revision 3* (CUF EIP, Revision 3; January 2018) and provides QA procedures and quality control (QC) measures to be applied to associated sampling and monitoring activities. This CUF QAPP will govern the quality aspects of the investigation-specific Sampling and Analysis Plans (SAPs).

This CUF QAPP describes the QA implementation for the CUF EIP and identifies the obligations of the various entities responsible for generating environmental data. Specific details on the various sampling programs and project-specific quality objectives are presented in this CUF QAPP and/or the associated SAPs, with TVA Technical Instructions (TIs) or standard operating procedures (SOPs) guiding the specific activities performed under these plans. The CUF QAPP describes the generation and use of environmental data associated with the CUF EIP and is applicable to current sampling and monitoring programs associated with the project. Data generated under the CUF EIP will be managed in accordance with the Data Management Plan for the TVA Multi-Site Order.

2.2 Quality Assurance Program Organization, Management, and Responsibilities

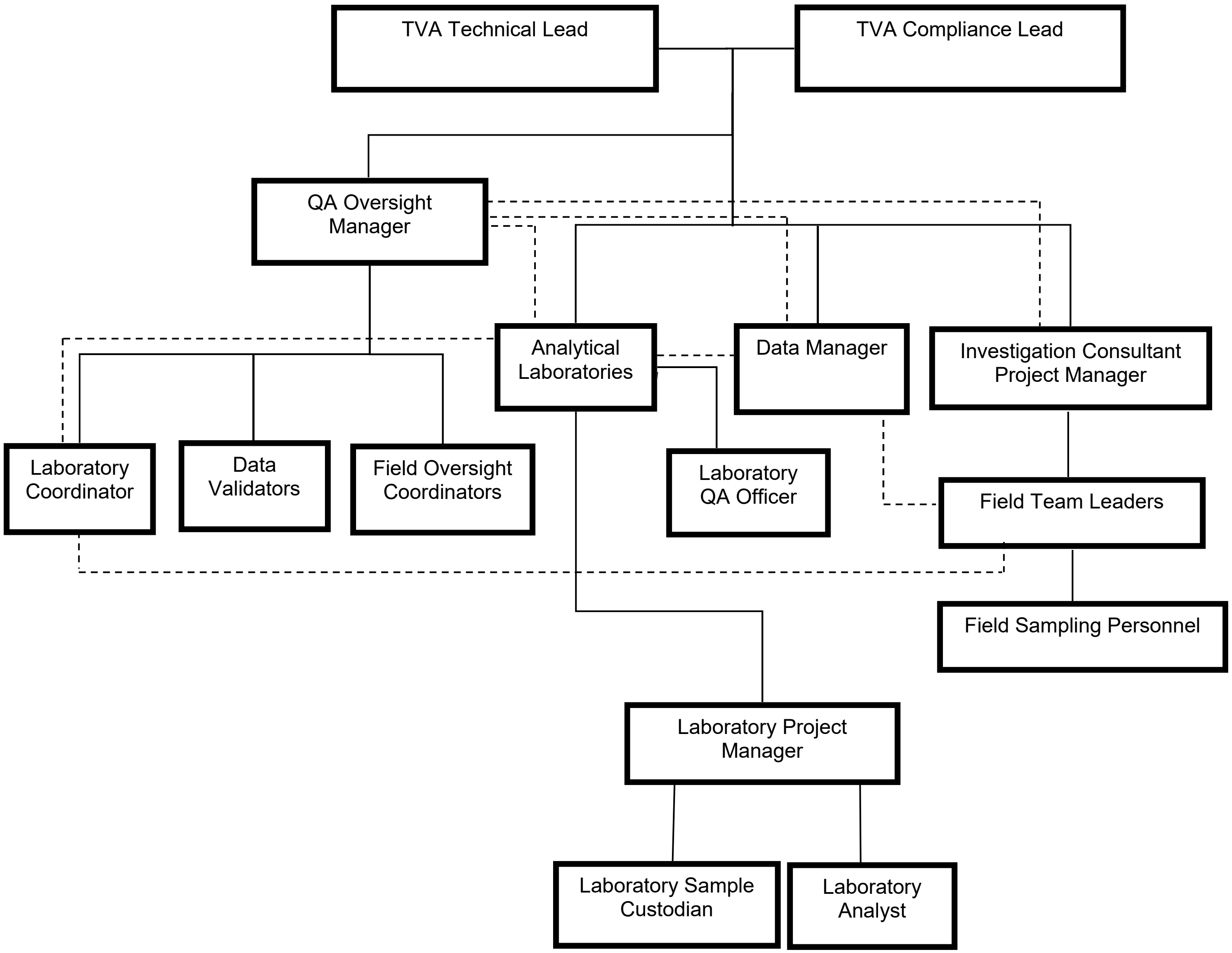
Successful implementation of a QA Program requires clear lines of reporting and authority, along with defined responsibilities for key individuals implementing and administrating the QA Program. This section describes the organizational structure, lines of authority, and responsibilities of key individuals accountable for the implementation and administration of the CUF EIP requirements. Project activities are performed within the framework of the organization and functions described in this section.

The organizational structure showing relationships of individuals with key responsibilities is presented in Figure 2-1. The organizational structure in Figure 2-1 represents a subset of the overall organizational structure for the project as directly related to implementation of the CUF QAPP. The QA Oversight Consultant provides independent QA support to TVA including QA oversight of field and laboratory personnel. The organizational structure is designed to provide clear lines of responsibility and authority, regardless of the individuals filling particular roles. This organizational structure encompasses the following activities:

- Identifying lines of communication and coordination.
- Monitoring project schedules and performance.
- Managing technical resources.
- Providing periodic progress reports.
- Coordinating support functions such as laboratory analysis and data management.
- Rectifying deficiencies and issues that could impact data quality.

Field and laboratory personnel providing services in support of project efforts must perform work in compliance with the appropriate technical specifications for the activity.

Figure 2-1. Organization Chart and Lines of Communication for the CUF EIP



The sections below detail the roles and responsibilities for the positions involved in the CUF EIP.

2.2.1 TVA Compliance Lead

The TVA Compliance Lead is responsible for the coordination and direction of the CUF EIP. The TVA Compliance Lead is ultimately responsible for design and implementation of the CUF EIP. The TVA Compliance Lead interfaces with TVA Legal Counsel as necessary and provides reports to TVA Senior Management.

TVA Compliance Lead's responsibilities and duties include:

- Identifying lines of communication and coordination.
- Managing key technical resources.
- Providing periodic progress reports to TVA Senior Management.
- Reviewing and approving the CUF EIP strategy.
- Reviewing and approving CUF EIP quality objectives.
- Reviewing and approving SAPs.
- Rectifying deficiencies and issues.
- Participating in meetings with Tennessee Department of Environment and Conservation (TDEC).
- Providing compliance support to TVA Technical Lead.

2.2.2 TVA Technical Lead

The TVA Technical Lead is responsible for providing technical guidance for the CUF EIP. The TVA Technical Lead directs the Investigation Consultant Project Manager and independent QA Oversight Manager and is ultimately responsible for design and implementation of the CUF EIP. The TVA Technical Lead interfaces with TVA Legal Counsel as necessary and provides reports to TVA Senior Management.

TVA Technical Lead's responsibilities and duties include:

- Developing and reviewing the CUF EIP strategy.
- Developing and reviewing CUF EIP quality objectives.
- Reviewing and approving SAPs.
- Reviewing and analyzing overall task performance relative to planned QA requirements.
- Managing support functions such as laboratory analysis and data management.
- Rectifying deficiencies and issues.
- Providing technical support to the TVA Compliance Lead.
- Overseeing the budget.
- Monitoring project schedules and performance.

2.2.3 Investigation Consultant Project Manager

The Investigation Consultant Project Manager plans, coordinates, and oversees the performance of all investigation and sample collection activities. Investigation Consultant Project Manager's responsibilities include:

- Developing SAPs.
- Planning and coordinating Field Sampling Personnel for investigation and sampling events.
- Reviewing field logbooks for completeness, consistency, and accuracy.
- Managing and reviewing field sample Chain-of-Custody (COC) Records and associated documentation.
- Obtaining the appropriate field gear and supplies.
- Notifying management of situations requiring corrective action.
- Responding to, and implementing corrective action, as described in Section 16.0.

2.2.3.1 Field Team Leaders

The Field Team Leaders are the primary contacts in the field and are responsible for field activities, as listed below.

- Provide coordination and management of Field Sampling Personnel and subcontractors involved in field investigation, sampling or calibration activities.
- Submit analytical requests to the Laboratory Coordinator.
- Ensure Field Sampling Personnel are familiar with field procedures and that these procedures are followed to achieve the data objectives.
- Review field logbooks and field data sheets for completeness, consistency, and accuracy.
- Conduct QA review of field data and coordinate submittal of field data to the Data Manager.

2.2.3.2 Field Sampling Personnel

Field Sampling Personnel are responsible for the performance of field activities as required by the program-specific SAPs and associated field TIs. Field Sampling Personnel document compliance with project requirements by recording field activities and observations in a field logbook at the time of the activity or observation. In addition, Field Sampling Personnel are responsible for collecting samples, submitting them to laboratories, and maintaining COC Records.

Field Sampling Personnel are responsible for field activities, including:

- Plan investigation and sample events and interface with the Laboratory Coordinator.
- Collect, label, and package samples.
- Ensure field procedures are followed to achieve the data objectives.
- Review field notebooks/logbooks for completeness, consistency, and accuracy.

- Provide coordination of sample delivery to project laboratories for analysis.

If there are problems encountered during any field activities, Field Sampling Personnel will inform the appropriate Field Team Leader and/or the Investigation Consultant Project Manager.

2.2.4 Analytical Laboratories

The functional roles for project analytical laboratories are described in this subsection. From the Project perspective, the structure is designed to facilitate information exchange about planning, technical requirements, schedules, and QA measures among the laboratories, Investigation Consultant, QA Oversight personnel, and TVA personnel. Project information exchange specifically includes sample identification; preservation procedures; sample container requirements; sample collection procedures; decontamination protocols; and sample labeling, packing, holding times, and shipping.

Although internal laboratory structures may differ depending on the specific contractor, key functional roles include division management, technical direction, subcontracting coordination, data review, and data management.

The responsibilities of the analytical laboratories include, but are not limited to:

- Preparing and analyzing samples in a manner consistent with the analytical request, the CUF QAPP, and any applicable TVA TIs or other work instructions.
- Communicating with the QA Oversight Team.
- Adhering to the laboratory QA Program.
- Implementing QC procedures for each test parameter.
- Reviewing analytical results, including raw data, calculations, and laboratory logbooks.
- Monitoring proper documentation and maintenance records.
- Identifying and implementing training requirements for the laboratory analytical personnel.
- Identifying QA problems and recommending appropriate corrective action.
- Preparing status reports (progress, problems, and recommended solutions).
- Preparing reports documenting completion of corrective actions.
- Providing electronic data deliverables (EDDs) in a format consistent with project requirements.

Laboratories will be selected based on a number of factors including capability, capacity, and ability generate quality data that meet project objectives. The primary contracted laboratories may subcontract samples for special studies or non-routine analyte lists. In the event that samples are subcontracted, the primary laboratory is responsible for ensuring that analyses conform to the CUF QAPP requirements and the associated investigation-specific SAP. Data for subcontracted analyses will be reported through the primary contracted laboratory, which remains responsible for data quality.

The primary analytical laboratories expected to analyze samples associated with the CUF EIP are presented on Table 2-1.

Table 2-1. Analytical Laboratories for CUF EIP

Parameter/ Sample Type	Laboratory	Facility Address	Laboratory Contact
Metals, General Chemistry Parameters	TestAmerica Laboratories, Inc.	301 Alpha Drive Pittsburgh, PA 15237	Ms. Carrie Gamber (carrie.gamber@testamericainc.com)
Potable Water Analyses	TestAmerica Laboratories, Inc.	2960 Foster Creighton Drive Nashville, TN 37204-3719	Ms. Gail Lage (gail.lage@testamericainc.com)
Radiological Parameters	TestAmerica Laboratories, Inc.	2800 George Washington Way Richland, WA 99354	Ms. Erika Jordan (erika.jordan@testamericainc.com)
Percent Ash	R.J. Lee Group	50 Hochberg Road, Monroeville, PA 15146	Ms. Monica Carse (MCarse@rjleegroup.com)
Biota Analyses	Pace Analytical Services, LLC	1241 Bellevue Street Suite 9 Green Bay, WI 54302	Mr. Tod Noltemeyer (tod.noltemeyer@pacelabs.com)
Geotechnical Characteristics	Stantec Consulting Services, Inc.	3052 Beaumont Centre Circle Lexington, KY 40513-1703	Ms. Ryan Jones (ryan.jones@stantec.com)
Benthic Invertebrate Community Assessment	Pennington & Associates, Inc.	161 McGee Lane Cookeville, TN 38501	Mr. Wendell Pennington (pai1@twlakes.net)

2.2.4.1 Laboratory QA Officer

The Laboratory QA Officer ensures conformance with authorized policies, procedures, and sound laboratory practices as necessary. The Laboratory QA Officer will inform the Laboratory Project Manager of any non-conformances, introduce control samples into the sample train, and establish testing lots. In addition, the Laboratory QA Officer approves laboratory data before reporting or transmitting to permanent storage and is responsible for retention of supporting information such as control charts and other performance indicators to demonstrate that the systems that produced the data were in control. The Laboratory QA Officer also reviews results of internal QA audits and recommends corrective actions and schedules for their implementation.

The responsibilities of the Laboratory QA Officer include, but are not limited to:

- Administering the laboratory QA Program.
- Implementing QC procedures for each test parameter.
- Reviewing analytical results, including raw data, calculations, and laboratory log books.
- Monitoring proper documentation and maintenance of the records.
- Identifying and implementing training requirements for the laboratory analytical personnel.
- Overseeing QA implementation at the laboratory on a daily basis.
- Identifying QA problems and recommending appropriate corrective action.
- Preparing status reports (progress, problems, and recommended solutions).
- Preparing reports documenting completion of corrective actions.

2.2.4.2 Laboratory Project Manager

The Laboratory Project Manager is the primary contact for the Project Team at the analytical laboratory. A primary responsibility of the Laboratory Project Manager is to schedule analytical work within the laboratory, ensure that project-specific analytical requirements are communicated to staff, monitor analytical status/deadlines, approve laboratory reports, coordinate data revisions/corrections and re-submittal of data packages as necessary, and communicate sample preparation and analysis issues to the QA Oversight Manager and TVA Technical Lead on a real-time basis. The Laboratory Project Manager provides direction and support for laboratory administrative and technical project staff, interfaces with laboratory project staff on technical issues, and performs QA oversight of analytical data. The Laboratory Project Manager contacts the QA Oversight Manager and TVA Technical Lead if, at any point, there is a need to deviate from the CUF QAPP or other cited published materials. Any problems or inconsistencies identified at any time after laboratory sample receipt will be documented on a nonconformance report initiated by the Laboratory Project Manager and forwarded to the TVA Technical Lead and the Laboratory Coordinator.

The Laboratory Project Manager will provide sample receipt confirmations to the Laboratory Coordinator and Investigation Consultant Project Manager within one business day of sample login.

2.2.4.3 Laboratory Sample Custodian

The Laboratory Sample Custodian receives samples from TVA or its contractors, signs and dates COC Records, records the date and time of receipt, and records the condition of shipping containers and sample containers.

The Sample Custodian will verify and record agreement or non-agreement of information on sample custody documents. If there is non-agreement, the Sample Custodian will record the problems/inconsistencies for the case file and will inform the Laboratory Project Manager.

The Sample Custodian will also label sample containers with laboratory sample numbers, place sample containers and spent sample containers into the appropriate storage and/or secure areas, and monitor storage conditions.

2.2.4.4 Laboratory Analyst

The Laboratory Analyst is responsible for preparing and/or analyzing samples in accordance with this document and/or the applicable analytical methods. If there are problems encountered during sample preparation or analysis, the Laboratory Analyst will inform the Laboratory QA Officer and Laboratory Project Manager.

2.2.5 QA Functions

QA oversight activities will be performed by a third-party, independent contractor. The QA Oversight Consultant is an independent third-party QA organization and reports directly to the TVA Technical Lead.

2.2.5.1 QA Oversight Manager

The QA Oversight Manager develops, implements, and administers the overall QA Program for the CUF EIP. The QA Oversight Manager holds overall authority for the project QA and maintains that authority independently from the operational/production aspects of the project. The QA Oversight Manager also holds the authority to communicate at any level of the project organization in order to be effective.

The QA Oversight Manager's responsibilities and duties include:

- Establish a documented quality system for the project.
- Identify QA problems through periodic auditing and validation procedures.
- Initiate, recommend, or provide solutions to QA problems through designated channels.
- Ensure that project activities, including processing of information, delivery of products, and installation or use of equipment, are reviewed in accordance with QA objectives.
- Ensure that deficiencies or non-conformances are corrected.
- Ensure that further processing, delivery, or use of deficient or non-conforming data is controlled until correction of the non-conformance, deficiency, or unsatisfactory condition has occurred.
- Review and analyze overall task performance with respect to planned requirements.
- Perform general oversight of corrective action processes.
- Initiate and direct internal audits, inspections, surveillances, and observation of quality-related activities.
- Serve as point of contact for audits, inspections, surveillances, data management, and observation activities.
- Ensure deficiencies and non-conformances are corrected.
- Maintain QA documentation and records, including this CUF QAPP.

2.2.5.2 Laboratory Coordinator

The Laboratory Coordinator serves as a liaison between Field Team Leaders and the analytical laboratories for all work conducted under the CUF EIP. The Laboratory Coordinator's responsibilities include:

- Review analytical requests to verify consistency with project SAPs.
- Submit analytical requests to the Laboratory Project Manager.
- Schedule sample submission and transportation (as needed).
- Review and approve laboratory bottleware orders.
- Review COC Records submitted to the laboratories and sample receipt documentation provided by the laboratories.
- Serve as the point of contact for questions and issues arising during laboratory analysis.

2.2.5.3 Data Validators

Data Validators are responsible for performing review and validation of project data generated by the laboratories in accordance with the CUF QAPP and data specifications, producing data validation reports, and notifying the QA Oversight Manager of any specific issues or concerns.

2.2.5.4 Field Oversight Coordinators

Field Oversight Coordinators are independent from field sampling activities and work with the Field Team Leaders to ensure compliance with the CUF QAPP, program-specific sampling plans, and the associated project TIs. The Field Oversight Coordinators are responsible for training personnel involved in field sampling activities (if training is required), sample handling procedures, and sample custody as detailed in project TIs and the investigation-specific SAPs, and for periodically overseeing their performance of these functions. The Field Oversight Coordinators perform quality oversight of the Field Teams during sample collection and assess the procedures and performance of the Field Teams relative to the requirements in the CUF QAPP, TIs, and investigation-specific SAPs. As part of the quality oversight, the Field Oversight Coordinators will review COCs prior to submission of samples to the analytical laboratories.

2.2.6 Data Manager

The Data Manager is responsible for managing the project EQuIS™ database, which includes analytical data from the project laboratories, field data from the Investigation Consultant, and historical data of known quality used as part of the CUF EIP. The Data Manager is the main point-of-contact for data-related issues. The Data Manager is responsible for ensuring compliance with the CUF QAPP and the Data Management Plan for the TVA Multi-Site Order (Data Management Plan). The Data Manager or designee receives EDDs directly from the project laboratories after sample analysis and formats the deliverables such that they can be used during the validation/verification process. Field data is collected and submitted to the Data Manager from the Investigation Consultant utilizing field EDDs and is loaded and managed in the project database. A complete description of the Data Manager's responsibilities and responsibilities of Data Management support staff is provided in the Data Management Plan.

3.0 PROJECT DESCRIPTION AND APPLICABILITY

On August 6, 2015, the TDEC issued Commissioner's Order No. OGC15-0177 (Order) to TVA, setting forth a process for the investigation, assessment, and remediation of unacceptable risks at TVA's coal ash disposal sites in Tennessee. The TDEC Order is limited to the purposes and processes set forth in the TDEC Order. In compliance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management activities at CUF. On April 11, 2016, TDEC sent a letter to TVA requesting additional work and/or information be provided in an EIP. TVA prepared the EIP as required under the TDEC Order and in response to TDEC's informational requests, and submitted the CUF EIP Revision 0 to TDEC on July 11, 2016. TDEC provided CUF EIP Revision 0 review comments to TVA in a letter dated January 13, 2017. As part of the response to TDEC's January 13, 2017 review comments, TVA submitted CUF EIP Revision 1 to TDEC on May 12, 2017. TDEC provided EIP Revision 1 review comments in a letter dated August 31, 2017; CUF EIP Revision 2 was issued to TDEC on November 9, 2017, to address these comments. TDEC provided CUF EIP Revision 2 review comments to TVA in a letter dated December 11, 2017. This CUF EIP Revision 3 responds to TDEC's December 11, 2017, comments.

The purpose of the CUF EI is to characterize the hydrology and geology of the CUF, identify the extent of soil, sediment, surface streams, seeps, pore water, groundwater, and ecological impact by CCR. At the conclusion of the investigation, an Environmental Assessment Report (EAR) analyzing results of these investigations will be prepared and submitted to TDEC. The EAR will support the development of an appropriate corrective action plan, if necessary, for CUF.

To support the CUF EI objectives, a QA program has been implemented to ensure the environmental data generated for use in decision making is of high-quality and is legally defensible. The project's environmental data have been and continue to be used for purposes such as, but not limited to, operational decisions; delineation of the extent of contamination and transport of ash by river flows; and demonstration of achievement of project objectives.

On behalf of TVA, Environmental Standards, Inc., an independent QA firm, has prepared this CUF QAPP. The requirements of the CUF QAPP are applicable to project environmental personnel, support staff, consultants, and subcontractors.

3.1 Purpose and Scope

The CUF QAPP is intended to establish an overall environmental QA framework for the CUF EIP and to provide quantitative quality objectives for analytical data generated under the CUF EIP. Requirements associated with various analyses; data generation, reduction, and management; and results reporting are stipulated herein. Additional specific requirements are described in the investigation-specific SAPs.

The scope of this document is to describe the QA requirements developed for the CUF EIP and provide the appropriate QA procedures and QC measures to be applied to the associated sampling and monitoring activities. The CUF QAPP addresses the following items:

- Project organizational structure, roles, and responsibilities.
- QA objectives.
- Training requirements.
- Field and laboratory documentation requirements.
- Sample collection, handling, and preservation.
- COC procedures.
- Field and laboratory instrumentation and equipment calibration and maintenance.
- Preventive maintenance procedures and schedules.
- Laboratory procedures.
- Analytical methods requirements.
- Sample analysis, data reduction, validation, and reporting.
- QC sample types and frequency.
- QA performance and system audits.
- Data assessment procedures, including processing, interpretation, and presentation.
- Corrective actions.
- QA reports to management.

Investigation-specific SAPs have been developed to address program-specific sampling requirements to provide data sufficient to address the objectives of the particular investigation. QC requirements and quantitative objectives for analytical data are presented in Attachments E through L of this CUF QAPP.

3.2 Schedule

Investigation-specific sampling schedules are addressed in each associated SAP.

In general, the anticipated schedule of activities related to analytical data generated from chemical analyses is presented below.

- The laboratory will provide analytical results and EDDs to TVA within its standard turn-around time (TAT; approximately 10 business days for chemical analyses and approximately 40 days for radiological analyses) from sample receipt (or sooner when expedited TAT is requested).
- The QA Oversight Consultant will screen the EDD for acceptability to the database and complete the initial verification within 2 business days of EDD receipt and successful EDD loading. Verified data will be available to TVA and Investigation Consultant personnel for internal use and reporting.
- The laboratory will provide full data deliverable packages to TVA and the QA Oversight Consultant within its standard TAT (approximately 20 business days for chemical analyses and approximately 45 days for radiological analyses) from sample receipt.
- The QA Oversight Consultant will complete data validation as requested by TVA, generate reports following receipt of the complete data package, and add data validation qualifiers to the database as appropriate.

The overall schedule for the CUF EIP is presented in the EIP. Schedules for the various sampling activities associated with each Environmental Investigation (EI) are addressed in the investigation-specific SAPs.

3.3 QAPP Distribution and Revision

The CUF QAPP will be distributed to each consultant and contractor responsible for the collection, generation, and interpretation of field and analytical data. The TVA Technical Lead, QA Oversight Manager, or designee will be responsible for ensuring that necessary revisions are made so that the CUF QAPP is up-to-date with actual practices and will ensure that revisions and updates are distributed to necessary users. The document control format used in the CUF QAPP will identify the revision number and revision date. A revision history that identifies each revision and a summary of the revision will be maintained.

4.0 DATA QUALITY OBJECTIVES PROCESS

The Data Quality Objectives (DQO) process is a series of planning steps based on a scientific method to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended application. In general, DQOs provide a qualitative and quantitative framework around which data collection programs can be designed. The qualitative aspect of DQOs seeks to encourage good planning for field investigations. The quantitative aspect of DQOs involves designing an efficient field investigation that reduces the possibility of incorrect decision-making.

The DQO process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA, its QA Oversight Consultant, and Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts at the CUF EIP.

5.0 SPECIAL TRAINING/CERTIFICATIONS

Field Sampling Personnel performing sample collection activities will be properly trained in equipment use and procedures necessary for each task prior to entering the field. Training will be conducted by TVA, the QA Oversight Consultant, the Investigation Consultant, and/or other subcontractors. Any proposed training not provided by the QA Oversight Consultant will be reviewed and approved by the Field Oversight Coordinator before training is conducted. Field Sampling Personnel training will be fully documented and the documentation will be maintained as part of the Project Record.

Individuals who plan to participate in field activities must have current health and safety training prior to commencement of sample collection activities. The Investigation Consultant Field Team Leader will verify that participants who arrive on site have provided evidence of health and safety training. It will be the responsibility of the Investigation Consultant Field Team Leader to ensure that Field Sampling Personnel understand and comply with the applicable requirements for their individual tasks.

Field Sampling Personnel will be trained on applicable field QC measures associated with a particular sampling program during program-specific training. Training received by Field Sampling Personnel will be documented. In addition, Field Sampling Personnel will receive training based on field oversight activities and additional training sessions on applicable project TIs.

Personnel who are responsible for performing laboratory analyses will be properly trained by the Laboratory Director or her/his designee to conduct the various laboratory analyses described in the CUF QAPP. Each laboratory shall assure sufficient personnel with the necessary education, training, technical knowledge, and experience for their assigned functions. Laboratory personnel training will be documented in accordance with the laboratory's Quality Program requirements.

Data verification and validation will be conducted under the direction of the QA Oversight Manager, who will be experienced with the production, reporting, verification, and validation of analytical data.

Additional QA training will be conducted at the discretion of the TVA Technical Lead and the QA Oversight Manager. Generally, the need for QA training for project personnel will be identified through systems and performance audits and training will be conducted as part of the corrective action process. Any QA training provided to project personnel will be documented.

6.0 DOCUMENTATION AND RECORDS

Appropriate records will be maintained in a secure project file to provide adequate documentation of the entire data generation process, including field sampling and laboratory analysis. Field records will include maintaining field logs, field data sheets, and sample COC documentation. Field QC samples will be documented in both the field logbook and sample COC Records.

The Project File will be the central repository for documents relevant to sampling and analysis activities as described in the CUF QAPP and in the investigation-specific Work Plans and/or SAPs. The TVA Technical Lead will hold overall responsibility for maintenance of documentation associated with the project, including relevant records, correspondence, reports, logs, data, field records, pictures, subcontractor reports, analytical data, and data reviews. The file will include the following information, if generated:

- Field records.
- Field data and data deliverables.
- Photographs.
- Drawings.
- Sample logs.
- Laboratory data deliverables.
- Data validation reports.
- Field and laboratory audit reports.
- Reports (*e.g.,* progress reports, QA reports).
- Custody documentation.

Electronic and hardcopy analytical data will be archived for a minimum of 10 years from the date of report. TVA will maintain a complete project file and will archive hardcopy and electronic data in accordance with TVA records retention rules as delineated by TVA's records management documents. Electronic or hardcopy data associated with the CUF EIP will not be discarded, deleted, or destroyed by any party without the written consent of TVA Legal Counsel.

6.1 Field Data Documentation

Field data collected during the EI will be evaluated for usability by conducting a QA review, which will consist of checking the procedures used by field staff and comparing the data to previous measurements. Field QC samples will be used to verify that field measurements and sampling protocols have been observed and followed. The field data will be reviewed by the Field QA Oversight Coordinator or designee for the following:

- Compliance with TIs.
- Compliance with SAPs.
- Field equipment calibration method and frequency.
- Field calibration standard lot numbers and expiration dates.
- Date and time sampled.
- Preservation.
- Sampler collection procedures.
- COC Records.

- Date sample shipped.

Any deviations from applicable TIs or the investigation-specific SAPs will be approved and documented in the field logbook during sampling and data collection operations. The Field Team leader or designee will be notified of deviations.

The original COC Records will accompany samples to the analytical laboratories. Upon receipt and login of the samples at the laboratory, the remaining sections of the COC Record (such as description of the sample condition at the time of receipt, assigned laboratory identification number, and any special conditions) will be completed. The completed original COC Record will be archived at the analytical laboratory in accordance with the laboratory's document retention requirements and the requirements herein.

6.2 Laboratory Data Documentation

Analytical laboratories performing work on this project will retain records of the analytical data for a minimum of 10 years after project completion. Analytical data will not be disposed of without TVA's consent. In addition, laboratory data will be provided to TVA in hardcopy or approved electronic form. TVA will retain data in accordance with TVA records management requirements. Laboratory data will not be disposed without specific approval from the TVA Legal Counsel and the TVA Technical Lead.

6.2.1 Laboratory Data Reporting/Deliverable Package

Analytical laboratories will report data at their standard TAT; generally, 10 business days from sample receipt at the laboratory for all chemical parameters. In some cases, expedited TATs are required. Results of sample chemical analyses are completed and results reported to TVA and the QA Oversight Consultant as a Level II report and EDD within 10 business days (refer to Attachment A for data deliverables requirements). Level IV data packages (refer to Attachment A for data deliverables requirements), in a hardcopy and/or electronic Adobe® Acrobat® portable document format (.pdf), will be submitted to TVA and the QA Oversight Consultant within approximately 20 business days from sample receipt at the laboratory. Radiological analysis results are completed and reported to TVA and the QA Oversight Consultant as a Level IV report and EDD within 40 business days.

Laboratories performing chemical analyses will be responsible for providing an EDD consistent with the Data Management Plan, as well as a Level II report and/or Level IV data package (see Attachment A). The deliverable package will contain final results (uncorrected for blanks and recoveries except where required by the referenced method), analytical method reference, sample results and detection limits, and results of field and laboratory QC samples. In addition, special analytical problems and/or any modifications of referenced methods will be noted in the Case Narrative of the laboratory report/data package. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method.

As a general statement, chemical analytical data will typically be reported as follows:

- Concentrations for aqueous samples are expressed in terms of weight per unit volume (such as milligrams per liter [mg/L] or micrograms per liter [µg/L]).

- Concentrations for chemical analyses of solid samples (including biological samples) are expressed in terms of weight per unit weight of sample (such as milligrams per kilogram [mg/kg] or micrograms per kilogram [µg/kg]). Unless specifically directed otherwise, solid sample chemical analysis results will be reported on a dry-weight basis. The reporting basis for solid samples will be clearly indicated in the laboratory data package.
- Radiological activities are expressed in terms of picocuries per unit volume or weight (such as pCi/L or pCi/g). For solid samples, radiological activities are not corrected for sample moisture content.

Chemical analytical data will be reported in the units specified in the Method Analyte Groups (MAGs) to ensure consistent reporting among the contracted laboratories.

Chemical analytical laboratory data will be provided in the Level II report and Level IV data package formats presented in Attachment A. In general, the Level IV data package will include summary forms and raw data for calibrations, QC, and sample analyses. QC results reported will include a method blank, matrix spike/matrix spike duplicate (MS/MSD) samples, field QC samples, and laboratory control samples (LCSs). Sample chemical analyses data (both field and laboratory QC sample results) will also be provided in EDDs. The laboratory is responsible for reviewing the electronic data to ensure that these data are consistent with those presented in the laboratory report/data package. Data discrepancies between the EDD submission and laboratory report/data package, if any, will be reconciled at validation; the data validators will notify the contract laboratory and TVA so that the laboratory deliverables may be revised by the contract laboratory. In the event that revisions to Level II or Level IV data packages are required based on data validation, complete revised deliverables clearly stamped with revision number and date will be provided by the contract laboratory so that a final complete data package is archived for each sample submittal.

6.3 Record Keeping

Written and/or electronic records generated under the CUF EIP, including but not limited to notes, logbooks, reports, draft and final documents, and forms, are maintained by the originator for inclusion in the project file as appropriate. In addition, electronic files, including but not limited to draft and final documents, and laboratory analytical reports are maintained as part of the electronic project file.

Chemical analytical data for this project will be reported in both an EDD and an analytical data package. An EarthSoft EQuIS database will be used for processing, storage, and reporting of all data (historical and investigatory) to be used as part of the CUF EIP. To maintain uniformity and consistency among analytical laboratories, the EDD format for the transfer of data associated with the CUF EIP will be a complex EDD specification compatible with EQuIS. A simple EDD specification may be substituted for laboratories that do not possess the capabilities to generate a complex EDD or for analyses for which automated data review is not applicable (*e.g.*, percent ash analyses by polarized light microscopy). The EQuIS data transfer parameters are discussed further in the Data Management Plan. The EDD will be generated by the laboratories and will be used to facilitate loading the analytical data into the EQuIS Project Database.

Field data generated during the CUF EIP will also be stored in the EQuIS Project Database. A simple EDD specification will be utilized by the Investigation Consultant Field Team Leader (or designee) to submit field data to the EQuIS Project Database.

Analytical data packages will be prepared by the laboratory for sample analyses performed. A Limited data deliverable (Attachment A) in Adobe Acrobat .pdf and EQuIS EDD will be provided by the contract laboratory within the laboratory's standard TAT for limited deliverables (approximately 10 business days from sample receipt for chemical analyses and approximately 40 business days from sample receipt for radiological analyses). Full deliverables (Attachment A) will be provided by the laboratory in an Adobe Acrobat .pdf electronic format for all analyses within the laboratory's standard TAT for Full data deliverables (approximately 20 business days from sample receipt for chemical analyses and approximately 45 business days from sample receipt for radiological analyses).

6.4 Data Archival

Applicable electronic field and laboratory data collected during sampling will be archived electronically. Backup tapes containing databases and programs or software utilities will be maintained in a secure location. Hardcopy data, including but not limited to field logbooks, laboratory data deliverables, and data validation reports, will be archived in accordance with TVA's Document Control protocols. Formal records custody procedures will be maintained in accordance with TVA's Records Custody procedures.

7.0 SAMPLING PROCESS DESIGN

This section briefly outlines field investigation procedures for the CUF EIP. Detailed discussions of field protocol are provided in the various TIs developed for the project. In addition, detailed descriptions of field activities are provided in the investigation-specific SAPs.

Aqueous, solid, and biological samples may be collected in association with the CUF EIP. These samples will be subject to a variety of chemical, radiological, and physical analyses to support the objectives outlined in the CUF EIP and associated investigation-specific SAPs.

Field investigation and sampling procedures will be conducted such that samples are representative of the media sampled and the resultant data can be compared to other data sets. Sampling schemes (as described in the associated investigation-specific SAPs) are designed to provide a statistically meaningful number of field sampling points and the rationale for the collection of these samples. A sufficient number of samples will be collected for each sampling program to adequately characterize the area and provide a sufficiently large data set such that statistical analyses can be performed. Field investigation and sampling methods will be conducted in accordance with the investigation-specific SAPs and associated TVA TIs, which include equipment requirements and decontamination procedures to meet the objectives of the project.

The investigative rationale for a specific sampling and analytical program is addressed in the investigation-specific SAPs. Sampling and monitoring activities are subject to the requirements set forth in the TVA TIs and this CUF QAPP. Investigation-specific SAPs will describe specific sampling and monitoring activities when QA requirements, more stringent than those presented herein, are required to support the sampling and monitoring projects.

The sampling design and execution for monitoring activities associated with the CUF EIP are described in the various investigation-specific SAPs. For some investigations it is anticipated that the sampling and monitoring activities will evolve in a phased approach as data are gathered under the planned investigations. As the sampling and monitoring programs are developed, additional SAPs and program-specific TIs may be prepared.

As the project progresses, the data generated will be used to evaluate sampling and analytical needs. Subject to regulatory approval, adjustments may be made to sampling schedules, analyte lists, and requested methods when supported by the results of field investigations.

Investigation-specific SAPs will present Site maps, including sampling locations (when applicable), for the various sampling and monitoring programs performed at the Site. Detailed descriptions of sampling process design and field sampling activities are provided in the investigation-specific SAPs. Field investigations will be addressed in investigation-specific SAPs.

8.0 SAMPLING METHODS REQUIREMENTS

Descriptions of the procedures for the sampling, identification, packaging, and handling of project samples; the decontamination of sampling equipment; and the calibration and maintenance of sampling equipment are presented in the associated TIs and the investigation-specific SAPs. An overview of sample identification, documentation, and custody as related to data collection activities is presented in Section 9.0.

8.1 Sample Containers, Preservation, and Holding Times

Sample container/media, preservation, and holding time requirements will be presented in the investigation-specific SAPs. Samples will be stored in accordance with the requirements set forth in the referenced analytical method and/or laboratory TIs.

Field samples will be contained and preserved in accordance with appropriate United States Environmental Protection Agency (US EPA) analytical method specifications which are cited in each SAP. Sampling containers and preservatives will be provided by the laboratory. In most cases, the supplied sampling containers will be pre-preserved by the laboratory prior to shipment. On an investigation-specific basis, samples may be filtered and/or preserved at the analytical laboratory. For chemical analyses, sample containers provided will be new pre-cleaned I-Chem® Series 300 (or equivalent). Samples will be placed in individual pre-cleaned containers for shipment to the laboratory.

Sample container orders, when shipped by the laboratory, will include a packing list that details the number and type of bottles shipped, the bottle lot numbers, chemical preservatives, and the packer’s signature. The COC Records will be completed by Field Sampling Personnel and returned to the laboratory with the samples. Sample containers will be individually custody-sealed and placed inside the sample cooler. After the cooler is sealed, sampling personnel will attach signed/dated custody seals to the outside of the cooler as described in TVA *Sample Labeling and Custody* TI (ENV-TI-05.80.02).

Samples will be stored according to the applicable storage criteria from the time of collection until the time of analysis by the laboratory. Field Sampling Personnel will keep samples cold by placing ice in the coolers in which samples will be stored until delivery to the analytical laboratory personnel. After receipt of the samples, it is the laboratory's responsibility to store the applicable samples according to the applicable preservation conditions until preparation and analysis has been initiated.

Samples have a finite holding time (the time between sample collection, sample digestion, and sample analysis) to limit the potential for degradation of the analytes. The holding times for required analyses are measured from the verified time of sample collection. When possible, samples will be shipped by overnight carrier or delivered by same-day courier to minimize the time between collection and laboratory receipt.

8.2 Decontamination

Tools and equipment decontamination procedures are implemented to prevent cross-contamination of samples and to control potential inadvertent transport of hazardous constituents. Disposable sampling equipment will be utilized to the extent possible in an effort to limit the potential for cross-contamination and to reduce labor costs. The non-disposable equipment will be decontaminated using the procedures described in the TVA *Field Sampling Equipment Cleaning and Decontamination* TI (ENV-TI-05.80.05) and/or the investigation-specific SAP.

9.0 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Field Sampling Personnel are responsible for the collection, description, documentation, labeling, packaging, storage, handling, and shipping of samples obtained in the field. These practices are necessary to ensure sample integrity from collection through laboratory analysis and data reporting. To demonstrate and document sample integrity aspects, information relative to the collected project samples will be described and thoroughly documented. Samples will be labeled, packaged, preserved, and shipped to the laboratories for analysis in appropriate sample containers, under the recommended temperature conditions with a COC Record documenting the time and day of sample collection.

Laboratory-supplied sample kits with custody seals, packing materials, sample containers and preservatives will be used for project samples during sample collection and transport to the TVA-contracted laboratories. The sample containers and preservation requirements for samples collected under each investigation will be presented in Attachments E through L to this CUF QAPP.

COC Records will be assigned standardized identification numbers and task codes describing the intended purpose of the sampling event. Attachment D provides specific requirements for sample nomenclature for the CUF EIP.

Samples will be assigned identifications using the sample nomenclature scheme identified in Attachment D of this document. As additional site sampling and monitoring plans are developed, nomenclature will be developed in accordance with the sample locations and naming codes (when necessary) will be generated.

9.1 Sample Documentation

Field activity evidentiary files will be maintained by the Investigation Consultant personnel and will include information that defines the Project in its entirety, including but not limited to, the information below.

- Field logbooks.
- Field data sheets.
- Raw data.
- QC information.
- COC Records.
- Airbills (when used) for sample shipments.
- Photographs.

Field documentation procedures are described in the *Field Record Keeping* TI (ENV-TI-05.80.03) and in the investigation-specific SAPs.

9.1.1 Chain-of-Custody Record

A primary consideration for environmental data is the ability to demonstrate that samples have been obtained from specific locations and have reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody while samples are in the laboratory's possession will be documented by maintaining a COC that records each sample and the individuals responsible for sample collection, shipment, and receipt at the project laboratory. Samples that are collected will be accompanied by a COC Record. An example COC Record is included in Attachment C. The following information will be recorded on the COC Record:

- Project name and number.
- Name of sampler.
- Sample identifier/name, location, date and time collected, and sample type.
- Analyses requested.
- Special instructions and/or sample hazards, if applicable.
- Signature of sampler in the designated blocks, including date, time, and company.
- Sample condition (including temperature) upon receipt as reported by the analytical laboratory.
- Signature of the laboratory receipt personnel in the designated blocks, including date, time, and company affiliation.

Original COC Records are transferred to the analytical laboratories such that sample custody is maintained through analysis and reporting. Copies of COC Records are maintained on site by the Investigation Consultant Field Team Leaders. Duplicates of COC Records are retained by the TVA Technical Lead and .pdf versions of COC Records are maintained by the Data Management Team as part of the Project File.

COC Records will reference defined MAGs to communicate sample analysis requirements to the analytical laboratories. MAGs identify the required analytical methods, parameter lists, and reporting units to ensure consistent reporting of data among multiple laboratories. In addition, MAGs enable automated data completeness evaluation and data verification upon receipt of electronic data. An overview of the data management process is provided in Section 15.0.

For samples collected for chemical, optical, or radiological analyses, field COCs are provided to the QA Oversight Consultant's Data Manager by the Field Sampling Personnel performing the sample collection. EQuIS field sample EDDs are subsequently created to facilitate completeness review upon laboratory submittal of the associated analytical data.

9.1.2 Sample Custody in the Field

The purpose of sample custody procedures is to document the history of samples (and sample extracts or digestates) from the time of sample collection through shipment and sample receipt, analysis, and disposal. A sample is considered to be in one's custody if one of the following conditions applies:

- The sample is in an individual's actual possession.
- The sample is in view after being in an individual's physical possession.
- It was in the physical possession of an investigator and then they secured it to prevent tampering; and/or
- It is placed in a designated secure area.

Each individual Field Sampler is responsible for the care and custody of the samples he/she collects until the samples are properly transferred to temporary storage or are shipped to the laboratory. The following COC procedures will be followed for samples submitted to the laboratory for analyses:

- Each individual field sampler is responsible for the care and custody of samples he/she collects until the samples are properly transferred (relinquished on the COC by a Field Team member) to another person ("acceptor" of the samples) or are shipped to the laboratory.
- A COC Record will be completed at the time of sample collection by the Field Sampling Personnel for each batch of samples submitted to the laboratory in accordance with the *Sample Labeling and Custody* Technical Instruction (ENV-TI-05.80.02). Field sampling logs may be used in the place of formal COCs in the field.
- If multiple coolers are needed, one COC Record will accompany each cooler that contains the samples identified on the COC.
- Sample coolers will be packed and sealed with custody seals for transport from field and shipment to laboratory in accordance with the *Handling and Shipping of Samples* Technical Instruction (ENV-TI-05.80.06).
- Each time a sample batch is transferred (Field Sampling Personnel relinquish custody to the laboratory or other sampling team personnel), signatures of the individuals relinquishing and receiving the sample batch, as well as the date and time of transfer, will be documented on the COC or courier documentation form. Note that commercial courier custody is tracked by commercial courier records and not by COC.
- A copy of the carrier air bill will be retained as part of the permanent COC documentation record.

- The laboratory will record the condition of the sample containers, and cooler temperature upon receipt, and record this information on a combination of sample receipt documentation including a sample receipt confirmation checklist and the COC. Documentation of sample preservation checks (where applicable) will be recorded in the sample preparation documentation.

Changes or corrections to the information documented by the COC Record (including, but not limited to, field sample ID or requested analyses) must be changed by marking through the incorrect information with a single strike through line and, dating, and initialing the change in accordance with the *Field Record Keeping* Technical Instruction (ENV-TI-05.80.03). If the request for a change or correction comes from the Field Team after the COC Records have been relinquished to the laboratory, a copy of the COC Record will be revised, initialed, and forwarded to the laboratory, where the revised version will supersede the original COC Record. This record will be used to document sample custody transfer from the sampler to the laboratory and will become a permanent part of the Project File.

Sample coolers with appropriate custody seals will be shipped to the contract laboratory in a timely fashion to ensure proper thermal preservation and meet analytical method holding times.

9.2 Sample Packaging and Shipment

Samples will be packed and shipped to the laboratory in accordance with applicable U.S. Department of Transportation (US DOT) regulations, consulting corporate guidelines, and International Air Transport Association (IATA) standards (as detailed in the most current edition of *IATA Dangerous Goods Regulations* for hazardous materials shipments), as applicable.

Samples that are to be stored at a temperature < 6 degrees Celsius (°C) (not frozen) will be placed on wet ice within 15 minutes of sample collection and packaged with additional wet ice for shipment to the analytical laboratory. Samples requiring temperature preservation at < -10°C are packaged with dry ice for shipment to the analytical laboratory.

9.3 Sample Custody in the Laboratory

The following subsections describe the COC procedures associated with sample receipt, storage, tracking, and documentation by the laboratory.

9.3.1 Sample Receipt

A designated Laboratory Sample Custodian will be responsible for samples received at the laboratory. The Laboratory Sample Custodian will be familiar with custody requirements and the potential hazards associated with environmental samples. In addition to receiving samples, the Laboratory Sample Custodian will also be responsible for documenting sample receipt, maintaining samples at < 6 °C during the sample log-in process, storage at < 6 °C (< -10 °for frozen samples) before and after sample analysis, and the proper disposal of samples. Upon sample receipt, the Laboratory Sample Custodian will:

- Inspect the sample containers for integrity and ensure that custody seals are intact on the shipping coolers. The temperature of the samples upon receipt and the presence of leaking or broken containers will be noted on the COC Record/sample receipt forms.

- Sign (with date and time of receipt) the COC/sample analysis request forms, thereby assuming custody of the samples and assign the laboratory sample identification numbers.
- Compare the information of the COC Record/sample receipt with the sample labels to verify sample identity. Any inconsistencies will be resolved through the Laboratory Coordinator before sample analysis proceeds.
- Store samples in accordance with Section 9.3.2.

The QA Oversight Manager and Laboratory Coordinator must be notified immediately via e-mail or documented telephone call when samples are received broken or improperly preserved. Samples received in a condition that may potentially impact results will be placed on hold pending direction from the QA Oversight Manager or Laboratory Coordinator. In the event that aqueous samples for metals analyses are received at pH > 2, acid preservative will be added in the originally received sample bottleware by the laboratory and the pH of the samples will be allowed to equilibrate in the originally received bottleware for a minimum of 24 hours prior to digestion. Sample preservation and equilibration will be fully documented via laboratory logbooks.

9.3.2 Sample Storage

Analytical samples will be stored in a locked facility and maintained within the appropriate temperature range as specified in US EPA SW-846 Chapter 3, or Table II of 40 CFR 136.3 sample storage requirements. The temperature will be monitored and recorded daily by laboratory personnel.

Required sample storage conditions are presented in Attachments E through L of this CUF QAPP.

9.3.3 Sample Tracking

Each sample will receive a unique laboratory sample identification number at the laboratory when the sample is logged into the laboratory information management system (LIMS).

Sample preparation/digestion records will be generated to fully document sample handling prior to analysis. Laboratory data will be entered on the sample digestion form and permanently recorded in a laboratory logbook.

The laboratory will maintain a sample tracking system that documents the following:

- Organization/individual who performed sample analyses.
- Date of sample receipt, extraction or digestion, and analysis.
- Names of Analysts.
- Sample preparation procedures.
- Analytical methods used to analyze the samples.
- Calibration and maintenance of instruments.
- Deviations from established analytical procedures, if applicable.

- QC procedures used to ensure that analyses were in control during data generation (instrument calibration, precision checks, method standards, method blanks, *etc*.).
- Procedures used for the calculation of precision and accuracy for the reported data.
- Statement of quality of analytical results.

9.4 Sample Archive

Upon request, unused portions of samples may be requested by TVA from the laboratory for archival. Archived samples will be shipped under COC and relinquished to the TVA Technical Lead or designee. The sample archive will be equipped to properly maintain thermal preservation of the samples and will be locked or in an access controlled locations such that sample custody is maintained.

Unused portions of samples collected in association with the CUF EIP may be returned to TVA for archive or disposal or may be disposed of by the contract laboratories. Archived samples will be cataloged and stored in an organized manner. In the event that project objectives are not met for a sample, any remaining portion with preparation/analytical holding time remaining may be retrieved and submitted to a TVA contracted laboratory for additional analysis.

10.0 ANALYTICAL METHODS REQUIREMENTS

Analytical methods cited in this CUF QAPP reference US EPA's *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846); US EPA Clean Water Act Test Methods; and *Standard Methods for the Examination of Water and Wastewater*. These and potentially other methods, constituents, and reporting limits for samples collected under this EI are presented in Attachments E through L of this CUF QAPP. Analytical methods will be selected based on the ability to detect constituents of concern at reporting limits sufficient to meet project requirements and quality objectives for precision, accuracy, and sensitivity.

10.1 Field Analysis

Field analyses will be conducted in accordance with the associated field sampling TIs and/or published field method as applicable. The results from field analysis are reviewed and stored electronically.

Detailed descriptions of field monitoring activities, the field analytical equipment, and the sampling equipment utilized to perform the field activities are provided in the investigation-specific SAPs and/or in the associated TVA TIs.

10.2 Laboratory Analysis

To support the objectives of the CUF EIP, the collected samples will be tested for the methods, constituents, and reporting limits presented in Attachments E through L of this CUF QAPP. Individual sample reporting limits may vary from the laboratory's routinely reported limits; this variance may be a result of dilution requirements, sample weight or volume used to perform the analysis, dry-weight adjustment for solid samples, the presence of analytical background contaminants, or other sample-related or analysis-related conditions. Additional analytical needs may be identified based on future project needs, and as such, the CUF QAPP and SAPs will be modified to document the QC requirements associated with these additional analyses.

Dissolved metals analysis of aqueous samples shall be performed on field-filtered (0.45-μm filter) select water samples. Alternatively, dissolved metals analysis of aqueous samples may be performed on a sample that has been filtered in the laboratory. In the event that laboratory filtration is required, sample aliquots collected for dissolved metals analyses will be preserved after filtration and these preserved aqueous samples will be allowed to equilibrate a minimum of 24 hours between sample preservation and digestion.

For some investigations, a filtered and nonfiltered sample aliquot may be submitted for all requested analytical parameters. In the event that the filtered and nonfiltered aliquots are not assigned distinct sample identifications (IDs), each parameter will be identified as either "total" (*i.e.*, nonfiltered) or "dissolved" (*i.e.*, filtered) in the project database.

The reporting limits indicated in Attachments E through L of this CUF QAPP shall represent the maximum reporting limits (not adjusted for sample weight/volume, dilution factors, and percent moisture for non-aqueous samples).

All analytical methods performed by the TVA-contracted laboratory must have valid method detection limit (MDL) studies and MDL verifications by matrix type, by preparation method, and by analytical method. MDL studies must include all preparatory and analytical processes used for the preparation and analysis of investigative samples. Formal MDL evaluations must be performed at the frequency dictated by the current US EPA-promulgated procedures or the current The NELAC Institute (TNI) laboratory accreditation standard or the frequency dictated below, whichever is more frequent. TVA's contracted laboratories will conduct MDL studies in accordance with the current TNI laboratory accreditation standard as described below.

The initial MDL study will include a minimum of seven spiked replicates prepared and analyzed in a minimum of three separate batches, spaced over the course of three separate calendar days. If an MDL is to be determined over more than one instrument, each instrument must have at least two analyses on two different calendar days. For an analyte to be considered detected during an MDL study it must meet the analytical method's qualitative identification criteria without any manual searching routines. Only analyses associated with acceptable initial calibration, continuing calibration, and batch QC can be used. The MDL based on spiked replicates will be calculated as follows:

$$MDL_s = t_{(n-1,1-\alpha=0.99)} S$$

Where: MDL_s = MDL based on analysis of replicate spikes,
t = Students 99th percentile single-tailed t-value and
S = the sample standard deviation of the replicate analyses.

If the calculated MDL_s for any analyte is less than 10% the concentration of the spiked concentration, repeat the study for that analyte at a lower spike concentration. If the calculated MDL_s is higher than the spiked concentration, the study must be repeated at a higher spike concentration from the original study.

In addition to the spiked samples, an MDL will be determined using method blank results (MDL_b). The initial MDL_b determined using the method blanks will be a minimum of seven method blanks prepared and analyzed in at least three separate batches, spaced over the course of three separate calendar days. If an MDL_b is to be determined over more than one instrument, each instrument must have at least two analyses on two different calendar days. For an analyte to be considered detected during an MDL study it must meet the analytical method qualitative identification criteria without any manual searching routines. Only analyses associated with acceptable initial calibration, continuing calibration, and batch QC can be used.

If the analytical system for which the MDL_b is being determined gives numeric results for every analysis, the MDL_b will be calculated as follows:

$$MDL_b = \overline{X} + t_{(n-1,1-\alpha=0.99)} S$$

Where: $\overline{X}$ = the mean of the method blank results,
t = Students 99th percentile single-tailed t-value and
S = the sample standard deviation of the replicate analyses.

If the analytical system for which the MDL_b is being determined gives censored results or otherwise gives numeric results for some, but not all method blanks:

- If fewer than 101 numeric method blank results are available, set the MDL_b to the highest method blank result.

- If more than 100 numeric method blank results are available, set the MDL_b to the level that is no less than the 99th percentile of the method blank results.

MDL_s and MDL_b must be compared and the higher value utilized for MDL reporting.

The MDL is to be verified annually through the quarterly analysis of standards spiked at the same concentration used to determine MDL_s. For verification analyses for a pooled MDL for more than one instrument, each instrument must have at least two analyses, prepared in different batches and analyzed on separate days. MDL verification analyses must meet the analytical method qualitative identification criteria, again without any manual searching routines. Only analyses associated with acceptable initial calibration, continuing calibration, and batch QC can be used.

On an annual basis, the MDL calculation is to be repeated using the results from the quarterly spiked samples and method blanks. The resulting MDL is to be compared to the initially derived MDL. If the repeated MDL is within a factor of 0.5 to 2.0 of the existing MDL, and fewer than 3% of the method blank results have numerical results above the existing MDL, then the initially derived MDL may be left unchanged. Otherwise, adjust the MDL to the new repeated MDL.

To add a new instrument, the new instrument must have at least two spike analyses and at least two method blanks. The new spike results would be combined with the existing results and a new MDL_s would be calculated. If the new MDL_s is within a factor of 0.5 to 2.0 of the existing MDL, then the initially derived MDL_s may be left unchanged. If all method blank analyses are below the existing MDL and the MDL_s meets the criteria described above, the MDL may be left unchanged. Otherwise, adjust the MDL to the new MDL. Once 6-months of blank data have been generated on a new instrument, MDLs will be evaluated to assess the need for adjustment.

The laboratory will perform a percent moisture analysis on solid and biological samples where possible. Chemical analysis results for solid samples will be reported on a dry-weight basis unless specifically requested otherwise. Radiological activities and physical/optical analysis results will not be corrected for sample moisture. The reporting basis (wet-weight, dry-weight, *etc*.) will be maintained as an attribute of the result in the database.

11.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

This section describes the data objectives and associated data quality indicators used for the project. QA procedures are designed to ensure high quality for all environmental data associated with this project.

The subsections below are intended to provide an introduction to site-wide QA objectives and protocols and set forth minimum requirements for the CUF EIP. Specific quantitative QA objectives for each investigation are presented in Attachments E through L of this CUF QAPP.

11.1 General

There are four levels of data quality that have been developed for this project. The data quality levels defined below provide general indications of measurement defensibility. The data quality level of a particular measurement is used to determine whether that measurement is sufficient to meet the program-specific DQOs.

Field Screening – This level is characterized by the use of portable analytical instruments (such as temperature probe) which can provide real-time data to assist in the optimization of sampling locations and health and safety support. Data can be generated regarding the presence or absence of certain contaminants at sampling locations.

Field Analyses – This level is characterized by the use of portable analytical instruments, which can be used on site (such as Hydrolab® instrument) or in a mobile laboratory stationed near a site. Depending on the types of contaminants, sample matrix, and personnel skills, qualitative and quantitative data can be obtained.

Screening Data with Definitive Confirmation – These data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provides analyte identification and quantitation, although the quantitation may be relatively imprecise. At least 10% of the screening data will be confirmed using appropriate analytical methods and QA/QC procedures and criteria associated with definitive data. Screening data without associated confirmation data is not considered to be data of known quality.

Definitive Data – These data are generated using rigorous analytical methods, such as approved US EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. These methods produce tangible raw data (such as chromatograms, spectra, or digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated by an on-site or off-site laboratory, as long as the QA/QC requirements are satisfied. To be definitive, either the analytical or total measurement error must be determined.

Field Screening data will be obtained with portable instruments, such as conductivity meters, temperature probes, and may be used for health and safety and field operational monitoring. In addition, these instruments and field test kits may be used to produce Field Analysis data to determine where to collect a sample to assess impacts and identify which samples are to be designated for laboratory confirmation analyses.

Field pH measurements for aqueous samples will be performed in accordance with TVA TI *Field Measurement Using a Multi-Parameter Sonde* (ENV-TI-05.80.46) and U.S. EPA SW-846 Method 9040C, and the associated investigation-specific SAP. Field pH meters used for collecting aqueous sample data will also meet the calibration requirements of these procedures including calibration adjustment to account for buffer temperature during calibration. Field-collected pH measurements for aqueous samples will be considered field analysis data and are appropriate for quantitative use. Field pH measurements for soil samples will be conducted using pH kits or equivalent with confirmation samples submitted to the fixed-base analytical laboratory for definitive analysis.

Attainment of qualitative data indicators is assessed by monitoring QA measures, such as precision, accuracy, representativeness, comparability, and completeness, as discussed in Section 19.0. Specific qualitative criteria for the chemical analyses to be performed in association with the CUF EIP are presented in Attachments E through L of this CUF QAPP. The objectives associated with accuracy and precision of laboratory results are assessed through an evaluation of the results of QC samples. The accuracy of field measurements will be assessed by calibration, as described in the associated field TIs.

11.2 Field and Laboratory Quality Control Samples

The quality of data collected in the field will be controlled, monitored, and verified by maintaining site logs, by documenting field activities, and by collecting and analyzing of QC samples concurrently with investigative samples. Field and laboratory QC samples will be used to assess accuracy and precision for chemical analyses to gauge both field and laboratory activities. Further discussion and equations for determining accuracy and precision may be found in Section 19.0 of the CUF QAPP. In addition, specific requirements for comparability, completeness and representativeness of field and laboratory QC samples may be found in Section 19.0 of the CUF QAPP. QC samples will be used to assess laboratory performance and gauge the likelihood of cross-contamination associated with both field and laboratory activities.

The subsections below apply to chemical analyses performed on aqueous, solid, and biological samples associated with the CUF EIP.

QC samples will be collected and analyzed in conjunction with samples designated for laboratory analysis. The QC checks that may be instituted by field and laboratory personnel may include, but not be limited to, the following:

- Equipment Rinsate Blanks.
- Field Blanks
- Filter Blank Samples
- Field Duplicate Samples.
- MS/MSD Samples.
- Laboratory Method Blanks.
- LCSs/Laboratory Control Sample Duplicates (LCSDs).
- Laboratory Duplicate Samples.

These types of QC samples are discussed in the following subsections. Field QC samples will be submitted to the laboratory using the same information as the associated investigative samples.

Field QC samples will be collected at the frequency specified on Table 11-1. Laboratory QC samples will be analyzed at the frequency specified in the associated laboratory SOPs and referenced analytical methods. The analysis frequencies specified below are considered the minimum required frequencies; investigation-specific Work Plans and/or SAPs and/or TIs may require more frequent collection of field QC samples.

Table 11-1. Field Quality Control Sample Minimum Frequency

Field QC Sample	Aqueous Sampling Frequency	Solids Sampling Frequency	Biological Sampling Frequency
Equipment Rinsate Blank	1 per sampling event	1 per 20 field samples	Prior to use for decontaminated equipment
Field Blank	1 per day of sampling activity	N/A	N/A
Filter Blank	1 per sampling event when dissolved parameters are collected for analysis and 1 per lot of filters used	N/A	N/A
Field Duplicate[a]	1 per 20 field samples; minimum of 1 per sampling event	1 per 20 field samples; minimum of 1 per sampling event	1 per 20 field sample aliquots or 1 per species (when possible)
MS/MSD or Laboratory Duplicate[b]	1 per 20 field samples; minimum of 1 per sampling event	1 per 20 field samples; minimum of 1 per sampling event	1 per 20 field sample aliquots or 1 per species[d] (when possible)

N/A Not Applicable
[a] True field duplicate samples are not feasible for whole ash/sediment cores (depending on volume recovered), or biological specimens; consequently, co-located samples will be collected when possible.
[b] Laboratory duplicate analyses will be performed in lieu of MS/MSD for parameters not amenable to spiking (*e.g.*, pH, total dissolved solids [TDS]).
[c] Filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.
[d] Sufficient biological sample mass is not always available to perform an MS/MSD pair; when sufficient mass does not exist, the laboratory will perform LCS/LCSD.

11.2.1 Equipment Rinsate Blanks

Collection and analysis of equipment rinsate blanks are performed to assess the efficiency of field equipment decontamination procedures in preventing cross-contamination between samples. Laboratory-supplied analyte-free reagent water will be poured into/through/over clean (decontaminated) sampling equipment used in the collection of investigative samples and subsequently collected into prepared sample bottles. For biological specimens, equipment rinsate blanks will be used to monitor decontamination of holding tanks, processing equipment or similar laboratory equipment; equipment blanks associated with biological specimens will be collected prior to specimen introduction. For Vibecore® sampling and other sediment/soil core sampling, analyte-free reagent water will be poured through Lexan® tubing. The rinsate blank will be analyzed for the same parameters as the investigative samples.

11.2.2 Field Blanks

Field blanks are used to assess the potential for cross-contamination of aqueous samples during the sampling process due to ambient conditions and to validate the cleanliness of sample containers. The collection of field blanks is recommended if known or suspected sources of contamination are located within close proximity to the sampling activities. Field blank samples will be generated using laboratory-supplied deionized water.

11.2.3 Filter Blank Samples

Filter blanks are samples of laboratory-supplied deionized water passed through in-line filters used in the collection of dissolved metals (and other analytes requested on a filtered basis).

11.2.4 Field Duplicate Samples

Field duplicate samples are used to check for sampling and analytical error, reproducibility, and homogeneity. For soil or sediment samples, the duplicate will be obtained by collecting a sample from an area adjacent to the routine sample (that is, co-located sample), or by collecting a separate aliquot of homogenized soil or sediment from within the same core, whichever is more appropriate for the type of sample/sampling technique (surface or subsurface sediment sample). For biological specimens, the duplicate will be obtained by collecting additional specimen(s) from a particular area. Duplicates will be analyzed for the same parameters as the associated investigative samples.

11.2.5 Matrix Spike/Matrix Spike Duplicate

MS/MSD samples are investigative samples to which known amounts of compounds are added in the laboratory before extraction/digestion and analysis. The recoveries for spiked analytes can be used to assess how well the method used for analysis recovers target analytes in the site-specific sample matrix, a measure of accuracy. Additionally, the relative percent difference (RPD) between the results of the MS and MSD provide a measure of precision. In the event that sufficient sample volume to perform MS/MSD analyses is not provided, the laboratory may substitute LCS/LCSD analyses (see Section 11.2.7).

For parameters that are not amenable to spiking (*e.g.*, pH, total dissolved solids [TDS]), a laboratory duplicate (see Section 11.2.8) will be used to demonstrate matrix-specific precision.

11.2.6 Laboratory Method Blanks

Method blanks consist of analyte-free materials (such as reagent water) and reagents (such as sodium sulfate) that are prepared in the same manner as the associated samples (digested, extracted, *etc*.) and that are analyzed and reported in the same manner as the associated investigative samples. Laboratory method blanks will be performed as indicated in the analytical method and in the associated laboratory SOPs.

11.2.7 Laboratory Control Samples/Laboratory Control Sample Duplicates

An LCS is a sample of laboratory certified material that is fortified (spiked) with the analytes of interest or a certified reference material that is prepared and analyzed in the same manner as investigative samples. The LCS must be from a source that is different from the source of the initial calibration standards (that is, second-source). LCS data are used to monitor analytical accuracy and laboratory performance. LCSs are prepared and analyzed with each preparation batch of 20 (or less) field samples. In the event that insufficient sample volume to perform MS/MSD analyses (Section 11.2.5) is received, an LCSD will be prepared to assess laboratory precision. LCS will be performed at a minimum frequency of 1 per batch of 20 (or fewer) field samples or as required by the referenced analytical method and as specified in the associated laboratory SOPs.

11.2.8 Laboratory Duplicate Samples

A duplicate sample is obtained by splitting a field sample into two separate aliquots and performing separate preparation and analysis on the respective aliquots. The analysis of laboratory duplicate samples monitors precision; however, precision may be affected by sample homogeneity, particularly in the case of solid samples. Laboratory duplicates will be analyzed and reported with every batch of 20 (or fewer) field samples. MSDs (see Section 11.2.5) may be substituted for laboratory duplicates for inorganic analyses. The laboratory will utilize a project sample for the laboratory duplicate in every batch that includes project samples.

12.0 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

12.1 Field Equipment

Equipment failure will be minimized by routinely inspecting field equipment to ensure that it is operational and by performing preventive maintenance procedures. Field sampling equipment will be inspected prior to sample collection activities by the Field Sampling Personnel and necessary repairs will be made prior to use of the sampling equipment. Routine preventive maintenance procedures, at a minimum, will include removal of foreign debris from exposed surfaces of the sampling equipment, storage of equipment in a cool dry place protected from the elements, inspections of the equipment each day prior to use, and verification of instrument calibrations as described in Section 13.0.

Field equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be obtained from a contracted equipment supplier. All equipment will be serviced in accordance with the manufacturer’s specified recommendations or written procedure based on the manufacturer’s instructions or recommendations. Maintenance will be performed in accordance with the schedule specified by the manufacturer to minimize the downtime of the measurement system. Maintenance work will be performed by qualified personnel.

Field equipment will be maintained in good working order to minimize downtime while fieldwork is in progress. Field equipment will be maintained under service contract for rapid instrument repair or provision of backup instruments in the case of instrument failure.

Non-routine maintenance procedures require field equipment be inspected prior to initiation of fieldwork to determine whether or not the equipment is operational. If not operational, the equipment will be serviced or replaced by a contracted equipment provider. Batteries will be fully charged or new, as applicable.

The ability to collect valid samples requires that field equipment be appropriately cleaned and maintained. The elements of an effective maintenance program are identified below.

- Pre-cleaned or certified-clean equipment.
- Spare parts or service contract for equipment repair or replacement.
- Contingency plan.
- Maintenance and repair of non-dedicated equipment.

12.2 Supplies and Consumables

Field supplies and consumable items (including, but not limited to, pre-cleaned containers, preserved containers, tubing, and filters) will be inspected upon receipt. Certificates of cleanliness for consumables provided by the laboratory will be retained on file at the laboratory. Chemical preservatives provided in pre-preserved containers will be certified by the laboratory prior to use. Certificates of cleanliness for supplies and lot numbers of supplies obtained by the Field Team will be retained by Investigation Consultant personnel as part of the project records. All supplies and consumable materials will be certified clean to levels sufficient to meet data objectives for the associated investigation.

12.3 Laboratory Equipment

The ability to generate valid analytical data requires that analytical instrumentation be properly maintained. The laboratory will be responsible for appropriate maintenance for major instruments. The elements of an effective maintenance program are identified below and discussed in the following subsection:

- Instrument maintenance logbooks.
- Instrument maintenance and repair.
- Available spare parts.
- Contingency plans.

Periodic preventive maintenance is required for sensitive equipment. Instrument manuals will be kept on file for reference when equipment needs repair. The troubleshooting sections of factory manuals may be used to assist personnel in performing maintenance tasks.

Major instruments in the laboratory are covered by annual service contracts with manufacturers or other qualified personnel (internal or external). Under these agreements, regular preventive maintenance visits are made by trained service personnel. Maintenance is documented and maintained in permanent records by the individual responsible for each instrument.

The calibration and maintenance sections of the laboratories' SOPs will establish the schedule for servicing critical items to minimize the downtime of the measurement system. The laboratory will adhere to the maintenance schedule and will promptly arrange any necessary service. Qualified personnel will perform the required service.

12.3.1 Instrument Maintenance Logbooks

In the laboratory, each analytical instrument will be assigned an instrument logbook. Maintenance activities will be recorded in the instrument logbook and the information entered will include:

- Date of service.
- Person performing the service.
- Type of service performed and reason for service.
- Replacement parts installed (if applicable).
- Miscellaneous information.

If service is performed by the manufacturer or its representative, a copy of the service record will be inserted into the page immediately following the logbook page where the above-cited information has been entered.

12.3.2 Instrument Calibration and Maintenance

An overview of the routine calibration procedures used for analytical instrumentation is presented in Section 13.0. Preventive maintenance and calibration by manufacturer service representatives will be provided on a routine basis.

In addition to maintenance by manufacturer service representatives, procedures for routine maintenance in accordance with manufacturer specifications for each analytical instrument will be followed by the laboratory. These procedures will include maintaining inventories of spare parts used routinely (such as spare torches for inductively coupled plasma/mass spectrometry [ICP/MS] instruments). Instrument operators have the responsibility to ensure that an acceptable inventory of spare parts is maintained.

Instrument calibration and maintenance procedures will be conducted in accordance with the laboratory's QA Program and the specific calibrations sections of the laboratory's analytical SOPs.

13.0 INSTRUMENT CALIBRATION AND FREQUENCY

This section provides the requirements for calibration of measuring and test equipment/instruments used in field sampling and laboratory analysis. The calibration procedures stipulated in the CUF QAPP are designed to ensure that field equipment and instrumentation are calibrated to operate within manufacturer specifications and that the required traceability, sensitivity, and precision of the equipment/instruments are maintained. Measurements that affect the quality of an item or activity will be taken only with instruments, tools, gauges, or other measuring devices that are accurate, controlled, calibrated, adjusted, and maintained at predetermined intervals to ensure the specified level of precision and accuracy.

In general, instrument calibration will be conducted in accordance with manufacturer's recommendations, method requirements, and field TIs or laboratory SOPs.

13.1 Field Equipment Calibration and Procedures

Field instruments that may be used include, but are not limited to, the following:

- Multi-parameter Sonde Water Quality Meter.
- Oxidation Reduction Potential Meter.
- Dissolved Oxygen Meter.
- Water Flow Meter.
- Depth-to-Water Level Meter.
- Turbidimeter.

All field analytical equipment used to conduct monitoring will be calibrated/standardized daily prior to use. The calibration/standardization procedures for field instrumentation are described in the calibration section of the applicable field TIs. The calibration/standardization acceptance criteria for field instruments are provided in the applicable TVA TIs.

Personnel performing instrument calibrations/standardizations shall be trained in its proper operation and calibration. Records of instrument calibration/standardization will be maintained by the Investigation Consultant Field Team Leader and will be subject to audit by the Field Oversight Coordinator or designee. The Investigation Consultant Field Team Leader will maintain copies of the instrument manuals on site.

The calibration records will include documentation of the following information:

- Instrument name and identification number.
- Name of person performing the calibration.
- Date of calibration.
- Calibration points.
- Results of the calibration.
- Manufacturer lot number of the calibration standards.
- Expiration dates for the calibration standards, when applicable.

Field equipment will be properly inspected, charged, and in good working condition prior to the beginning of each working day. Prior to the start of each working day, the Investigation Consultant Field Team Leader will inspect equipment to ensure its proper working condition. If equipment is not in the proper working condition, the Investigation Consultant Field Team Leader must repair or replace the equipment prior to the start of field activities. Field equipment and instruments will be properly protected against inclement weather conditions during the field work. At the end of each working day, field equipment and instruments will be properly decontaminated, taken out of the field, and appropriately placed for overnight storage and/or charging.

Field-collected pH measurements for aqueous samples will be considered field analysis data and are appropriate for quantitative use. Field-collected pH measurements for solid samples will be considered field screening data. Field pH measurements for aqueous samples will be conducted using calibrated instrumentation sufficient to meet the requirements of SW-846 Method 9040C. In addition to the TVA and method requirements, post-calibration checks will be performed on pH 4.0 and pH 10.0 buffer solutions. All post-calibration checks (pH 4.0, 7.0, and 10.0) will be subject to an acceptance criterion of ±0.05 pH units. Aqueous sample pH measurements will not be conducted until the pH meter is calibrated within these acceptance criteria. Field pH measurements for solid samples will be conducted using pH test kits or equivalent; samples will be subsequently submitted to a fixed-base laboratory for definitive pH analysis.

Dissolved oxygen meter calibration will be conducted using a single-point water-saturated air method in accordance with the instrument manufacturer's recommendations.

Calibration checks may suggest the need for maintenance or calibration by the manufacturer. Field instruments that do not meet the calibration requirements will be taken out-of-service until acceptable performance can be verified. Maintenance will be performed when the instrument will not adequately calibrate. Maintenance of field equipment will be noted in an instrument logbook or field notebook.

Field equipment calibration is addressed in greater detail in the TIs associated with each field investigation or monitoring activity.

13.2 Laboratory Equipment Calibration

Instruments and equipment used in the laboratory will be controlled by a formal calibration program as described in the laboratory's Quality Assurance Manual. The program will verify that the equipment has the proper calibration range, accuracy, and precision to generate data comparable with specific requirements. Calibration will be performed by laboratory personnel experienced in the referenced methods for the analysis of project samples for the constituents of concern.

Instrument calibration procedures and corrective actions are described in the calibration section of the associated laboratory SOP. At a minimum, laboratory instrument calibration will be performed in accordance with the associated technical and quality control requirements specified in the method applicable to the associated SAPs.

The laboratory will provide all data and information to demonstrate that the analytical system was properly calibrated at the time of analysis, including calibration method, required frequency, source of standards, response factors, linear range, check standards, and applicable control limits, as part of the data deliverables.

Before any instrument is used as a measuring device, the instrument's response to reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. Preparation of reference materials used for calibration will be documented in a laboratory notebook.

The two types of laboratory instrument calibration are initial calibration and continuing calibration verification. Initial calibration procedures establish the calibration range of the instrument. Typically, multiple analyte concentrations are used to establish the calibration range and calibration data. The laboratory evaluates the resulting calibration data as detailed in the calibration section of the associated SOP.

Continuing calibration verification usually measures the instrument's response to fewer calibration standards and requires instrument response to fall within certain limits of the initial measured instrument response. Continuing calibration verification may be used within an analytical sequence to verify stable calibration throughout the sequence and/or to demonstrate that instrument response did not drift during a period of non-use of the instrument.

The QA measures in the calibration section of the associated laboratory SOP will be used for calibration, calibration verification, and subsequent sample analyses. In addition, the following procedures will be used for the calibration of balances and thermometers.

Laboratory balances will be calibrated and serviced annually by a certified contractor. Balances will undergo a calibration check prior to use each day using multiple S-Class or equivalent class weights that bracket the usage range. A record of calibrations and daily checks will be documented.

Oven and refrigerator thermometers will be calibrated annually against a National Institute of Standards and Technology- (NIST-) certified thermometer in the range of interest. Annual calibrations will be documented. Daily oven and refrigerator readings will be recorded. Thermometers must be tagged with any applicable correction factors.

Records will be maintained as evidence of required calibration frequencies, and equipment will be marked suitably to indicate calibration status. If marking on the equipment is not possible, records traceable to the equipment will be readily available for reference.

14.0 DATA ACQUISITION REQUIREMENTS FOR NON-DIRECT MEASUREMENTS

Historical and legacy data will be gathered and evaluated for acceptability prior to use in the CUF EIP and inclusion in the EAR. Historical and legacy data may be procured from several sources, including TVA and TDEC records or TVA-led investigations performed outside the scope of the CUF EIP. Historical and legacy chemical data of known quality/defensibility may be used quantitatively as supplemental information to design specific investigation or for human health and ecological risk assessments. Chemical data are considered of known quality/defensibility if sample collection information and data deliverables are available to substantiate the reported analytical results. Historical and legacy data of unknown quality may be used for qualitative purposes.

Historical and legacy geotechnical data of known quality/defensibility may be used quantitatively as supplemental information to planned investigations under the CUF EIP. The quality/defensibility of geotechnical data will be determined by qualified personnel (*i.e.*, Professional Engineer or Professional Geologist) depending on the type of data requiring evaluation. Generally, these data will be compared against changes in site conditions, changes in the state of practice (*e.g.,* revisions/updates to standard methods), and changes in governing standards (*e.g.*, technical standards or professional guidelines) since the data were generated and also will be compared to more recently collected data for consistency of results.

Historical and legacy data will be transmitted in its original format whenever possible. In addition, raw data and other supporting documentation is acquired and may be validated if appropriate or feasible.

Historical and legacy data that are determined to be intended for quantitative use will be subjected to a formal critical review process. Historical data will minimally be subjected to a reasonability review to identify potentially suspect data, apparent anomalies, or data that are not representative of current site conditions. Additional evaluation and/or validation may be conducted following the reasonability review; the level of review and validation conducted will be dependent on the data type, availability of supporting documentation, and criticality of the dataset for completing project objectives. In the event that historical or legacy data cited in the CUF EIP cannot be substantiated, the data may not be suitable to support certain aspects of the investigation, and new data may be collected to supplement the historical/legacy data.

TVA, QA Oversight, and Investigation Consultant subject-matter experts will cooperatively develop formal criteria for evaluating historical data sets for potential quantitative use in the EAR.

15.0 DATA MANAGEMENT

A comprehensive Data Management Plan has been developed for all data generated and used under the TVA Multi-Site Order. Consolidated management of data related to the Order will ensure that environmental data associated with the EIs are appropriately maintained and accessible to data end users. The Data Management Plan will provide a basis for supporting a full technical data management business cycle from pre-planning of sampling events to reporting and analysis with a particular emphasis on ensuring completeness, data usability, and most importantly defensibility of the data.

Historical data and data generated from EI collection events at each facility addressed in the Order will be consolidated in the single EQuIS database. The EQuIS database will implement QA procedures at each step in the data transfer process to ensure that a complete, correct data set is maintained. A detailed description of the various elements of the data management program is presented in the Data Management Plan. In addition, the Data Management Plan describes sample planning and tracking process and details the flow of field and laboratory data into the project database. Finally, the Data Management Plan describes the process by which errors in data already reported in the project database are rectified and how those changes are managed and documented.

16.0 ASSESSMENTS AND RESPONSE ACTIONS

The primary goal of the CUF QAPP is to ensure that project data objectives are met and that defensible, high-quality, analytical data are generated for use decision-making processes. The CUF QAPP includes systems and performance audits to ensure that established QA procedures are properly implemented.

The CUF QAPP will be distributed to each consultant and contractor responsible for the collection, generation, and interpretation of field and analytical data. The QA Oversight Manager or designee will be responsible for ensuring that necessary revisions are made so that the CUF QAPP is up-to-date with actual practices and will ensure that revisions and updates are provided to everyone on the distribution list. The document control format used in the CUF QAPP will identify the revision number and revision date. A revision history that identifies each revision and a summary of the revision will be maintained.

16.1 Field Activities

Field QA will include (but not be limited to) the following:

- Instrument calibration.
- Documentation of sample collection and field conditions.
- Adherence to COC procedures.
- Adherence to the CUF QAPP, the investigation-specific SAPs, and the associated field TIs.
- Collection of field QC samples.

The QA review for usability of objective field data will be performed at two levels. For the first level, data will be reviewed at the time of collection by following SAPs and TVA TIs. For the second level, after data reduction to table format or arrays, the data will be reviewed for inconsistent values.

Any inconsistencies identified during data review will be investigated by the Field Team Leader. When possible, the Investigation Consultant Field Team Leader will seek clarification from the Field Sampling Personnel responsible for collecting the data. Resolution of discrepancies will be documented using the corrective action process detailed in Section 16.4.

Field data will be reviewed for reasonableness and completeness. In addition, random checks of sampling and field conditions will be made to check recorded data at that time to confirm the recorded observations. Whenever possible, peer review will also be incorporated into the QA review process in order to maximize consistency among Field Sampling Personnel.

Any observed discrepancies between the COC Record and the samples received will be documented by the laboratory, and the TVA Technical Lead, QA Oversight Manager, and the Investigation Consultant Field Team Leader will be contacted for resolution.

The field COC Record information will be initially keyed into and maintained in the laboratory's database. A copy of the laboratory's COC Record, referred to as sample receipt confirmation, will be sent to the QA Oversight Manager and Data Manager following sample login for verification of properly entered and COC Record requests and information such as sample identification numbers, analyses requested, and the quantity of samples. In case of discrepancies between the COC Record and the sample receipt confirmation, the appropriate revisions will be communicated to the laboratory for the appropriate COC Record corrections. Corrected information on the COC Record will be recorded into the project data management system.

16.2 Laboratory Analysis

Internal laboratory QA will consist of the following:

- Instrument performance checks.
- Instrument calibration and calibration verification.
- Retrieval of documentation pertaining to instrument standards, samples, and data.
- Adherence to the CUF QAPP and the associated laboratory SOPs.
- Documentation of sample preservation, transport, and analytical methodology.
- Adherence to the analytical methodology (at a minimum).
- Analysis of QC samples (discussed in Section 11.2).

The samples received by the laboratory will be handled in accordance with internal laboratory QC procedures. The laboratory's deliverables, on submission to Data Validators, will be verified and/or validated with guidance from the National Functional Guidelines. Data package completeness will be assessed and missing or incomplete information will be obtained from the laboratory. Any incorrect data will be corrected. Data usability will be evaluated and appropriate qualifiers will be added to the database. Any data deemed unreliable by data validation efforts due to imprecision, holding time exceedances, and failure of relevant QC measures will be qualified appropriate and/or not utilized for the project.

16.2.1 Data Reduction

Data reduction is performed by the individual Analysts and consists of calculating concentrations in samples from the raw data obtained from the measuring instruments. Data reduction complexity is dependent upon the specific method and the number of discrete operations (extractions/digestion, dilutions, and levels/concentrations) involved in obtaining a sample that can be measured.

For analytical methods, sample response will be applied to the average response factor or the regression line to obtain an initial raw result, which will then be factored into equations to obtain the estimate of the concentration in the original sample. Rounding will not be performed until after the final result has been obtained to minimize rounding errors; results will not normally be expressed in more than three significant figures.

Copies of raw data and calculations used to generate the final results will be retained on file to allow reconstruction of the data reduction process at a later date.

The laboratory data reduction process is described in detail in the associated laboratory SOPs.

16.2.2 Laboratory Data Review

System reviews are performed at all levels. The individual analyst continuously reviews the quality of data through calibration checks, QC sample results, and performance evaluation (PE) samples. These reviews will be performed prior to submission to the Laboratory Project Manager or designee.

Criteria for analytical data review/verification include checks for internal consistency, transmittal errors, laboratory protocol, and laboratory QC. QC sample results and information documented in field notes will be used to interpret and evaluate laboratory data. The Laboratory QA Department will independently conduct a complete review of selected reports to confirm analytical results.

The laboratory will complete data verification procedures, including:

- Verifying analyses requested were analyses performed.
- Preliminary data proofing for inconsistencies; investigation and corrections, where possible.
- Reviewing laboratory data sheets for reporting/detection limits, holding times, surrogate recovery performance, and spike recovery performance.
- Double-checking computerized data entry, if applicable.

The Laboratory Project Manager or designee will review data for consistency and reasonableness with other generated data and determine whether project requirements have been satisfied. Selected hardcopy output of data will be reviewed to ensure that results have been interpreted correctly. Unusual or unexpected results will be reviewed, and a determination will be made as to whether the analyses will be repeated. In addition, the Laboratory Project Manager or designee may recalculate selected results to verify the calculation procedure.

The Laboratory QA Officer will independently conduct a review of the Project data to determine project requirements have been met. Discrepancies will be reported to the Laboratory Project Manager or designee for resolution.

Prior to final review/signoff by the Laboratory Project Manager or designee, the laboratory personnel will verify that the report deliverable is complete and in proper format, screen the report for compliance to laboratory and CUF QAPP requirements, and ensure that the Case Narrative addresses any noted deficiencies. The Laboratory Project Manager or designee will perform the final laboratory review prior to reporting the results to the QA Oversight Consultant and TVA. Any discrepancy noted during laboratory review that results in sample reanalysis or data correction must be documented using the corrective action procedure addressed in Section 16.4.

16.3 Performance and System Audits

Internal audits will be initiated by the QA Oversight Manager at the discretion of the TVA Technical Lead. Internal audits may be conducted based upon issues identified during various other assessment activities. The internal systems and performance audits will be planned and conducted by the QA Oversight Manager or designee or other appropriate QA Program personnel with the experience and competency to perform the audits/assessments. As part of the planning process for conducting internal audits, internal audits or assessments will first be scheduled. Next, the Audit Team will be identified, and the pertinent documentation and procedures relevant to the audit will be obtained and reviewed by the Audit Team. Internal audits may be announced or unannounced. The Audit Team members will hold a minimum of a Bachelor's degree in a scientific discipline and have 5 or more years of QA and on-site laboratory auditing experience. As indicated in Section 2.0, the QA Oversight Manager holds overall authority for the project QA Program and maintains that authority independently from the operational/production aspects of the project.

Documentation of systems and performance audits and any resulting corrective actions will be maintained as part of the Project File. Audit documentation will be reported to the TVA Technical Lead.

16.3.1 Performance Audits

Performance audits are quantitative evaluations of data quality produced by a particular activity or function. Performance audits of the participating laboratories performing chemical analyses of project samples may be conducted through the submission and analysis of performance evaluation samples.

The QA Oversight Manager or designee will coordinate the manufacture and submission of performance audit samples to the laboratory. A TNI-approved performance testing sample provider will be used to obtain the performance evaluation samples. PE sample studies will be conducted at the discretion of the TVA Technical Lead for TVA contract laboratories analyzing aqueous, solid, and biological samples associated with the CUF EIP. The performance evaluation sample matrices and requested analytes will be determined based on the nature of the work performed by that laboratory for the project.

Upon receipt of results from the performance evaluation study analyses, the QA Oversight Manager or designee will evaluate the data relative to the certified "true values" and will prepare a comprehensive report (including a discussion of non-analytical issues, such as data package preparation and presentation). If multiple laboratories are included in the performance evaluation study, a statistical evaluation of the results will be performed and a simple fencepost test will be conducted for each analyte to determine outliers; a set of warning limits and acceptance limits (based on the set of data excluding outliers) will be generated for the analytes. The performance evaluation study report will contain a detailed account of any results that are outside of the established acceptance limits. Laboratories will be contacted to explain discrepancies between the reported concentrations and the "known" (true) concentrations of the analytes in the performance evaluation samples and to provide corrective actions in accordance with the corrective action process described in Section 16.4. Performance evaluation sample documentation, inclusive of corrective action responses, will be maintained as part of the Project File.

16.3.2 System Audits

System audits entail on-site observation and evaluation of participating laboratories and field sampling activities for compliance with the CUF QAPP, TIs, and/or investigation-specific Work Plans and/or SAPs. Prior to conducting an on-site audit, the Auditor will conduct a thorough examination of procedures and records. These on-site audits will also include verification of effectiveness of implemented corrective actions.

The system audits will address both field and laboratory activities, including a review of personnel qualifications, equipment, documentation, sampling techniques, analytical methods, and adherence to QA procedures. Each laboratory has its own QA Plan; therefore, the laboratory audit activities under the CUF QAPP will entail a general review of laboratory QA practices.

Systems audits of laboratories conducting chemical analyses of project samples will be performed by the QA Oversight Manager or designee. Field Audits will be conducted by the Field Oversight Coordinator or designee.

On-site audits of laboratories analyzing samples associated with the CUF EIP will be conducted at the discretion of the TVA Technical Lead. Each laboratory will be audited on an annual basis or more frequently as directed by the TVA Technical Lead. Field activities will be subjected to assessments and/or surveillances on a regular basis as new sampling teams, new procedures, or new sampling activities are performed. In addition, the Field Oversight Coordinator may observe sampling events as appropriate given the sensitivity of the samples collected.

16.4 Feedback and Corrective Action

In general, feedback and corrective action processes for the CUF EIP will be conducted in accordance with TVA's *Corrective Action Program*. TVA's Corrective Action Program includes various pathways depending on the nature and severity of the issue identified. Issues will be resolved using the lowest-level pathway that adequately identifies and addresses the cause of the non-conformance or deficiency and prevents recurrence.

16.4.1 Feedback Mechanism

There are mechanisms within the project structure that allow for the identification, feedback, and control of any non-conformances or deficiencies. In general, the technical personnel involved with the project are responsible for reporting suspected technical non-conformances through standard communication channels established by the organizational structure. In the same manner, project personnel are responsible for reporting suspected QA non-conformances.

Feedback will be provided to laboratory personnel and the field team by the TVA Technical Lead, QA Oversight Manager, and/or Investigation Consultant Project Manager. Laboratories may receive feedback based on systems and performance audits and ongoing data validation. In addition, laboratories may provide feedback to the QA Oversight Manager. Documentation of feedback will be maintained in the Project File.

16.4.2 Corrective Action for Field Activities

Field Sampling Personnel have the initial responsibility to monitor the quality of field measurements and observations. The Investigation Consultant Field Team Leader is responsible for verifying that QC procedures are followed. This responsibility requires the Investigation Consultant Field Team Leader to assess the correctness of field methods and the ability to meet QA objectives. If a problem occurs that might jeopardize the integrity of the project or that might cause a specific QA objective not to be met, the Investigation Consultant Field Team Leader will notify the TVA Technical Lead and QA Oversight Manager. An appropriate corrective action will then be determined and implemented. The Investigation Consultant Field Team Leader will document the problem, the corrective action, and the results. A copy of the documentation form will be provided to the TVA Technical Lead.

Field auditing is a recognized technique for evaluating the performance of Field Sampling Personnel and assessing how team performance may affect data quality. Field audits will be conducted by the Field Oversight Coordinator to ensure that sampling, handling, and transportation to project laboratories provide assurance that such procedures meet QA protocols and that field documentation is sufficient to produce data of satisfactory quality, to provide a "defense" in the event that field procedures are called into question, and to identify ways to reduce sampling costs. Field audits will be conducted at a minimum of once (for one-time field collection activity) or semi-annually (for reoccurring field activities), or as directed by the TVA Technical Lead or designee to verify that corrective actions have been implemented if deficiencies were identified in prior field audits or as requested by the TVA Technical Lead.

16.4.3 Laboratory Corrective Action

Corrective action within the laboratory will be performed in accordance with the laboratory's formal QA Program.

The laboratory has the responsibility to monitor the quality of the analytical system and to provide a corrective action process adequate to address problems encountered in laboratory analysis of samples. The laboratory will verify that QC procedures are followed and that the analytical results of QC samples are within the acceptance criteria. The verification requires that the laboratory assess the correctness of the following items, as appropriate:

- Sample preparation procedure.
- Initial calibration.
- Calibration verification.
- Method blank result.
- Laboratory control sample.
- Laboratory duplicate analysis.
- Fortified sample result.
- Internal standard performance.

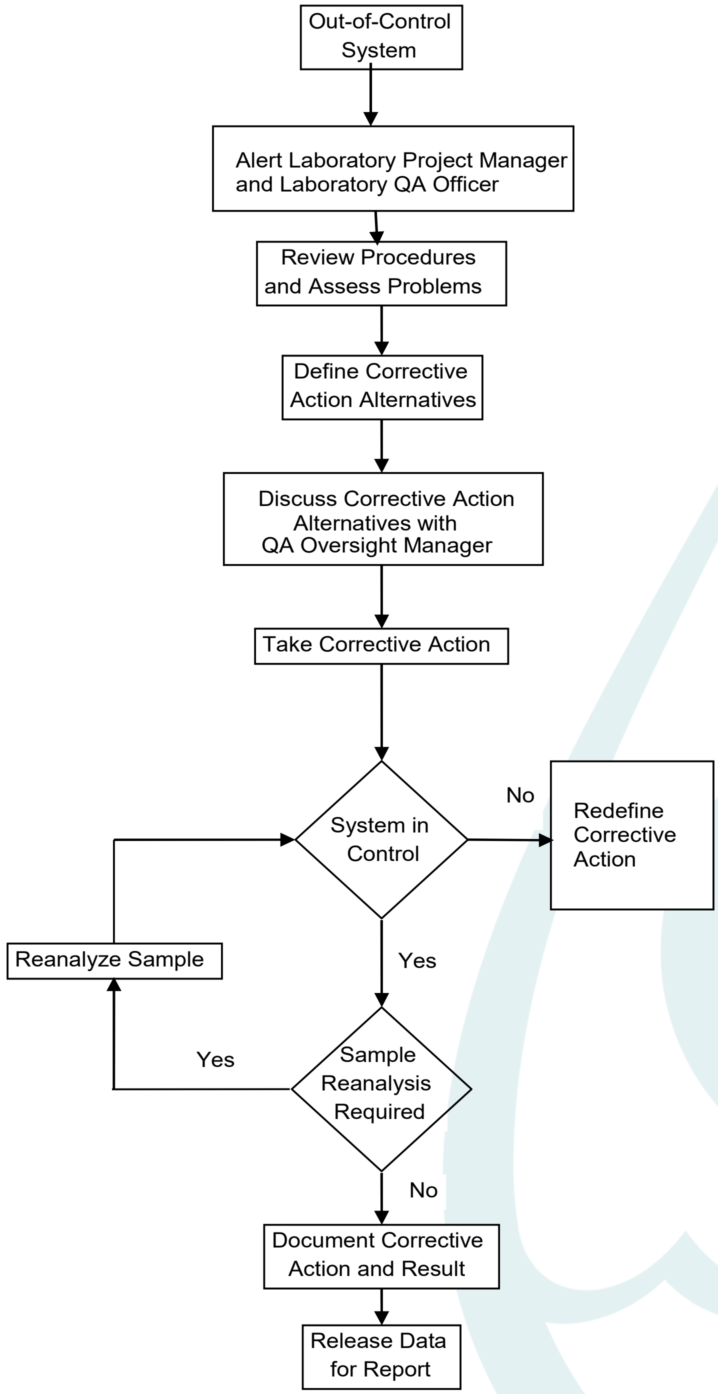
If the assessment reveals that the QC acceptance criteria are not met, the laboratory must immediately evaluate the analytical system and correct the problem. The Laboratory Analyst will notify the Laboratory Project Manager and Laboratory QA Officer of the problem and, if possible, will identify potential causes and suggest correct action.

When the appropriate corrective action measures have been implemented and the analytical system is determined to be “in control,” the Laboratory Analyst will document the problem, the corrective action taken, and resultant data demonstrating that the analytical system is in control. Copies of the documentation will be provided to the Laboratory Project Manager and the Laboratory QA Officer.

Data generated concurrently with an out-of-control system will be evaluated for usability relative to the nature of the deficiency. If the deficiency does not adversely impact the usability of the results, data will be reported and the deficiency will be addressed in the Case Narrative. If sample results are adversely impacted, the Laboratory Project Manager will be notified and appropriate corrective action (such as reanalysis) will be taken.

Figure 16-1 presents the critical pathway for laboratory corrective actions.

Figure 16-1. Critical Path for Laboratory Corrective Action



17.0 REPORTS TO MANAGEMENT

The QA activities performed by laboratories conducting analyses of CUF EIP samples will be monitored by the TVA Technical Lead and the QA Oversight Manager.

Communication among TVA, QA personnel, the Investigation Consultant, and laboratory personnel is important to ensure that problems are remedied and that solutions are documented in an informed and timely manner.

After the completion of a performance and systems audit, the QA Oversight Manager will submit an audit report to the TVA Technical Lead. This audit report will include a list of observed field activities, a list of reviewed documents, and any observed deficiencies. The TVA Technical Lead and QA Oversight Manager or designee will meet with the laboratory Project Managers of any area with observed deficiencies to review the audit findings, confirm the observations, and resolve misunderstandings. In the event that inadequacies are identified, corrective actions will be undertaken as outlined in Section 16.4.

17.1 Field QA Reports

The Field Team Leader and Investigation Consultant Project Manager will provide the TVA Technical Lead with routine field progress reports. Compiled field data sets will be provided to the Data Manager for inclusion in the project EQuIS database. The TVA Technical Lead and QA Oversight Manager or designee will be immediately notified about field QA situations that require corrective action. Corrective action will be performed and documented in accordance with the protocol set forth in Section 16.4.

17.2 Laboratory QA Reports

The Laboratory QA Officer may provide periodic summary reports specific to the project to the QA Oversight Manager. These reports may summarize QA activities for the reporting period, including results of performance audits (external and internal), results of system audits (external and internal), summaries of corrective action to remedy out-of-control situations, and recommendations for revisions of laboratory procedures to improve the analytical systems. The Laboratory Project Manager will notify the QA Oversight Manager and Laboratory Coordinator about laboratory QA situations that appear to systematically impact data quality.

The Laboratory QA Officer will immediately notify the QA Oversight Manager and the Laboratory Coordinator of any laboratory QA situations that require corrective action and ascertain if such measures meet the DQOs of the project. Corrective action will be performed and documented in accordance with the protocol set forth in Section 16.4 or internal laboratory corrective action tracking system, as appropriate.

17.3 Internal Performance and System Audit/Assessment Reports

Documentation of systems and performance audits and any resulting corrective actions will be maintained as part of the Project File. Audit documentation will be reported to the TVA Technical Lead.

18.0 DATA REVIEW, VERIFICATION, AND VALIDATION

The Data Validators will verify or validate data generated by the laboratories for chemical analyses of project samples. Any issues observed during data validation will be brought to the attention of the QA Oversight Manager and TVA Technical Lead; the Laboratory Project Manager will be contacted to determine and implement an appropriate corrective action.

The purpose of analytical data verification and validation is to ensure data completeness, correctness, and method compliance/conformance, and identify data quality, including unusable data that would not be sufficient to support environmental decisions. In addition to the laboratory QA review, the data presented in Level IV data packages will be verified and validated by the Data Validators for the following:

- Compliance with requested testing requirements.
- Completeness.
- Reporting accuracy (including hardcopy to EDD).
- Confirmation of receipt of requested items.
- Traceability, sensibility, and usability of the data.

In addition to the above criteria, data will be validated with guidance from the following documents:

- US EPA Contract Laboratory Program (CLP) National Functional Guidelines (NFG) for Superfund Organic Methods Data Review (June 2008);
- US EPA CLP NFG for Inorganic Data Review (October 2004);
- US EPA Region 4 Data Validation SOPs for CLP Inorganic Data by Inductively Coupled Plasma – Atomic Emission Spectroscopy (September 2011);
- US EPA Region 4 Data Validation SOPs for CLP Mercury Data by Cold Vapor Atomic Absorption (September 2011);
- US EPA Region 4 Environmental Investigations SOPs and Quality Assurance Manual (November 2001).

It should be noted that data validation guidelines specified above were developed for work conducted under the US EPA Contract Laboratory Program; therefore, these guidelines are not completely applicable to the Clean Water Act (CWA), Standard Methods, and SW-846 methods referenced for the CUF EIP. Professional judgment will be used as necessary to adapt the guidelines for use in evaluating usability of data generated in accordance with CWA, Standard Methods, and SW-846 methodology.

Analytical data from off-site, commercial laboratories will be qualified with guidance from the National Functional Guidelines previously referenced. The data validation qualifiers listed below will be used for project samples:

- Organic Data Validation Qualifiers

U*	This result should be considered "not detected" because it was detected in an associated field or laboratory blank at a similar level.
R	Unreliable positive result; compound may or may not be present in sample.
UR	Unreliable reporting or detection limit; compound may or may not be present in sample.
J	Quantitation is approximate due to limitations identified during data validation.
UJ	This compound was not detected, but the reporting or detection limit should be considered estimated due to a bias identified during data validation.

- Inorganic Data Validation Qualifiers

U*	This result should be considered "not detected" because it was detected in a rinsate blank or laboratory blank at a similar level.
R	Unreliable positive result; analyte may or may not be present in sample.
UR	Unreliable reporting or detection limit; analyte may or may not be present in sample.
J	Quantitation is approximate due to limitations identified during data validation.
UJ	This analyte was not detected, but the reporting or detection limit may or may not be higher due to a bias identified during data validation.

The EDD and Full data packages for data generated from the chemical analysis of project samples will summarize the deviations from approved protocols and significant data findings in the Case Narratives. Analytical reports will be submitted to TVA and the QA Oversight Consultant as separate documents and will be transmitted in an electronic (.pdf and EDD) and/or hardcopy formats. The QA Oversight Consultant will maintain a database of TVA data for data validation and/or verification. The QA Oversight Consultant will complete data validation and generate reports for TVA. Data validation and project reports will be submitted to the TVA Technical Lead. Electronic validated data will be submitted upon approval from the TVA Technical Lead. The Data Management Plan details the process for appending data qualifiers in the EQuIS database and submitting verified and validated data to data users.

In addition to the validation qualifiers, qualifier reason codes will be maintained in the database. The reason codes below will be used to describe the usability issue(s) associated with results qualified during data review. Additional reason codes may be added as needed to address recurring usability issues.

Reason Code	Explanation
BE	Equipment blank contamination. The result should be considered "not-detected."
BF	Field blank contamination. The result should be considered "not-detected."
BL	Laboratory blank contamination. The result should be considered "not-detected."
BN	Negative laboratory blank contamination.
C	Initial and/or continuing calibration issue, indeterminate bias.
C+	Initial and/or continuing calibration issue. The result may be biased high.

Reason Code	Explanation
C-	Initial and/or continuing calibration issue. The result may be biased low.
FD	Field duplicate imprecision.
FG	Total versus Dissolved Imprecision.
H	Holding time exceeded.
I	Internal standard recovery outside of acceptance limits.
L	LCS and LCSD recoveries outside of acceptance limits, indeterminate bias.
L+	LCS and/or LCSD recoveries outside of acceptance limits. The result may be biased high.
L-	LCS and/or LCSD recoveries outside of acceptance limits. The result may be biased low.
LD	Laboratory duplicate imprecision.
LP	LCS/LCSD imprecision.
M	MS and MSD recoveries outside of acceptance limits, indeterminate bias.
M+	MS and/or MSD recoveries outside of acceptance limits. The result may be biased high.
M-	MS and/or MSD recoveries outside of acceptance limits. The result may be biased low.
MP	MS/MSD imprecision.
P	Post-digestion spike recoveries outside of acceptance limits, indeterminate bias.
P+	Post-digestion spike recovery outside of acceptance limits. The result may be biased high.
P-	Post-digestion spike recovery outside of acceptance limits. The result may be biased low.
Q	Chemical preservation issue.
R	RL standards outside of acceptance limits, indeterminate bias.
R+	RL standard(s) outside of acceptance limits. The result may be biased high.
R-	RL standard(s) outside of acceptance limits. The result may be biased low.
S	Radium-226+228 flagged due to reporting protocol for combined results.
SD	Serial dilution imprecision.
T	Temperature preservation issue.
X	Percent solids < 50%.
Y+	Chemical yield outside of acceptance limits. The result may be biased high.
Y-	Chemical yield outside of acceptance limits. The result may be biased low.
Z	ICP/MS interference.
ZZ	Other.

19.0 VERIFICATION AND VALIDATION METHODS

The overall QA objective for field activities, laboratory analyses, and data assessment is to produce data of sufficient and known quality to support the investigation-specific objectives and to produce high-quality, legally defensible data.

This data assessment activity is an ongoing coordinated process with data production and is intended to ensure that data produced during the CUF EI are acceptable for use in subsequent evaluations. Both statistical and qualitative evaluations will be used to assess the quality of the data. The primary evaluation of the data will be based upon the control samples. The blank samples will be used to evaluate whether or not the laboratory and/or field sample handling represent a possible source of sample contamination. Duplicate sample results will be used to evaluate data precision.

All data submitted to the project EQuIS database will undergo data verification. Analytical data will be available for preliminary internal use after verification. Initially, 100% of the all chemical and physical analysis data will be reported in fully documented (Level IV) data packages for independent data validation. If after the percentage of full data validation has decreased, a trend in frequency of reporting issues, method non-compliances, or data usability issues is identified, data validation will be conducted for specific data points or the percentage of full data validation percentage may be increased until the issues have been minimized to their initial frequency.

Data verification includes the review of laboratory deliverables for completeness, correctness, and compliance with applicable methods. The validation of data presented in a Level IV data package includes the review of commercially-available raw data and associated QC summary forms for compliance with the applicable methods and for data usability with respect to the appropriate guidance documents. The nature and extent of the data package available for review is dependent on the analytical method used (such as US EPA methods, SW-846, *etc.*) and the reporting and deliverables requirements defined in the CUF QAPP and investigation-specific SAPs. After completion of either Full or Limited data validation, a QA report will be prepared. The QA report will address CUF QAPP and method non-compliance issues, reporting errors, data usability issues, and include summary tables with qualified sample results. The QA report will also address laboratory calculation errors (*i.e.*, the reported value is more than 10% different than the value calculated from the raw data by the data validator). The summary tables will include reported sample results and the associated data qualifiers. The QA report will be fully supported by photocopied pages of the laboratory data showing deficiencies identified in the review, as an attachment to the report.

The data produced during the sampling tasks included in the field investigation will be compared with the defined QA objectives and criteria for precision, accuracy, representativeness, completeness, and comparability (PARCC) and sensitivity. The primary goal of these procedures is to ensure that the data reported are representative of actual conditions at the Site.

Standard procedures are used so that known and acceptable levels of PARCC are maintained for each data set. Descriptions of these criteria are presented in the following subsections.

Specific quantitative QA objectives for chemical analyses associated with the CUF EIP are presented in Attachments E through L of this CUF QAPP.

19.1 Precision

The degree of agreement between the numerical values of a set of duplicate samples performed in an identical fashion constitutes the precision of the measurement.

During the collection of data using field methods and/or instruments, precision is checked by reporting measurements at one location and comparing results. For example, soil measurements are taken in pairs at a certain point and depth and the values compared. The measurements are considered sufficiently precise only if the values are within a specified percentage of each other.

Analytical precision is calculated by expressing, as a percentage, the RPD between results of analyses of laboratory duplicate samples for a given analyte. Precision is expressed as an RPD when both results are greater than 5× the reporting limit as calculated by the following formula:

$$RPD = abs\left[\frac{\mathrm{A} - \mathrm{B}}{\left(\frac{A+B}{2}\right)}\right] \times 100$$

Where: A = Value of original sample
B = Value of duplicate sample

When at least one result is less than 5× the reporting limit, the difference between the results is used to evaluate precision.

Specific precision and difference objectives for field duplicate samples and laboratory duplicate samples (including MSDs) are presented in Attachments E through L of this CUF QAPP.

19.2 Accuracy

Accuracy is the degree of agreement of a measurement, X, with an accepted reference or true value, T. Accuracy is usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100(X-T)/T; accuracy is also sometimes expressed as a ratio X/T. Accuracy, which is a measure of the bias in a system, is assessed by means of reference samples and percent recoveries. Error may arise due to personal, instrumental, or method factors.

The two types of analytical check samples used are LCSs and MSs. Analytical accuracy is expressed as the percent recovery (%R) of an analyte that has been added to the control sample or a standard matrix (such as blank soil) at a known concentration prior to analysis.

The formula used to calculate accuracy for the LCS is:

$$\%\,R = \left(\frac{A_T}{A_F}\right) \times 100$$

Where: A_T = Total concentration of the analyte measured or recovered
A_F = Concentration of the analyte spiked

When calculating accuracy for the MS analysis, a correction for background concentration found in the unspiked sample must be made. MS recovery is calculated using the following formula:

$$\% R = \left(\frac{A_T - A_O}{A_F}\right) \times 100$$

Where: A_T = Concentration of the analyte measured or recovered
A_0 = Unspiked concentration of the analyte
A_F = Concentration of the analyte spiked

In general, the accuracy objectives are based on the requirements set forth in the referenced analytical method and in Attachments E through L of this CUF QAPP.

19.3 Representativeness

Representativeness expresses the degree to which sample data are accurate and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter associated with the proper design of the sampling program. The representativeness criterion can, therefore, be met through the proper selection of sampling locations, the collection of a sufficient number of samples and the use of standardized sampling procedures (*viz*., TVA TIs) to describe sampling techniques and the rationale used to select sampling locations to ensure representativeness of the sample data.

Representativeness will also be measured by the collection of field duplicates or co-located samples, as appropriate given the sample matrix. Comparison of the analytical results of field duplicates will provide a direct measure of individual sample representativeness.

19.4 Completeness

Completeness is a measure of the degree to which the amount of sample data collected meets the needs of the sampling program and is quantified as the relative number of analytical data points that meet the acceptance criteria (including accuracy, precision, and any other criteria required by the specific analytical method used). Completeness is defined as a comparison between actual numbers of usable data points expressed as a percentage of expected number of points.

Difficulties encountered while handling samples in the laboratory, as well as unforeseen complications regarding analytical methods, may affect completeness during sample analysis. The minimum goal for completeness is 90%; the ability to exceed this goal is dependent on the applicability of the analytical methods to the sample matrix analyzed. If data cannot be reported without qualifications, project completion goals may still be met if the qualified data (data of known quality, even if not perfect) are suitable for specified project goals. Percent completeness will be expressed as the ratio of the total number of usable results relative to the total number of analytical results. The total number of usable analytical results will be total number of results minus any results deemed unusable (or rejected) at validation.

19.5 Comparability

Comparability is a qualitative parameter used to express the confidence with which one data set can be compared with another. The comparability of the data, a relative measure, is influenced by sampling and analytical procedures. By providing specific protocols for obtaining and analyzing samples, data sets should be comparable regardless of who collects the sample or who performs the sample analysis.

The laboratory will be responsible providing the following controls to allow assessment of comparability:

- Adherence to current, standard US EPA-approved methodology for sample preservation.
- Compliance with holding times and analysis consistent with CUF QAPP.
- Consistent reporting units for each parameter of similar matrices.
- US EPA-traceable or NIST-traceable standards, when applicable.

20.0 RECONCILIATION OF DATA TO PROJECT OBJECTIVES

The QA Oversight Manager, in conjunction with the TVA Technical Lead, will determine whether field and validated analytical data or data sets meet the requirements necessary for decision-making. The results of measurements will be compared to the objectives set forth in the program-specific SAPs.

Generally, data assessment begins with verification and validation of project data to ensure that the sampling and analysis protocols specified in the associated TVA TIs and SAPs were followed, and that the measurement systems were performed in accordance with the criteria specified in these documents and this CUF QAPP. Data limitations identified during data verification and validation are communicated to the project team via reports and qualification in the project database.

Following data assessment, statistical analysis is performed to determine if the investigation and project objectives were achieved. As data are evaluated, anomalies in the data or data gaps may become apparent to the data users. Data that do not meet the data users' needs will be identified and appropriately noted so that decision-makers are aware of data limitations.

Data that are determined not to meet the investigation and project objectives may be used qualitatively or may be rejected depending on the program-specific requirements and the intended use of the data. The TVA Technical Lead, with the support of the QA Oversight Manager or designee and Data Validators, will assist data end users in evaluating data limitations identified and determining whether data are acceptable for their intended use.

21.0 REFERENCES

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ATTACHMENT A

DATA PACKAGE DELIVERABLE REQUIREMENTS

Required Data Deliverables Elements

All Sample Data Packages will include data for analyses of all samples in one sample delivery group (SDG), including field samples, reanalyses, secondary dilutions, blanks, laboratory control samples (LCS), laboratory control sample duplicates (LCSD), matrix spikes (MS), matrix spike duplicates (MSD), and/or laboratory duplicates. A fraction-specific unit is not a required deliverable if the analysis of that fraction was not required for samples in the SDG. The Sample Data Package must be complete before submission and must be consecutively paginated. The Sample Data Package will be arranged in the following order:

- Cover Letter/Letter of Transmittal signed by Technical Project Manager or designee
- Title Page
- Table of Contents
- SDG Narrative

The SDG Narrative will be clearly labeled "SDG Narrative" and will contain laboratory name; SDG number; TVA sample identifications; laboratory sample numbers; and detailed documentation of any QC, sample, shipment, and/or analytical problems encountered in processing (preparing and analyzing) the samples reported in the data package. A glossary of qualifier codes used in the SDG must also be provided.

The laboratory must also include reference to preparation and analytical methods performed and applicable project documents (*e.g.,* approved work plans), any problems encountered, both technical and administrative, corrective actions taken and resolution, and an explanation of all flagged edits (*i.e.*, exhibit edits) on quantitation reports (including results flagged due to storage blank contamination).

The SDG Narrative must be signed and dated by the Laboratory Manager or designee. The SDG Narrative must include a statement or statements relative to compliance with this document and any applicable project documents and description of any deviations from these documents:

- Field and Internal (Laboratory) Chain-of-Custody Records
- Sample Receipt Documentation Log, and all Project Correspondence

Copies of both the external and internal Chain-of-Custody Records for all samples within the SDG must be included in the deliverables. The Chain-of-Custody Records will list all temperature and pH measurements for all samples requiring pH adjustment for preservation.

A.1 Inorganic and General Chemistry Deliverables Requirements

The following subsections provide detailed requirements for the information presented on each of the deliverables elements referenced in Table A-1. In the event that certain required information is not included on a particular form, the laboratory will provide additional documentation (e.g., preparation logs or analytical runlogs) to ensure that the minimum required level of documentation is supplied.

A.1.1 Target Analyte Results Summaries

Target analyte results summaries are required for all MS/MSD samples, laboratory duplicate samples, LCS/LCSDs, and preparation blanks and will be arranged in increasing alphanumeric order by laboratory sample number.

The target analyte results summary must include:

- SDG Number
- TVA sample number
- laboratory sample identifier
- matrix of the TVA sample
- date of sample collection
- sample percent solids (if applicable)
- name and CAS number for each target analyte
- concentration or project-required detection limit (PRDL) for each target analyte
- any applicable flags for target analyte results (e.g., “U” to designate a “not-detected” result)
- concentration units

A.1.2 Initial and Continuing Calibration Verification Summary

The initial and continuing calibration verification summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- names for all target analytes
- instrument identifier

- start and end dates and times of the analytical sequence
- true concentrations for all target analytes for the ICV and CCV standards
- observed concentrations for all target analytes for each ICV and CCV analyses
- calculated percent recoveries for all target analytes for each ICV and CCV analyses
- control limits for ICV and CCV
- percent recoveries
- concentration units

A.1.3 PRDL Standard Summary

The PRDL standard summaries will be arranged in chronological order, by instrument and must include the following:

- SDG number
- names for all target analytes
- instrument identifier
- dates and times for the PRDL standard analyses
- true concentrations for all target analytes
- observed concentrations for all target analytes for each PRDL standard analysis
- calculated percent recoveries for all target analytes for each PRDL
- standard analysis
- control limits for PRDL standard recoveries
- concentration units

A.1.4 Initial and Continuing Calibration Blank Summary

The initial and continuing calibration blank summaries will be arranged in chronological order, by instrument and must include the following:

- SDG number

- names for all target analytes
- instrument identifier
- start and end dates and times of the analytical sequence
- observed concentration or PRDL for each target analyte for each initial calibration blank (ICB) or continuing calibration blank (CCB) analysis
- acceptance limits for ICB and CCB analyses
- concentration units

A.1.5 Preparation Blank Analytical Summary

The preparation blank analytical summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- preparation blank sample identifier
- names for all target analytes
- instrument identifier
- observed concentration or PRDL for each target analyte
- acceptance limits
- concentration units

A.1.6 ICP and/or ICP/MS Interference Check Sample Summary

The ICP and/or ICP/MS interference check sample summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- names for all target analytes
- instrument identifier
- dates and times for the ICP interference check standard analyses
- true concentrations for all target analytes
- observed concentrations for all target analytes observed in each ICP

interference check standard analysis

- calculated percent recoveries for all target analytes for each ICP interference check standard analysis
- control limits for ICP interference check standard recoveries
- concentration units

A.1.7 Matrix Spike /Matrix Spike Duplicate Summary

The MS/MSD summaries will be arranged in alphanumeric order by laboratory sample number and must include:

- SDG number
- TVA sample number for the spiked sample
- percent solids for the TVA sample (if applicable)
- names for all target analytes
- analyte concentration observed in the non-spiked sample aliquot
- true concentrations for all target analytes in the spike solutions
- observed concentrations for all target analytes in the spike sample/spike sample duplicate analyses
- calculated percent recoveries for all target analytes
- control limits for spike sample/spike sample duplicate recoveries
- calculated RPD between spike sample/spike sample duplicate results
- RPD limit for each analyte
- concentration units

A.1.8 Post-Digestion Spike Sample Recovery Summary (if applicable)

The post-digestion spike sample recovery summaries will be arranged in alphanumeric order by laboratory sample number and must include:

- SDG number

- TVA sample number for the post-digestion spike parent sample
- percent solids for the TVA sample (if applicable)
- names for all target analytes
- analyte concentration observed in the non-spiked sample aliquot
- true concentrations for all target analytes in the post-spike solution
- observed concentrations for all target analytes in the post-spike sample analysis
- calculated percent recoveries for all target analytes
- control limits for post-spike sample recoveries
- concentration units

A.1.9 Duplicates Precision Summary

The duplicate precision summaries will be arranged in alphanumerical order by TVA sample number and must include:

- SDG number
- TVA sample number for the duplicate sample
- percent solids for the TVA sample (if applicable)
- names for all target analytes
- analyte concentration observed in the original sample aliquot
- observed concentrations for all target analytes in the duplicate sample analysis
- calculated RPD for all target analytes
- control limits for RPD
- concentration units

A.1.10 LCS/LCSD Recovery Summary

The LCS/LCSD recovery summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- LCS/LCSD identification number
- names for all target analytes
- true concentrations for all target analytes in the LCS/LCSD solution
- observed concentrations for all target analytes in the LCS/LCSD analysis
- calculated percent recoveries for all target analytes
- control limits for LCS/LCSD recoveries
- concentration units
- RPD between LCS/LCSD results
- RPD limit for each analyte

A.1.11 Standard Addition Results Summary (where applicable) must include:

- SDG number
- TVA sample number for the sample that underwent the standard additions procedure
- names for all target analytes
- analyte concentration or absorbance observed in the non-spiked sample aliquot
- true concentrations for all target analytes for each standard addition analysis
- observed concentration or absorbance for each standard addition analysis
- calculated concentration for each target analyte
- calculated correlation coefficient for each target analyte
- concentration units

A.1.12 ICP and/or ICP/MS Serial Dilution Summary

The ICP and/or ICP/MS serial dilution summaries will be arranged in alphanumeric order by laboratory sample number and must include:

- SDG number
- TVA sample number for the ICP serial dilution sample
- names for all target analytes
- analyte concentration observed in the original sample aliquot
- observed concentrations for all target analytes in the ICP serial dilution analysis
- calculated RPD for all target analytes
- control limits for RPD
- concentration units

A.1.13 PRDL and MDL Summary

The PRDL and MDL summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- instrument identifier
- date the MDL determination was performed
- names for all target analytes
- determined MDL for all target analytes
- PRDL for all target analytes
- concentration units

A.1.14 ICP Interelement Correction Factors Summary

The ICP interelement correction factors summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- instrument identifier
- date the ICP interelement correction factors determination was performed
- names for all target analytes

- determined ICP interelement correction factors concentrations for all target analytes
- concentration units

A.1.15 ICP and/or ICP/MS Linear Range Summary

The ICP and/or ICP/MS linear range summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- instrument identifier
- date the ICP linear range determination was performed
- names for all target analytes
- determined ICP linear range concentrations for all target analytes
- concentration units

A.1.16 Preparation Logs

- TCLP or SPLP Preparation Logs (if TCLP or SPLP extraction was performed)
- TVA sample and QC sample digestion logs

A.1.17 Analytical Sequence Form

The analytical sequence forms will be arranged in chronological order, by analyte, by instrument and must include:

- SDG number
- instrument identifier
- TVA sample numbers associated with the sequence
- QC sample identifiers associated with the sequence
- analysis date and time for each TVA sample and QC sample associated with the sequence
- identification of all target analytes reported from each TVA sample and QC sample analysis

- dilution factor for each TVA sample and QC sample analysis
- start and end dates and times for the sequence

A.1.18 ICP/MS Additional Forms

ICP/MS Data Packages will include the following forms in addition to the requirements listed above.

- ICP/MS Tune Summary
- ICP/MS Internal Standards Relative Intensity Summary

A.1.19 Raw Data for Metals/Mercury

- For each reported value, the laboratory will provide all raw data used to obtain that value. This requirement applies to all required QA/QC measurements and instrument standardization as well as all sample analysis results. This statement does not apply to the Quarterly Verifications Parameters submitted as part of each data package. Raw data must contain all instrument readouts used for the sample results. Each exposure or instrumental reading must be provided, including those readouts that may fall below the PRDL. All ICP, ICP/MS, and AA instruments must provide a legible hardcopy of the direct real-time instrument readout (e.g., strip-charts, printer tapes, etc.). A photocopy of the instrument's direct sequential readout must be included. A hardcopy of the instrument's direct instrument readout for cyanide must be included if the instrumentation has the capability.

- Raw data must include instrument calibration and calibration curves/equations.

A.1.20 Raw Data for General Chemistry Parameters

- For each reported value, the laboratory will provide all raw data (instrument printouts or logbook pages) used to obtain that value. This requirement applies to all required QA/QC measurements and instrument standardization, as well as all sample analysis results. Raw data must contain all instrument readouts/logbooks pages used for the sample results. Each exposure or instrumental reading must be provided, including those readouts/logbook pages that may fall below the quantitation limit. A photocopy of the instrument's direct sequential readout must be included if the instrumentation has the capability.

- Raw data must include instrument calibration and calibration curves/equations as applicable.

- Wet Chemistry Preparation Logs (by parameter)

Table A-1: Required Deliverables for Inorganic and General Chemistry Analyses

	Section	ICP/MS Metals	Mercury	General Chemistry Parameters
Cover Letter/Letter of Transmittal	n/a	X	X	X
Case Narrative	n/a	X	X	X
Field and Internal (Laboratory) COC Records	n/a	X	X	X
Sample Receipt Documentation Log	n/a	X	X	X
Project Correspondence	n/a	X	X	X
Target Analyte Results Summary	A.1.1	X	X	X
ICP/MS Tune Summary	A.1.18	F		
Initial Calibration Summary	A.1.19 A.1.20	F	F	F
Initial and Continuing Calibration Verification (ICV/CCV) Summary	A.1.2	F	F	F
PRDL Standard Summary	A.1.3	F	F	
Initial and Continuing Calibration Blank Summary	A.1.4	F	F	F^A
Preparation Blank Summary	A.1.5	X	X	X
ICP and/or ICP/MS Interference Check Sample Summary	A.1.6	F		
MS/MSD Duplicate Summary	A.1.7	X	X	X^A
Post-Digestion Spike Sample Recovery Summary	A.1.8	F	F	
Duplicates Precision Summary	A.1.9	X	X	X
LCS/LCSD Recovery Summary	A.1.10	X	X	X
ICP and/or ICP/MS Serial Dilution Summary	A.1.12	F		
PRDL and MDL Summary	A.1.13	F	F	F^A
Standard Additions Results Summary	A.1.11	F^A	F^A	
ICP Interelement Correction Factors Summary	A.1.14	F		
ICP and/or ICP/MS Linear Range Summary	A.1.15	F		
ICP/MS Tune Internal Standards Relative Intensity Summary	A.1.18	F		
TCLP or SPLP Preparation Logs	A.1.16	F^A	F^A	
Digestion Logs	A.1.16	F	F	
General Chemistry Preparation Logs	A.1.20			F
Analytical Sequence Form	A.1.17	F	F	F
Raw Data	A.1.19	F	F	F

Notes:

X Required element for all deliverables Levels

F Required additional element for full deliverables (in addition to elements required for all deliverables levels)

[A] Required element for associated deliverable level when applicable to the analyses performed

A.2 Radiological Deliverables Requirements

The following subsections provide detailed requirements for the information presented on each of the deliverables elements referenced in Table A-2. In the event that certain required information is not included on a particular form, the laboratory will provide additional documentation (e.g., preparation logs or analytical runlogs) to ensure that the minimum required level of documentation is supplied.

The radiological data will be arranged in the following order by individual parameter requested for the samples in the SDG.

A.2.1 Target Analyte Results Summaries: Target analyte results summaries are required for all samples and will be arranged in increasing alphanumeric order by TVA sample number. The target analyte results summary must include the following:

- SDG Number
- TVA sample number
- laboratory sample identifier
- matrix of the TVA sample
- date of sample collection
- date of sample analysis
- sample activity, uncertainty, and the sample-specific minimum detectable activity (MDA). The sample-specific MDA will be based on the background of the detector that the sample was counted on. The sample activity (positive or negative), uncertainty, and sample-specific MDA will be reported for positive and “not-detected” results
- any applicable flags for target analyte results (e.g., “U” to designate a “not-detected” result)
- measurement units

A.2.2 Chemical Yield (Tracer/Carrier) Recovery Summary that must include the following:

- SDG number
- TVA sample number
- Method blank sample number
- Laboratory Duplicate sample number

- LCS identification number
- LCSD identification number (if performed)
- percent recovery for all tracers/carriers
- applicable recovery limits for each tracer/carrier

A.2.3 Method Blank Summary: The method blank summaries will be arranged in chronological order, by instrument and method and must include the following:

- SDG number
- names for all target analytes
- observed activity, uncertainty, and MDA for each target analyte for each method blank analysis
- concentration units

A.2.4 Duplicates Precision Summary: The duplicate precision summaries will be arranged by instrument and method and must include the following:

- SDG number
- TVA sample number for the duplicate sample
- names for all target analytes
- analyte activity, uncertainty, and MDA observed in the original sample aliquot
- observed activity, uncertainty, and MDA for all target analytes in the duplicate sample analysis
- calculated RPD/Replicate Error Ratio (RER) for all target analytes
- control limits for RPD/RER
- concentration units

A.2.5 LCS Recovery Summary: The LCS recovery summaries will be arranged by instrument and method and must include the following:

- SDG number
- LCS identifier

- names for all target analytes
- true concentrations for all target analytes in the LCS solution
- observed concentrations for all target analytes in the LCS analysis
- calculated percent recoveries for all target analytes
- control limits for LCS recoveries
- concentration units

A.2.6 Calibration Verification Summary: The calibration verification summaries will be arranged by instrument and method and must include the following:

- SDG number
- names for all target analytes
- instrument identifier
- date the calibration verification was performed. For each method and analyte, the Contracted Laboratories will provide Calibration Verification summaries that include or bracket the analysis dates of the field and QC samples.
- acceptance limits for the calibration verification
- the following calibration verification summaries will be provided for Gas Flow Proportional Counter data
    a. Efficiency Checks
    b. Background Checks
- the following calibration verification summaries will be provided for Alpha Spectroscopy data
    a. Energy Calibration Checks
    b. Efficiency Checks
    c. Background Checks
    d. Resolution (FWHM) Checks
- the following calibration verification summaries will be provided for Alpha Scintillation data
    a. Daily Instrument Performance Checks
    b. Background Checks

A.2.7 Raw Data

For each reported value, the Contracted Laboratories will provide all raw data (instrument printouts) used to obtain that value. This applies to all required QA/QC measurements (including tracer/carrier recoveries) as well as all sample analysis results. Raw data must contain all instrument readouts and worksheets used for the sample results. An exhibit work sheet per method (including example calculations showing how sample activity, total propagated uncertainty [TPU] and minimum detectable activity [MDA] are calculated) will be provided.

A.2.8 Preparation Logs (by method)

A.2.9 Traceability Documents (by method)

Table A-2: Required Deliverables for Radiological Analyses

	Section	**Radiological Parameters**
Cover Letter/Letter of Transmittal	n/a	X
Case Narrative	n/a	X
Field and Internal (Laboratory) COC Records	n/a	X
Sample Receipt Documentation Log	n/a	X
Project Correspondence	n/a	X
Target Analyte Results Summary	A.2.1	X
Chemical Yield (Tracer/Carrier) Recovery Summary	A.2.2	X
Method Blank Summary	A.2.3	X
Duplicates Precision Summary	A.2.4	X
LCS Recovery Summary	A.2.5	X
Calibration Verification Summary	A.2.6	X
Raw Data	A.2.7	X
Preparation Logs	A.2.8	X
Traceability Documents	A.2.9	F

Notes:

X Required element for all deliverables levels

F Required additional element for full deliverables (in addition to elements required for all deliverables levels)

ATTACHMENT B

SAMPLING PROCEDURES LIST

The TVA Technical Instructions (TIs) and/or standard operating procedures (SOPs) associated with the CUF EI are identified on Table B-1. Current versions of these documents are maintained on TVA's Accellion Workspace.

Table B-1: Applicable TIs and SOPs

Document Number	**Document Title**
ENV-TI-05.80.02	*Sample Labeling and Custody*
ENV-TI-05.80.03	*Field Record Keeping*
ENV-TI-05.80.04	*Field Sampling Quality Control*
ENV-TI-05.80.05	*Field Sampling Equipment Cleaning and Decontamination*
ENV-TI-05.80.06	*Handling and Shipping of Samples*
EMA-TI-05.80.40	*Surface Water Sampling*
ENV-TI-05.80.42	*Groundwater Sampling*
ENV-TI-05.80.44	*Groundwater Level and Well Depth Measurement*
ENV-TI-05.80.46	*Field Measurements Using a Multi-Parameter Sonde*
GAF-PW.01	*Potable Water Sampling*
TVA-GAF-SOP-02	*Sediment Sampling*

ATTACHMENT C

EXAMPLE CHAIN OF CUSTODY RECORD

TENNESSEE VALLEY AUTHORITY

Populate COC

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: ____ of ____
Cooler # ____ of ____

COC #

Task Desc

Required Ship to Lab:		Required Project Information:		Required Sampler Information:	
Lab Name:		Site ID #:	GAF	Sampler	
Address:		Project #	Gallatin Environmental Investigations	Sampling Company	
				Address:	
		Site Address	1499 Steam Plant Rd	City/State	Phone #:
Lab PM:		City	Gallatin State, Zip TN 37066	Reimbursement project?	Non-reimbursement project? Mark one
Phone/Fax:		Site PM Name		Send EDD to	TVAEDD@envstd.com
Lab PM email		Phone/Fax:		CC Hardcopy report to	TVA_Deliverables@envstd.com
Applicable Lab Quote #:		Site PM Email:		CC Hardcopy report to	

TAT: Standard		Rush		Mark One

Filtered / Preserve / Analysis

ITEM #	SAMPLE ID Samples IDs MUST BE UNIQUE	SAMPLE LOCATION	Sample Depth: Depth Unit: Start Depth	End Depth	MATRIX CODE	G=GRAB C=COMP	SAMPLE TYPE	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	Comments/Lab Sample I.D.
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Additional Comments/Special Instructions:	SAMPLE REASON (check only one)	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	Sample Receipt Conditions			
	Investigatory								Y / N	Y / N	Y / N
	Split Comparison								Y / N	Y / N	Y / N
	Split Legal								Y / N	Y / N	Y / N
									Y / N	Y / N	Y / N
	Special Study	SHIPPING METHOD: (mark as appropriate)	SAMPLER NAME AND SIGNATURE					Temp In °C	Samples on Ice?	Sample Intact?	Trip Blank?
	Plant Ops	UPS COURIER \ FEDEX	PRINT Name of SAMPLER:								
	Oth:	US MAIL	SIGNATURE of SAMPLER:	DATE Signed	Time:						

ATTACHMENT D

TDEC ORDER SAMPLE NAMING CONVENTIONS

CUMBERLAND FOSSIL PLANT

Table A: TVA - TDEC Order Sample Naming Conventions - Cumberland Fossil Plant

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Sample Type Acronym	Location	Location ID	Depth Interval (If Applicable)	Quality Control/Quality Assurance Sample Type	Sample Type Acronym	Date of Sample	Example
Cumberland Fossil Plant	CUF	Background Soil	BS	Soil Boring or Monitoring Well Number	SBXX MWXX	Feet/Feet	Equipment Rinsate Blank	EBXX	Year/Month/Day	CUF-BS-SBXX-6.0/8.0-20180123 CUF-BS-MWXX-6.0/8.0-20180123 CUF-BS-EBXX-20180123 CUF-BS-FBXX-20180123 CUF-BS-DUPXX-20180123
		Coal Combustion Residual	CCR	Temporary Well Number	TWXX	Feet/Feet	Field Blank	FBXX	Year/Month/Day	CUF-CCR-TWXX-6.0/8.0-20180123 CUF-CCR-EBXX-20180123 CUF-CCR-FBXX-20180123 CUF-CCR-DUPXX-20180123
		Water Supply	WS	Well ID # or Property Owner Name	State or USGS Well # or Property Owner Name	NA	Filter Blank	FLBXX	Year/Month/Day	CUF-WS-TN0001-20180123 CUF-WS-JOHNDOE-20180123 CUF-WS-EBXX-20180123 CUF-WS-FBXX-20180123 CUF-WS-FLBXX-20180123 CUF-WS-DUPXX-20180123
		Groundwater	GW	Monitoring Well Number	MWXX or Existing Name	Feet Below Top of Casing	Field Duplicate	DUPXX	Year/Month/Day	CUF-GW-MWXX-35-20180123 CUF-GW-CUF201-35-20180123 CUF-GW-EBXX-20180123 CUF-GW-FBXX-20180123 CUF-GW-FLBXX-20180123 CUF-GW-DUPXX-20180123
		Pore Water	PW	Temporary Well Number	TWXX	Feet Below Top of Casing	Matrix Spike/Matrix Spike Duplicate *For MS/MSD note applicable sample on COC	MS/MSD	Year/Month/Day	CUF-PW-TWXX-35-20180123 CUF-PW-EBXX-20180123 CUF-PW-FBXX-20180123 CUF-PW-FLBXX-20180123 CUF-PW-DUPXX-20180123
		Seep Soil	SeS	Seep Number	XX	NA			Year/Month/Day	CUF-SeS-XX-20180123 CUF-SeS-EBXX-20180123 CUF-SeS-FBXX-20180123 CUF-SeS-DUPXX-20180123
		Seep Water	SeW	Seep Number	XX	NA			Year/Month/Day	CUF-SeW-XX-20180123 CUF-SeW-EBXX-20180123 CUF-SeW-FBXX-20180123 CUF-SeW-FLBXX-20180123 CUF-SeW-DUPXX-20180123
		Surface Stream:**Not Stratified**	STR	Water Body Acronym Spatial Location Number	CuR = Cumberland RiverWC = Wells CreekUT = Unnamed TributaryDC = Discharge ChannelPO = Pond/ Embayment	Top = Water SurfaceMid = Mid ColumnEpB = Epibenthic			Year/Month/Day	CUF-STR-CuRXX-Top-20180123 CUF-STR-CuRXX-Mid-20180123 CUF-STR-CuRXX-EpB-20180123 CUF-STR-WCXX-Top-20180123 CUF-STR-WCXX-Mid-20180123 CUF-STR-WCXX-EpB-20180123 CUF-STR-UTXX-Top-20180123 CUF-STR-UTXX-Mid-20180123 CUF-STR-UTXX-EpB-20180123 CUF-STR-DCXX-Top-20180123 CUF-STR-DCXX-Mid-20180123 CUF-STR-DCXX-EpB-20180123 CUF-STR-POXX-Top-20180123 CUF-STR-POXX-Mid-20180123 CUF-STR-POXX-EpB-20180123 CUF-STR-EBXX-20180123 CUF-STR-FBXX-20180123 CUF-STR-FLBXX-20180123 CUF-STR-DUPXX-20180123

Site (Plant) Name	**Site Acronym**		**Sample Type (Matrix)**	**Sample Type Acronym**		**Location**	**Location ID**		**Depth Interval (If Applicable)**		**Quality Control/Quality Assurance Sample Type**	**Sample Type Acronym**		**Date of Sample**		**Example**
			Surface Stream: **Stratified**	STR		Water Body Acronym Spatial Location Number	CuR = Cumberland River WC = Wells Creek UT = Unnamed Tributary DC = Discharge Channel PO = Pond/ Embayment		NS = Near Surface ME = Mid-Epillimnion MH = Mid-Hypolimnion NB = Near Bottom					Year/Month/Day		CUF-STR-CuRXX-NS-20180123 CUF-STR-CuRXX-ME-20180123 CUF-STR-CuRXX-MH-20180123 CUF-STR-CuRXX-NB-20180123 CUF-STR-WCXX-NS-20180123 CUF-STR-WCXX-ME-20180123 CUF-STR-WCXX-MH-20180123 CUF-STR-WCXX-NB-20180123 CUF-STR-UTXX-NS-20180123 CUF-STR-UTXX-ME-20180123 CUF-STR-UTXX-MH-20180123 CUF-STR-UTXX-NB-20180123 CUF-STR-DCXX-NS-20180123 CUF-STR-DCXX-ME-20180123 CUF-STR-DCXX-MH-20180123 CUF-STR-DCXX-NB-20180123 CUF-STR-POXX-NS-20180123 CUF-STR-POXX-ME-20180123 CUF-STR-POXX-MH-20180123 CUF-STR-POXX-NB-20180123 CUF-STR-EBXX-20180123 CUF-STR-FBXX-20180123 CUF-STR-FLBXX-20180123 CUF-STR-DUPXX-20180123
			Fish	FH		See Table B										
			Adult Mayflies	MFA		See Table B										
			Purated Mayfly Nymphs	MFP		See Table B										
			Non-Purated Mayfly Nymphs	MFN		See Table B										
			Macro-invertebrate	MAC		See Table C										
			Sediment	SED		See Table C										

Table B: TVA - TDEC Order Fish & Mayfly Sample Naming Conventions

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Biota Matrix Code	Species Identifier	Species Identifier Acronym	River & River Mile Collection Location	Environmental Medium Identifier	Quality Control/Quality Assurance Sample Type	Sample Type Acronym	Date of Sample	Example
Cumberland Fossil Plant	CUF	Adult Mayflies	MFA	NA	NA	CuRD: Cumberland River Downstream Reach (Approximately CuRM 98.5 - 100.5)	NA	Field Duplicate	DUPXX	Year/Month/Day	CUF-MFA-CuRD-20180123 CUF-MFA-DUPXX-20180123 CUF-MFA-EBXX-20180123
		Purated Mayfly Nymphs	MFP	NA	NA	CuRU: Cumberland River Upstream Reach (Approximately CuRM 106 - 108)	NA	Equipment Rinsate Blank	EBXX	Year/Month/Day	CUF-MFP-CuRU-20180123 CUF-MFP-DUPXX-20180123 CUF-MFP-EBXX-20180123
		Non-Purated Mayfly Nymphs	MFN	NA	NA	CuRA: Cumberland River Adjacent Reach (Approximately CuRM 102.3 - 103.3)	NA	Matrix Spike/Matrix Spike Duplicate *For MS/MSD note applicable sample on COC	MS/MSD	Year/Month/Day	CUF-MFN-CuRA-20180123 CUF-MFN-DUPXX-20180123 CUF-MFN-EBXX-20180123
		Fish	FH	Blue Gill	BG	WCD: Wells Creek Downstream Reach (Approximately WcRM 0.50 – 1.0)	F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	CUF-FH-BG-WCD-F-20180123 CUF-FH-BG-WCD-O-20180123 CUF-FH-BG-WCD-L-20180123 CUF-FH-BG-F-DUPXX-20180123 CUF-FH-BG-F-EBXX-20180123
				Channel Catfish	CC	WCU: Wells Creek Upstream Reach (Approximately WcRM 1.5 – 2.0)	F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	CUF-FH-CC-WCU-F-20180123 CUF-FH-CC-WCU-O-20180123 CUF-FH-CC-WCU-L-20180123 CUF-FH-CC-O-DUPXX-20180123 CUF-FH-CC-O-EBXX-20180123
				Largemouth Bass	LB		F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	CUF-FH-LB-CuRD-F-20180123 CUF-FH-LB-CuRD-O-20180123 CUF-FH-LB-CuRD-L-20180123 CUF-FH-LB-L-DUPXX-20180123 CUF-FH-LB-L-EBXX-20180123
				Redear Sunfish	RS		F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	CUF-FH-RS-CuRU-F-20180123 CUF-FH-RS-CuRU-O-20180123 CUF-FH-RS-CuRU-L-20180123 CUF-FH-RS-F-DUPXX-20180123 CUF-FH-RS-F-EBXX-20180123
				Shad	SH		WF = Whole Fish			Year/Month/Day	CUF-FH-SH-CuRA-WF-20180123 CUF-FH-SH-WF-DUPXX-20180123 CUF-FH-SH-WF-EBXX-20180123

Table C: TVA - TDEC Order Sediment and Benthic Sample Naming Conventions

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Biota Matrix Code	Location	Location ID	Transect Number	Sample Number	Depth Interval (If Applicable)	Quality Control/Quality Assurance Sample Type	Sample Type Acronym	Date of Sample	Example
Cumberland Fossil Plant	CUF	Macroinvertebrate	MAC	Water Body Acronym	CuR = Cumberland River WC = Wells Creek	CuRXX WCXX	BENXX	Feet/Feet	Equipment Rinsate Blank	EBXX	Year/Month/Day	CUF-MAC-CuRXX-BENXX-0.0/0.5-20180123 CUF-MAC-WCXX-BENXX-0.0/0.5-20180123 CUF-MAC-CuRXX-EBXX-20180123 CUF-MAC-CuRXX-DUPXX-20180123
		Sediment	Sed	Water Body Acronym	CuR = Cumberland River WC = Wells Creek UT = Unnamed Tributary DC = Discharge Channel PO = Pond/ Embayment	CuRXX WCXX UTXX DCXX POXX	CORXX	Feet/Feet	Field Duplicate	DUPXX	Year/Month/Day	CUF-SED-CuRXX-CORXX-0.0/0.5-20180123 CUF-SED-WCXX-CORXX-0.0/0.5-20180123 CUF-SED-UTXX-CORXX-0.0/0.5-20180123 CUF-SED-DCXX-CORXX-0.0/0.5-20180123 CUF-SED-POXX-CORXX-0.0/0.5-20180123 CUF-SED-CuRXX-EBXX-20180123 CUF-SED-CuRXX-DUPXX-20180123 CUF-SED-WCXX-EBXX-20180123 CUF-SED-WCXX-DUPXX-20180123 CUF-SED-UTXX-EBXX-20180123 CUF-SED-UTXX-DUPXX-20180123 CUF-SED-DCXX-EBXX-20180123 CUF-SED-DCXX-DUPXX-20180123 CUF-SED-POXX-EBXX-20180123 CUF-SED-POXX-DUPXX-20180123
									Matrix Spike/Matrix Spike Duplicate *For MS/MSD note applicable sample on COC	MS/MSD		

ATTACHMENT E

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

BACKGROUND SOIL SAMPLING

Table E-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Soil	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	8-oz glass	20 g	Cool to < 6°C	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	28 days
	pH				NA*
	Percent Ash	4-oz glass	5 g	NA	NA
Aqueous Blanks	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days

*Holding time for soil pH samples is 15 minutes following creation of soil paste. Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time.

Notes:

oz	-	ounce
g	-	grams
mL	-	milliliter
L	-	liter
HDPE	-	High Density Polyethylene
NA	-	Not applicable

Table E-2: Analytes, Methods, and Reporting Limits – Solid Matrices

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.200	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.100	mg/kg
Barium	7440-39-3	SW-846 6020A	1.00	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.100	mg/kg
Boron	7440-42-8	SW-846 6020A	0.5	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.100	mg/kg
Calcium	7440-70-2	SW-846 6020A	50.0	mg/kg
Chromium	16065-83-1	SW-846 6020A	0.200	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.0500	mg/kg
Copper	7440-50-8	SW-846 6020A	0.200	mg/kg
Lead	7439-92-1	SW-846 6020A	0.100	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.500	mg/kg
Mercury	7487-94-7	SW-846 7471B	0.0330	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.500	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.100	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.500	mg/kg
Silver	7440-22-4	SW-846 6020A	0.100	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.100	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.100	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.500	mg/kg
Radium-226	13982-63-3	EPA 901.1	1.00	pCi/g
Radium-228	15262-20-1	EPA 901.1	1.00	pCi/g
Radium-226+228	RA226/228	CALC	1.00	pCi/g
Percent Ash	%ASH	R.J. Lee SOP OPT23.02	1	%
Chloride	16887-00-6	SW-846 9056A Modified	10.0	mg/kg
Fluoride	16984-48-8	SW-846 9056A Modified	1.0	mg/kg
Sulfate	14808-79-8	SW-846 9056A Modified	10.0	mg/kg
pH[2]	PH	SW-846 9045D Modified (laboratory-based definitive analysis)	0.1	pH units

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram
pCi/g - picoCuries per gram
CALC - Parameter determined by calculation.

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

2 Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time (15 minutes following creation of soil paste).

Table E-3: Quantitative QA Objectives – Soil Samples

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	NA	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	NA	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	30-110	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 901.1	30-110	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Anions	SW-846 9056A Modified	NA	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
Percent Ash	R.J. Lee SOP OPT23.02	NA	< RL	NA	NA	NA	NA	±10%	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified (laboratory-based definitive analysis)	NA	pH 6-8 for laboratory-supplied deionized water	NA	NA	NA	NA	±0.2 pH units	±0.5 pH units

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT F

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

CCR MATERIAL CHARACTERISTIC SAMPLING

Table F-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation[1]	Holding Time
CCR Material	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	8-oz glass	20 g	Cool to < 6°C	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	28 days
	pH				NA
	Percent Ash	4-oz glass	5 g	NA	NA
	Total Organic Carbon	8-oz G	10 g	Cool to <6°C	28 days
Pore Water	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Total Dissolved Solids (TDS)[2]	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Total Organic Carbon	2x 40-mL VOA Vial	40-mL	Cool to ≤ 6°C HCl to pH < 2	28 days
	pH (field measurement)	NA	NA	NA	15 minutes

Notes:

mL - milliliters
L - Liters
HDPE - High Density Polyethylene
NA - Not applicable

[1] Filtered samples requiring chemical preservation will be preserved after field filtration.

[2] TDS will be performed for unfiltered sample volume only.

Table F-2: Analytes, Methods, and Reporting Limits – CCR Material

Parameter	CAS No.	Method	Reporting Limit [1]	Units
Antimony	7440-36-0	SW-846 6020A	0.2	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.1	mg/kg
Barium	7440-39-3	SW-846 6020A	1	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.1	mg/kg
Boron	7440-42-8	SW-846 6020A	0.5	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.1	mg/kg
Calcium	7440-70-2	SW-846 6020A	50	mg/kg
Chromium	16065-83-1	SW-846 6020A	0.2	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.05	mg/kg
Copper	7440-50-8	SW-846 6020A	0.2	mg/kg
Iron	7439-89-6	SW-846 6020A	5	mg/kg
Lead	7439-92-1	SW-846 6020A	0.1	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.5	mg/kg
Mercury	7487-94-7	SW-846 7471B	0.033	mg/kg
Manganese	7439-96-5	SW-846 6020A	0.5	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.5	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.1	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.5	mg/kg
Silver	7440-22-4	SW-846 6020A	0.1	mg/kg
Sodium	7440-23-5	SW-846 6020A	50	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.1	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.1	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.5	mg/kg
Radium-226	13982-63-3	EPA 901.1	1.00	pCi/g
Radium-228	15262-20-1	EPA 901.1	1.00	pCi/g
Radium-226+228	RA226/228	CALC	1.00	pCi/g
Total Organic Carbon	7440-44-0	Lloyd Kahn or SW-846 9060A	1000	mg/kg
Percent Ash	%ASH	R.J. Lee SOP OPT23.02	1	%
Chloride	16887-00-6	SW-846 9056A Modified	10.0	mg/kg
Fluoride	16984-48-8	SW-846 9056A Modified	1.0	mg/kg
Sulfate	14808-79-8	SW-846 9056A Modified	10.0	mg/kg

Parameter	CAS No.	Method	Reporting Limit [1]	Units
pH	PH	SW-846 9045D Modified	0.1	pH units

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram
pCi/g - picoCuries per gram
CALC - Parameter determined by calculation

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table F-3: Analytes, Methods, and Reporting Limits – Pore Water Samples (Filtered and Unfiltered)

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
pH	pH	SW-846 Method 9040C	0.05	pH units
Antimony	7440-36-0	SW-846 6020A	2.00	µg/L
Arsenic	7440-38-2	SW-846 6020A	1.00	µg/L
Barium	7440-39-3	SW-846 6020A	10.0	µg/L
Beryllium	7440-41-7	SW-846 6020A	1.00	µg/L
Boron	7440-42-8	SW-846 6020A	80.0	µg/L
Cadmium	7440-43-9	SW-846 6020A	1.00	µg/L
Calcium	7440-70-2	SW-846 6020A	500	µg/L
Chromium	16065-83-1	SW-846 6020A	2.00	µg/L
Cobalt	7440-48-4	SW-846 6020A	0.50	µg/L
Copper	7440-50-8	SW-846 6020A	2.00	µg/L
Copper	7440-50-8	SW-846 6020A	2.00	µg/L
Lead	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium	7439-93-2	SW-846 6020A	5.00	µg/L
Mercury	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel	7440-02-0	SW-846 6020A	10.0	µg/L
Selenium	7782-49-2	SW-846 6020A	5.00	µg/L
Silver	7440-22-4	SW-846 6020A	1.00	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Sodium	7440-23-5	SW-846 6020A	500	µg/L
Thallium	7440-28-0	SW-846 6020A	1.00	µg/L
Vanadium	7440-62-2	SW-846 6020A	1.00	µg/L
Zinc	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L
Total Organic Carbon	7440-44-0	SM 5310C/SW-846 9060A	1.00	mg/L

Notes:

CAS No.	-	Chemical Abstracts Service registry number
mg/L	-	milligrams per liter
µg/L	-	microgram per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation.

Table F-4: Quantitative QA Objectives – CCR Material

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% Recovery)	MS/MSD Accuracy (% Recovery)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	NA	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	NA	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	30-110	< RL	75-125	NA	RER<2	NA	RER<2	RER<2
Radium-228	EPA 901.1	30-110	< RL	75-125	NA	RER<2	NA	RER<2	RER<2
Total Organic Carbon	Lloyd Kahn or SW-846 9060A	NA	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified	NA	pH 6-8 for laboratory-supplied deionized water	NA	NA	NA	NA	±0.2 pH units	±0.5 pH units
% Ash	RJ Lee SOP OPT-23.2	NA	NA	NA	NA	NA	NA	±10%	RPD < 10%

Notes:

[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
RER - Relative Error

Table F-5: Quantitative QA Objectives – Pore Water (Filtered and Unfiltered)

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury	SW-846 7470A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Organic Carbon	SM 5310C/SW-846 9060A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT G

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

SURFACE STREAM SAMPLING

Table G-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Surface Water	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to <6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	pH (field measurement)	NA	NA	NA	15 minutes
	Total Dissolved Solids (TDS)	250-mL HDPE	100 mL	Cool to < 6°C	7 days
	Total Suspended Solids (TSS)	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days

Notes:

oz - ounce
g - grams
mL - milliliter
L - liter
HDPE - High Density Polyethylene
NA - Not applicable

Table G-2: Analytes, Methods, and Reporting Limits – Surface Water Samples (Filtered and Unfiltered)

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
Total Suspended Solids	TSS	SM2540D	10.0	mg/L
pH	pH	SW-846 Method 9040C	0.05	pH units
Antimony	7440-36-0	SW-846 6020A	2.00	µg/L
Arsenic	7440-38-2	SW-846 6020A	1.00	µg/L
Barium	7440-39-3	SW-846 6020A	10.0	µg/L
Beryllium	7440-41-7	SW-846 6020A	1.00	µg/L
Boron	7440-42-8	SW-846 6020A	80.0	µg/L
Cadmium	7440-43-9	SW-846 6020A	1.00	µg/L
Calcium	7440-70-2	SW-846 6020A	500	µg/L
Chromium	16065-83-1	SW-846 6020A	2.00	µg/L
Cobalt	7440-48-4	SW-846 6020A	0.5	µg/L
Copper	7440-50-8	SW-846 6020A	2.00	µg/L
Lead	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium	7439-93-2	SW-846 6020A	5.00	µg/L
Mercury	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel	7440-02-0	SW-846 6020A	10.0	µg/L
Selenium	7782-49-2	SW-846 6020A	5.00	µg/L
Silver	7440-22-4	SW-846 6020A	1.00	µg/L
Thallium	7440-28-0	SW-846 6020A	1.00	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Vanadium	7440-62-2	SW-846 6020A	1.00	µg/L
Zinc	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L

Notes:

CAS No.	-	Chemical Abstracts Service registry number
mg/L	-	milligrams per liter
µg/L	-	micrograms per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation.

Table G-3: Quantitative QA Objectives – Surface Water (Filtered and Unfiltered)

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury	SW-846 7470A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Total Suspended Solids	SM 2540D	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	Field Measurement	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT H

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

WATER USE SURVEY SAMPLING

Table H-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Water Supply Water	Metals (Total)	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury (Total)				28 days
	Metals (Dissolved)	250-mL HDPE	250 mL	HNO_3 to pH < 2 after laboratory filtration Cool to < 6°C	180 days
	Mercury (Dissolved)				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Total Dissolved Solids (TDS)	250-mL HDPE	100 mL	Cool to < 6°C	7 days
	Total Suspended Solids (TSS)	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Alkalinity (Total, Carbonate, and Bicarbonate)	250 mL HDPE	50-mL	Cool to < 6°C	14 days
	pH (field measurement)	NA	NA	NA	15 minutes

Notes:

mL - milliliter
L - liter
HDPE - High Density Polyethylene
NA - Not applicable

Table H-2: Analytes, Methods, and Reporting Limits – Water Supply Well Samples

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
Total Suspended Solids	TSS	SM2540D	10.0	mg/L
pH	pH	SW-846 9040C	0.05	pH units
Antimony (Total and Dissolved)	7440-36-0	EPA 200.8	2.00	µg/L
Arsenic (Total and Dissolved)	7440-38-2	EPA 200.8	1.00	µg/L
Barium (Total and Dissolved)	7440-39-3	EPA 200.8	10.0	µg/L
Beryllium (Total and Dissolved)	7440-41-7	EPA 200.8	1.00	µg/L
Boron (Total and Dissolved)	7440-42-8	EPA 200.8	80.0	µg/L
Cadmium (Total and Dissolved)	7440-43-9	EPA 200.8	1.00	µg/L
Calcium (Total and Dissolved)	7440-70-2	EPA 200.8	500	µg/L
Chromium (Total and Dissolved)	16065-83-1	EPA 200.8	2.00	µg/L
Cobalt (Total and Dissolved)	7440-48-4	EPA 200.8	0.50	µg/L
Copper (Total and Dissolved)	7440-50-8	EPA 200.8	2.00	µg/L
Lead (Total and Dissolved)	7439-92-1	EPA 200.8	1.00	µg/L
Lithium (Total and Dissolved)	7439-93-2	EPA 200.8	5.00	µg/L
Magnesium (Total and Dissolved)	7439-95-4	SW-846 6020A	500	µg/L
Mercury (Total and Dissolved)	7487-94-7	EPA 245.1	0.200	µg/L
Molybdenum (Total and Dissolved)	7439-98-7	EPA 200.8	5.00	µg/L
Nickel (Total and Dissolved)	7440-02-0	EPA 200.8	10.0	µg/L
Potassium (Total and Dissolved)	7440-09-7	SW-846 6020A	500	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Selenium (Total and Dissolved)	7782-49-2	EPA 200.8	5.00	µg/L
Silver (Total and Dissolved)	7440-22-4	EPA 200.8	1.00	µg/L
Sodium (Total and Dissolved)	7440-23-5	EPA 200.8	500	µg/L
Thallium (Total and Dissolved)	7440-28-0	EPA 200.8	1.00	µg/L
Vanadium (Total and Dissolved)	7440-62-2	EPA 200.8	1.00	µg/L
Zinc (Total and Dissolved)	7440-66-6	EPA 200.8	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L
Alkalinity, Total	ALK	SM2320B	5.0	mg/L
Alkalinity, Carbonate	CARB	SM2320B	5.0	mg/L
Alkalinity, Bicarbonate	BICARB	SM2320B	5.0	mg/L

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/L - milligrams per liter
pCi/L - picoCuries per liter
CALC - Parameter determined by calculation.

Table H-3: Quantitative QA Objectives – Water Supply Well Sampling

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals (Total and Dissolved)	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury (Total and Dissolved)	SW-846 7470A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Total Suspended Solids	SM 2540D	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS	-	Laboratory Control Sample
LCSD	-	Laboratory Control Sample Duplicate
MS/MSD	-	Matrix Spike/Matrix Spike Duplicate
NA	-	Not Applicable
RPD	-	Relative Percent Difference
RER	-	Relative Error
RL	-	Reporting Limit
%R	-	Percent Recovery

ATTACHMENT I

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

FISH TISSUE SAMPLING

Table I-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

<table>
<tr><th>Matrix</th><th>Parameter(s)</th><th>Container Type</th><th>Recommended Sample Mass/Volume</th><th>Preservation</th><th>Holding Time</th></tr>
<tr><td rowspan="4">Fish Tissue</td><td>Metals</td><td rowspan="4">8-oz WM jar or aluminum foil for filets

Resealable plastic bag or small WM jar (1 to 4-oz) for liver/ovary tissue</td><td>5 g</td><td rowspan="4">During sample collection and transportation to the laboratory, cool to < 6°C

After receipt at the laboratory, freeze at < -10°C</td><td rowspan="4">1 year</td></tr>
<tr><td>Mercury</td><td>1 g</td></tr>
<tr><td>Percent Lipids</td><td>5 g</td></tr>
<tr><td>Percent Moisture</td><td>2 g[1]</td></tr>
<tr><td rowspan="2">Aqueous Blanks</td><td>Metals</td><td rowspan="2">250-mL HDPE</td><td rowspan="2">250 mL</td><td rowspan="2">HNO_3 to pH < 2
Cool to < 6°C</td><td>180 days</td></tr>
<tr><td>Mercury</td><td>28 days</td></tr>
</table>

Notes:

oz	-	ounce
WM	-	wide-mouth
g	-	grams
HDPE	-	High Density Polyethylene
NA	-	Not applicable.

1 A minimum of 2 grams is required for moisture analysis when sufficient sample mass is available. For samples with limited mass (*e.g.*, liver or ovary tissue), moisture analysis will be performed on a minimum 1-gram mass.

Table I-2: Analytes, Methods, and Reporting Limits – Fish Tissue Samples

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.5	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.5	mg/kg
Barium	7440-39-3	SW-846 6020A	0.5	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.5	mg/kg
Boron	7440-42-8	SW-846 6020A	0.5	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.5	mg/kg
Calcium	7440-70-2	SW-846 6020A	0.5	mg/kg
Chromium	16065-83-1	SW-846 6020A	0.5	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.5	mg/kg
Copper	7440-50-8	SW-846 6020A	0.5	mg/kg
Lead	7439-92-1	SW-846 6020A	0.5	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.5	mg/kg
Mercury	7487-94-7	SW-846 7473	0.5	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.5	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.5	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.5	mg/kg
Silver	7440-22-4	SW-846 6020A	0.5	mg/kg
Strontium	7440-24-6	SW-846 6020A	0.5	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.5	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.5	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.5	mg/kg
Percent Lipids	LIPID	Pace SOP S-GB-L-003	0.1	%
Percent Moisture	MOISTURE	ASTM D2974-87	0.1	%

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table I-3: Quantitative QA Objectives – Fish Tissue Samples

Analyte/ Parameter Group	Method	Equipment Rinsate Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7473	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Percent Lipids	Pace SOP S-GB-L-003	< RL	NA	NA	NA	NA	20	RPD < 35% difference < 2× the RL
Percent Moisture	ASTM D2974-87	< RL	NA	NA	NA	NA	10	RPD < 35% difference < 2× the RL

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT J

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

BENTHIC SAMPLING

Table J-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Sediment	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	8-oz glass	20 g	Cool to < 6°C	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	28 days
	pH				NA
	Percent Ash	4-oz glass	5 g	NA	NA
Benthic Invertebrates	Metals	16 oz./32 oz. glass jars	5 g	10% buffered formalin solution	NA
	Mercury		1 g		
	Percent Moisture		5 g (2 g minimum)		
Mayflies	Metals	4-oz glass	5 g	Frozen < - 10°C	NA
	Mercury		1 g		
	Percent Moisture		5 g (2 g minimum)		
Aqueous Blanks	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	pH				24 hours
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days

Notes:

oz	-	ounce
g	-	grams
HDPE	-	High Density Polyethylene
mL	-	milliliters
L	-	liters
NA	-	Not applicable.

Table J-2: Analytes, Methods, and Reporting Limits – Sediment Samples

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.200	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.100	mg/kg
Barium	7440-39-3	SW-846 6020A	1.00	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.100	mg/kg
Boron	7440-42-8	SW-846 6020A	0.5	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.100	mg/kg
Calcium	7440-70-2	SW-846 6020A	50.0	mg/kg
Chromium	16065-83-1	SW-846 6020A	0.200	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.0500	mg/kg
Copper	7440-50-8	SW-846 6020A	0.200	mg/kg
Lead	7439-92-1	SW-846 6020A	0.100	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.500	mg/kg
Mercury	7487-94-7	SW-846 7471B	0.0330	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.500	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.100	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.500	mg/kg
Silver	7440-22-4	SW-846 6020A	0.100	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.100	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.100	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.500	mg/kg
Radium-226	13982-63-3	EPA 901.1	1.00	pCi/g
Radium-228	15262-20-1	EPA 901.1	1.00	pCi/g
Radium-226+228	RA226/228	CALC	1.00	pCi/g
Percent Ash	%ASH	R.J. Lee SOP OPT23.02	1	%
Chloride	16887-00-6	SW-846 9056A Modified	10.0	mg/kg
Fluoride	16984-48-8	SW-846 9056A Modified	1.0	mg/kg
Sulfate	14808-79-8	SW-846 9056A Modified	10.0	mg/kg
pH	PH	SW-846 9045D Modified	0.1	pH units

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram
pCi/g - picoCuries per gram
CALC - Parameter determined by calculation

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table J-3: Analytes, Methods, and Reporting Limits – Benthic Invertebrates and Mayflies

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.5	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.5	mg/kg
Barium	7440-39-3	SW-846 6020A	0.5	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.5	mg/kg
Boron	7440-42-8	SW-846 6020A	0.5	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.5	mg/kg
Calcium	7440-70-2	SW-846 6020A	0.5	mg/kg
Chromium	16065-83-1	SW-846 6020A	0.5	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.5	mg/kg
Copper	7440-50-8	SW-846 6020A	0.5	mg/kg
Lead	7439-92-1	SW-846 6020A	0.5	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.5	mg/kg
Mercury	7487-94-7	SW-846 7473	0.5	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.5	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.5	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.5	mg/kg
Silver	7440-22-4	SW-846 6020A	0.5	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.5	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.5	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.5	mg/kg
Percent Moisture	MOISTURE	ASTM D2974-87	0.1	%

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table J-4: Quantitative QA Objectives – Sediment Samples

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Percent Ash	R.J. Lee SOP OPT23.02	NA	< RL	NA	NA	NA	NA	±10%	RPD < 35% difference < 2× the RL
Metals	SW-846 6020A	NA	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	NA	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	30-110	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 901.1	30-110	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Anions	SW-846 9056A Modified	NA	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified	NA	pH 6-8 for laboratory-supplied DI water	NA	NA	NA	NA	±0.2 pH units	±0.5 pH units

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

Table J-5: Quantitative QA Objectives – Benthic Invertebrate Samples

Analyte/ Parameter Group	Method	Equipment Rinsate Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7473	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Percent Moisture	ASTM D2974-87	< RL	NA	NA	NA	NA	10	RPD < 35% difference < 2× the RL

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT K

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

SEEP SAMPLING

Table K-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation[1]	Holding Time
Seeps Water	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	pH (field measurement)	NA	NA	NA	15 minutes
	Total Dissolved Solids (TDS)	250-mL HDPE	100 mL	Cool to < 6°C	7 days
	Total Suspended Solids (TSS)	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
Seeps Soil	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	8-oz glass	20 g	Cool to < 6°C	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	28 days
	pH				NA*
	Percent Ash	4-oz glass	5 g	NA	NA

Notes:

HDPE - High Density Polyethylene.
g - grams
mL - milliliters
L - liters
NA - Not applicable.

1 Filtered samples requiring chemical preservation will be preserved after field filtration.

*Holding time for soil pH samples is 15 minutes following creation of soil paste. Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time.

Table K-2: Analytes, Methods, and Reporting Limits – Seeps Soil

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.200	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.100	mg/kg
Barium	7440-39-3	SW-846 6020A	1.00	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.100	mg/kg
Boron	7440-42-8	SW-846 6020A	0.5	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.100	mg/kg
Calcium	7440-70-2	SW-846 6020A	50.0	mg/kg
Chromium	16065-83-1	SW-846 6020A	0.200	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.0500	mg/kg
Copper	7440-50-8	SW-846 6020A	0.200	mg/kg
Lead	7439-92-1	SW-846 6020A	0.100	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.500	mg/kg
Mercury	7487-94-7	SW-846 7471B	0.0330	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.500	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.100	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.500	mg/kg
Silver	7440-22-4	SW-846 6020A	0.100	mg/kg
Sodium	7440-23-5	SW-846 6020A	50.0	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.100	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.100	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.500	mg/kg
Radium-226	13982-63-3	EPA 901.1	1.00	pCi/g
Radium-228	15262-20-1	EPA 901.1	1.00	pCi/g
Radium-226+228	RA226/228	CALC	1.00	pCi/g
Percent Ash	%ASH	R.J. Lee SOP OPT23.02	1	%
Chloride	16887-00-6	SW-846 9056A Modified	10.0	mg/kg
Fluoride	16984-48-8	SW-846 9056A Modified	1.0	mg/kg
Sulfate	14808-79-8	SW-846 9056A Modified	10.0	mg/kg
pH	PH	SW-846 9045D Modified (laboratory-based definitive analysis)	0.1	pH units

Notes:

CAS No.	-	Chemical Abstracts Service registry number
mg/kg	-	milligrams per kilogram
pCi/g	-	picoCuries per gram
CALC	-	Parameter determined by calculation

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table K-3: Analytes, Methods, and Reporting Limits – Seeps Water Samples (Filtered and Unfiltered)

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
Total Suspended Solids	TSS	SM2540D	10.0	mg/L
pH	pH	SW-846 9040C	0.05	pH units
Antimony	7440-36-0	SW-846 6020A	2.00	µg/L
Arsenic	7440-38-2	SW-846 6020A	1.00	µg/L
Barium	7440-39-3	SW-846 6020A	10	µg/L
Beryllium	7440-41-7	SW-846 6020A	1.00	µg/L
Boron	7440-42-8	SW-846 6020A	80	µg/L
Cadmium	7440-43-9	SW-846 6020A	1.00	µg/L
Calcium	7440-70-2	SW-846 6020A	500	µg/L
Chromium	16065-83-1	SW-846 6020A	2.00	µg/L
Cobalt	7440-48-4	SW-846 6020A	0.5	µg/L
Copper	7440-50-8	SW-846 6020A	2.00	µg/L
Lead	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium	7439-93-2	SW-846 6020A	5.00	µg/L
Mercury	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel	7440-02-0	SW-846 6020A	10	µg/L
Selenium	7782-49-2	SW-846 6020A	5.00	µg/L
Silver	7440-22-4	SW-846 6020A	1.00	µg/L
Sodium	7440-23-5	SW-846 6020A	500	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Thallium	7440-28-0	SW-846 6020A	1.00	µg/L
Vanadium	7440-62-2	SW-846 6020A	1.00	µg/L
Zinc	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L

Notes:

CAS No.	-	Chemical Abstracts Service registry number
mg/L	-	milligrams per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation

Table K-4: Quantitative QA Objectives – Seeps Soil Samples

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries / Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Percent Ash	R.J. Lee SOP OPT23.02	NA	< RL	NA	NA	NA	NA	±10%	RPD < 35% difference < 2× the RL
Metals	SW-846 6020A	NA	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	NA	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	30-110	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 901.1	30-110	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Anions	SW-846 9056A Modified	NA	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified (laboratory-based definitive analysis)	NA	pH 6-8 for laboratory-supplied deionized water	NA	NA	NA	NA	±0.2 pH units	±0.5 pH units

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

Table K-5: Quantitative QA Objectives – Seeps Water Samples (Filtered and Unfiltered)

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury	SW-846 7470	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Total Suspended Solids	SM 2540D	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
RER - Relative Error

ATTACHMENT L

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

GROUNDWATER INVESTIGATION SAMPLING

Table L-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	**Parameter(s)**	**Container Type**	**Recommended Sample Mass/Volume**	**Preservation[1]**	**Holding Time**
Groundwater	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Total Dissolved Solids (TDS)	250-mL HDPE	100 mL	Cool to < 6°C	7 days
	Total Suspended Solids (TSS)	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Alkalinity (Total, Carbonate, and Bicarbonate)	250 mL HDPE	50-mL	Cool to < 6°C	14 days
	pH (field measurement)	NA	NA	NA	15 minutes

Notes:

HDPE - High Density Polyethylene
mL - milliliters
L - liters
NA - Not applicable.

[1] Filtered samples requiring chemical preservation will be preserved after field filtration.

Table L-2: Analytes, Methods, and Reporting Limits – Groundwater Samples

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
Total Suspended Solids	TSS	SM2540D	10.0	mg/L
pH	pH	SW-846 9040C	0.05	pH units
Antimony (Total and Dissolved)	7440-36-0	SW-846 6020A	2.00	µg/L
Arsenic (Total and Dissolved)	7440-38-2	SW-846 6020A	1.00	µg/L
Barium (Total and Dissolved)	7440-39-3	SW-846 6020A	10.0	µg/L
Beryllium (Total and Dissolved)	7440-41-7	SW-846 6020A	1.00	µg/L
Boron (Total and Dissolved)	7440-42-8	SW-846 6020A	80.0	µg/L
Cadmium (Total and Dissolved)	7440-43-9	SW-846 6020A	1.00	µg/L
Calcium (Total and Dissolved)	7440-70-2	SW-846 6020A	500	µg/L
Chromium (Total and Dissolved)	16065-83-1	SW-846 6020A	2.00	µg/L
Cobalt (Total and Dissolved)	7440-48-4	SW-846 6020A	0.500	µg/L
Copper (Total and Dissolved)	7440-50-8	SW-846 6020A	2.00	µg/L
Lead (Total and Dissolved)	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium (Total and Dissolved)	7439-93-2	SW-846 6020A	5.00	µg/L
Magnesium (Total and Dissolved)	7439-95-4	SW-846 6020A	500	µg/L
Mercury (Total and Dissolved)	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum (Total and Dissolved)	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel (Total and Dissolved)	7440-02-0	SW-846 6020A	10.00	µg/L
Potassium (Total and Dissolved)	7440-09-7	SW-846 6020A	500	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Selenium (Total and Dissolved)	7782-49-2	SW-846 6020A	5.00	µg/L
Silver (Total and Dissolved)	7440-22-4	SW-846 6020A	1.00	µg/L
Sodium (Total and Dissolved)	7440-23-5	SW-846 6020A	500	µg/L
Thallium (Total and Dissolved)	7440-28-0	SW-846 6020A	1.00	µg/L
Vanadium (Total and Dissolved)	7440-62-2	SW-846 6020A	1.00	µg/L
Zinc (Total and Dissolved)	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L
Alkalinity, Total	ALK	SM2320B	5.0	mg/L
Alkalinity, Carbonate	CARB	SM2320B	5.0	mg/L
Alkalinity, Bicarbonate	BICARB	SM2320B	5.0	mg/L

Notes:

CAS No.	-	Chemical Abstracts Service registry number
mg/L	-	milligrams per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation.

Table L-3: Quantitative QA Objectives – Groundwater

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals (Total and Dissolved)	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury (Total and Dissolved)	SW-846 7470A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Total Suspended Solids	SM 2540D	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:

[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS/LCSD - Laboratory Control Sample/Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

APPENDIX D
FIGURES

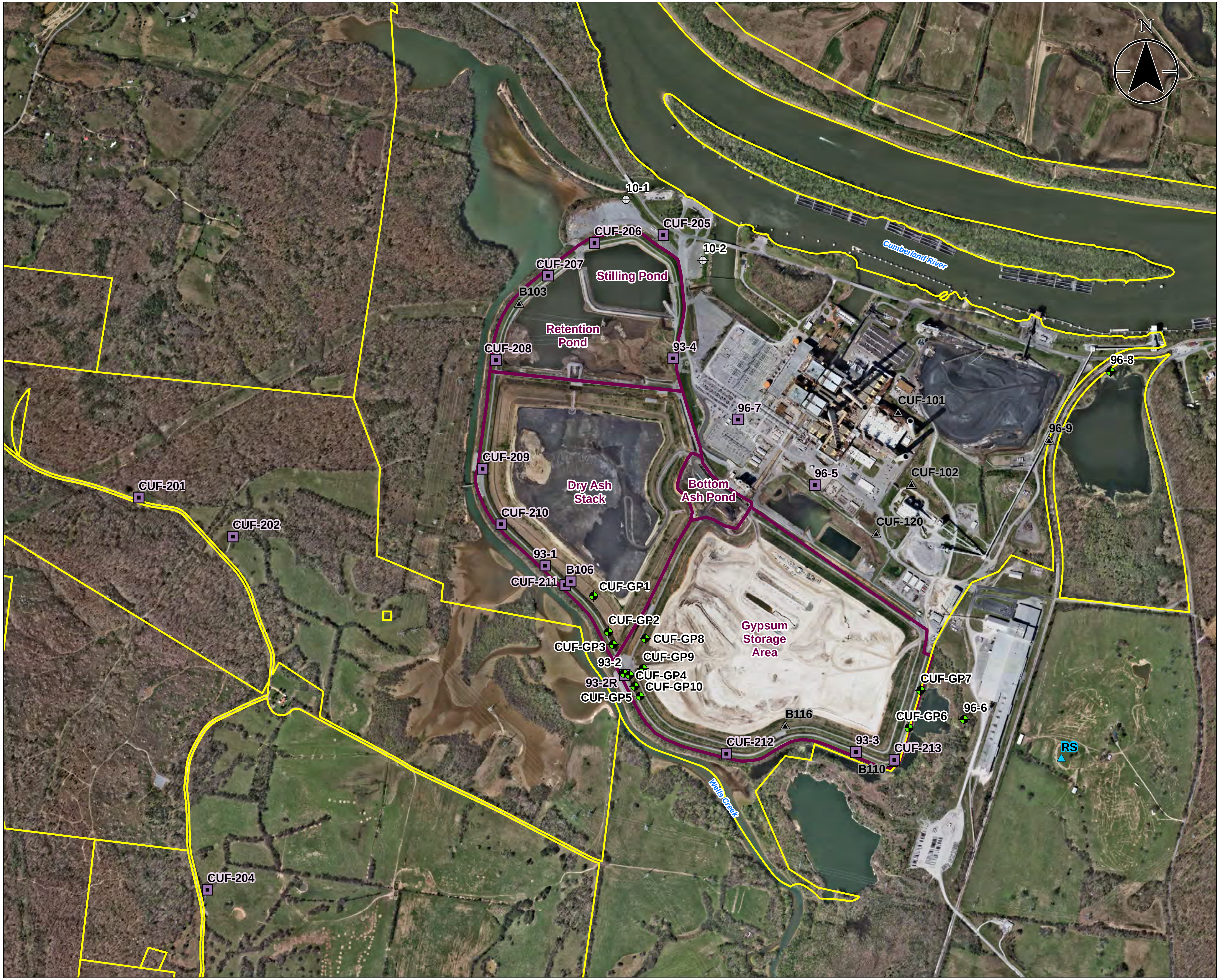


Figure No.

1

Title

Existing and Abandoned Groundwater Wells

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location 175566329

Stewart County, Tennessee

Prepared by MW on 2017-11-07
Technical Review by JG on 2017-11-01

0 500 1,000 1,500 2,000 Feet

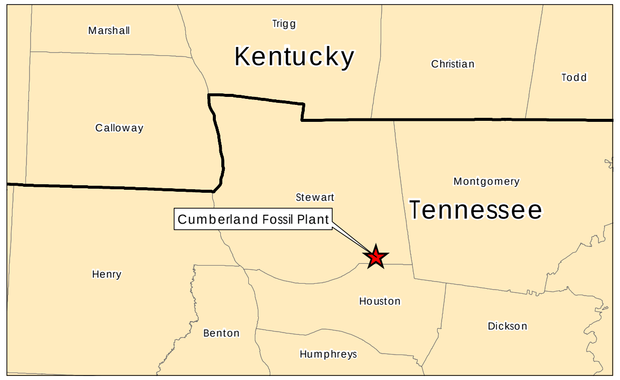
1:6,000 (At original document size of 22x34)

Legend

- Existing Groundwater Monitoring Well
- Abandoned Groundwater Monitoring Well
- Existing Observation Well
- Abandoned Observation Well
- Surface Water
- TVA Property Boundary
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec

TVA

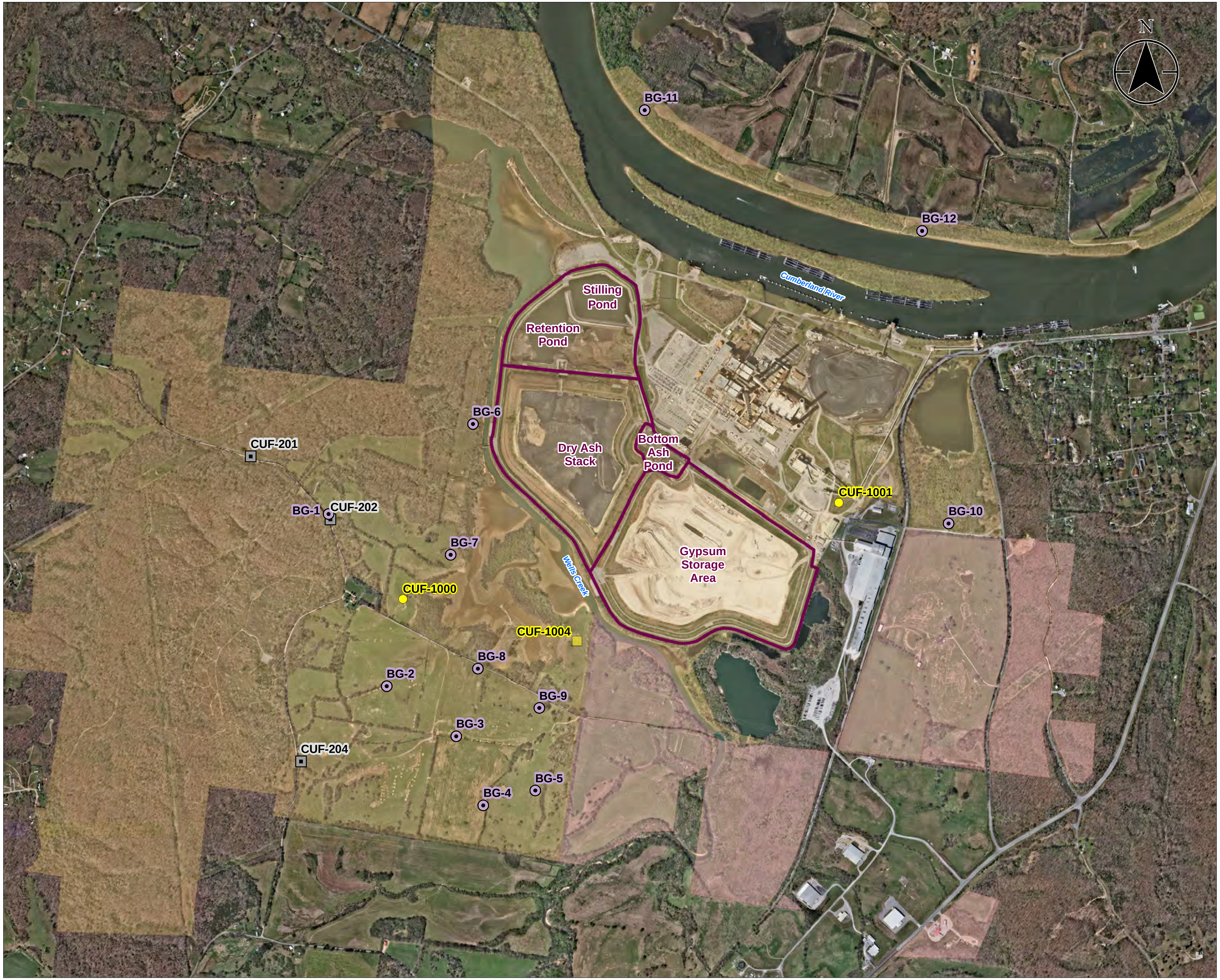


Figure No.
2

Title
Proposed Soil Sample Locations

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

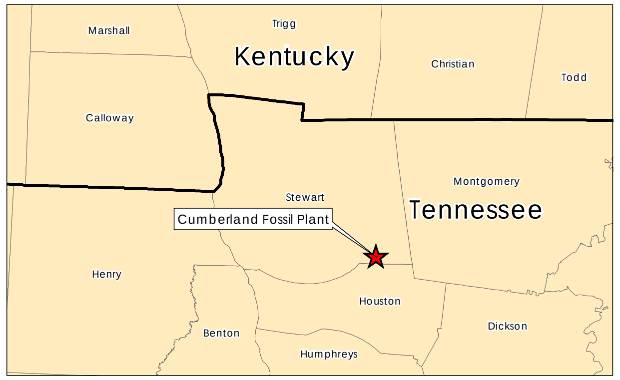
175566329
Prepared by TR on 2018-01-24
Technical Review by EM on 2018-01-24

0 700 1,400 2,100 2,800 Feet
1:8,400 (At original document size of 22x34)

Legend

- Existing Background Groundwater Monitoring Well
- Proposed Background Soil Sample Location
- Proposed Background Monitoring Well
- Proposed Well Area
- TVA Property
- Rye Property - No Access
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Property digitized from Tennessee Property Viewer



Stantec TVA

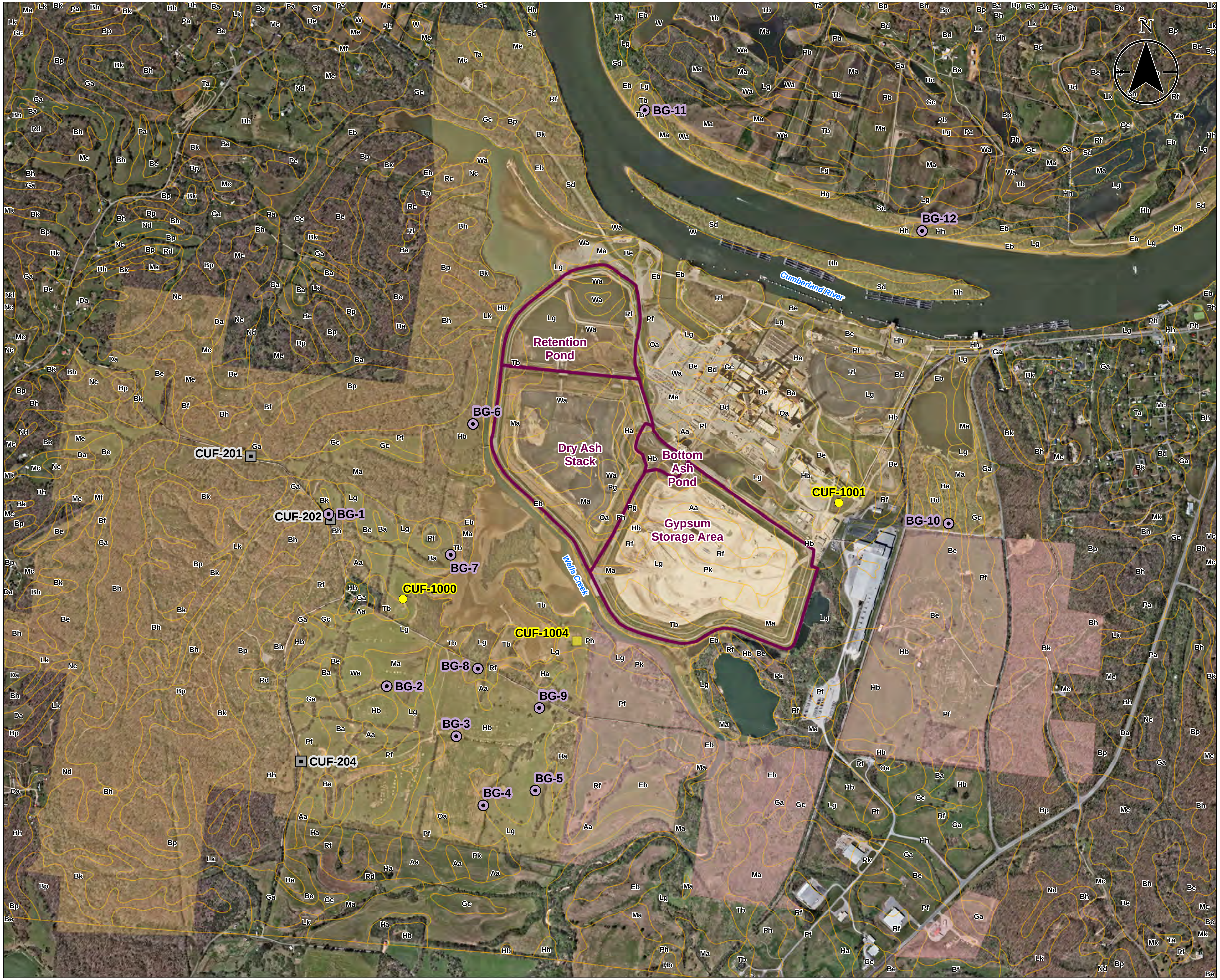


Figure No.
3

Title
Proposed Soil Sample Locations

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2018-01-24
Technical Review by EM on 2018-01-24

0 700 1,400 2,100 2,800 Feet

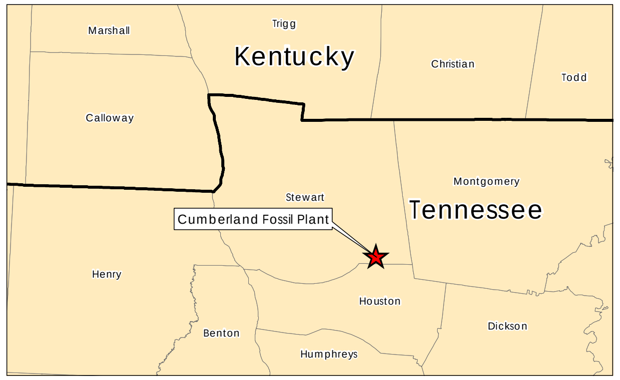
1:8,400 (At original document size of 22x34)

Legend

- Existing Background Groundwater Monitoring Well
- Proposed Background Soil Sample Location
- Proposed Background Monitoring Well
- Proposed Well Area
- TVA Property
- Rye Property - No Access
- Soil Map Unit
- CCR Unit Area (Approximate)

Soil Unit	Soil Map Unit Name	Soil Unit	Soil Map Unit Name
Aa	Nolin silt loam, occasionally ponded	Lk	Lobelville silt loam, occasionally flooded
Ba	Sengtown gravelly silt loam, 5 to 12 percent slopes	Ma	Melvin silt loam, frequently flooded
Bd	Sengtown gravelly silt loam, 12 to 20 percent slopes, severely eroded	Mc	Mountview silt loam, 5 to 12 percent slopes, eroded
Be	Sengtown gravelly silt loam, 12 to 20 percent slopes	Me	Sengtown silt loam, 12 to 20 percent slopes
Bf	Sengtown gravelly silt loam, 30 to 60 percent slopes	Nc	Hawthorne gravelly silt loam, 12 to 20 percent slopes
Bh	Bodine gravelly silt loam, 12 to 20 percent slopes, eroded	Oa	Newark silt loam, occasionally ponded
Bk	Bodine gravelly silt loam, 5 to 12 percent slopes, eroded	Pf	Byler silt loam, 5 to 12 percent slopes, eroded
Bp	Bodine gravelly silt loam, 20 to 60 percent slopes	Pg	Armour silt loam, 12 to 20 percent slopes
Eb	Egam silty clay loam, occasionally flooded	Ph	Armour silt loam, 5 to 12 percent slopes
Ga	Humphreys gravelly silt loam, 2 to 5 percent slopes	Pk	Armour silt loam, 2 to 5 percent slopes, eroded
Gc	Trace silt loam, 2 to 5 percent slopes	Rc	Sengtown-Gullied land complex, 12 to 20 percent slopes
Ha	Maury silty clay loam, 12 to 20 percent slopes, eroded	Rf	Sengtown-Rock outcrop complex, 20 to 60 percent slopes
Hb	Maury silty clay loam, 5 to 12 percent slopes, eroded	Sd	Staser fine sandy loam, occasionally flooded
Hg	Sequatchie fine sandy loam, 2 to 5 percent slopes	Tb	Gumdale silt loam, rarely flooded
Hh	Nolin silt loam, occasionally flooded	W	Water
Lg	Lindell silt loam, 0 to 2 percent slopes, occasionally flooded	Wa	Wolftever silt loam, 1 to 5 percent slopes, occasionally flooded

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Property digitized from Tennessee Property Viewer
4. Soil Map Unit data was obtained from U.S. Department of Agriculture



Stantec

TVA

Figure 4

Geologic Map of Wells Creek Basin (Tiedemann et al. 1968)

GEOLOGIC MAP OF WELLS CREEK BASIN

By
Herbert A. Tiedemann, Charles W. Wilson, Jr., and Richard G. Stearns

1968

EXPLANATION

QUATERNARY

Qal

Alluvial Deposits

Flood plain deposits of the Cumberland River consist of clay and silt, light- to medium-gray and yellowish-orange; with lenses of quartz sand and chert sand, gray to brownish-orange, fine- to coarse-grained; chert and quartz gravel, gray to yellowish-orange and yellowish- to reddish-brown. Thickness as much as 90 feet.

Flood plain deposits of the larger creeks are similar to those of the Cumberland River, except for a lack of quartz pebbles. They consist of unsorted, angular to subrounded chert gravel with clay, silt, and sand. Thickness highly variable.

MISSISSIPPIAN / DEVONIAN and MISSISSIPPIAN

Mfp

Fort Payne Formation, New Providence Shale, and Chattanooga Shale

Fort Payne Formation

Argillaceous or siliceous limestone and calcareous siltstone, brownish-gray to light olive gray, fine-grained, thin- to thick-bedded. Weathers to two markedly different units, an upper scraggy chert and a lower bedded chert.

Upper scraggy chert consists of masses of banded, fine-grained, rough and porous, pale-orange and yellowish-brown chert. Upper part of this unit also may contain nodules and beds of streaked, fossiliferous chert. Thickness about 100 feet.

Lower bedded chert consists of layers of dark-gray, streaked, nonfossiliferous chert, which breaks into a rubble of blocks. Partial weathering of the original calcareous siltstone in this zone yields blocks having a core of medium-gray siltstone surrounded by a yellowish-brown peripheral band, resembling weathered Hermitage Formation. Thickness about 280 to 400 feet.

Estimated thickness of formation 380 to 500 feet.

New Providence Shale

Shale, medium-gray and greenish-gray with thin zones of reddish-brown; at base is olive-gray and light brownish-gray, fine-grained limestone. Thickness 0 to 20 feet. Beneath the New Providence, or at the base of the Fort Payne where the New Providence is absent, is greenish-gray shale or mudstone (Maury Shale), 1 to 4 feet thick, containing phosphatic nodules.

Chattanooga Shale

Shale, carbonaceous, grayish-black, fissile, pyritic. Thickness 15 to 58 feet; averages 25 to 30 feet. Mapped separately (as MDc) only in cross sections.

Thickness of Fort Payne, New Providence, and Chattanooga 400 to 500 feet.

DEVONIAN

Dcr

Camden, Harriman, and Ross Formations

The Camden and Harriman Formations are lithologically identical, and not enough fossils are locally present to form a convenient basis for subdivision. Because exposures of the Ross Formation are scarce, it is mapped with the Camden and Harriman. Combined thickness of Camden, Harriman, and Ross about 100 feet.

Camden and Harriman Formations

These formations consist of siliceous limestones which have been largely replaced by chert. Limestone is gray to light olive-gray, micrograined to fine-grained, thin- to medium-bedded, siliceous and glauconitic. Chert is light-gray to white with light-gray, yellowish- to grayish-brown, and yellowish-gray specks and mottlings (surfaces stained pale to dark yellowish-orange and yellowish-brown), bedded and blocky (beds 2 to 6 inches thick), dense and subnovaculitic, conchoidal fracture, with white to light-gray tripolitic clay.

Combined thickness of both formations 50 to 95 feet.

Ross Formation

Birdsong Shale Member at top is calcareous shale with thin beds of argillaceous limestone, fine- to coarse-grained, very thin- to thin-bedded; both lithologies light olive- and greenish-gray, glauconitic, fossiliferous. Thickness 15 to 40 feet.

Rockhouse Limestone Member at base is limestone, light olive- and greenish-gray to light brownish-gray with pink to reddish-brown grains, fine- to coarse-grained and coarsely crystalline, medium-bedded, glauconitic, fossiliferous, with thin shale partings. Thickness 10 to 30 feet.

Thickness of formation about 45 feet.

SILURIAN

Sd

Decatur Limestone

Limestone, gray to light olive-gray, pale-olive, and yellowish- to greenish-gray with varied concentrations of reddish-brown and reddish-orange grains, fine- to coarse-grained (coarser grains predominate), medium- to thick-bedded. Shale, pale-olive, moderate yellowish-brown, dark yellowish-orange, and grayish-orange, is present locally as thin partings. Thickness about 70 feet.

Sbp

Brownsport Formation

Lobelville Member is argillaceous limestone, fine- to coarse-grained, very thin- to medium-bedded, and calcareous shale; both lithologies light olive-gray to yellowish-gray and dusky-yellow with scattered streaks and mottlings of grayish red-purple, fossiliferous. Thickness 15 to 46 feet.

Bob Limestone Member is light olive-gray to light yellowish-gray, medium- to coarse-grained, medium- to thick-bedded, with thin partings of light olive-gray argillaceous limestone and shale. Thickness 10 to 20 feet.

Beech River Member is argillaceous limestone, fine- to medium grained, thin- to medium-bedded, and calcareous shale; both lithologies light olive-gray to yellowish-gray and dusky-yellow with scattered streaks and mottlings of grayish red-purple, fossiliferous. Basal 10 feet consists of light olive-gray and greenish-gray to grayish red-purple, fine- to medium-grained, medium-bedded limestone. Thickness of member 14 to 35 feet.

Thickness of Formation about 55 to 75 feet.

Sdx

Dixon Formation

Limestone, argillaceous, grayish-red to dark reddish-brown and grayish-olive to greenish-gray, fine- to medium-grained, thin- to medium-bedded, with shale and mudstone; shale zone at top about 3 feet thick, upper part light-gray, lower part dark reddish-brown. Formation grades into underlying Lego Limestone. Thickness 40 to 50 feet.

Slw

Lego Limestone and Waldron Shale

Lego Limestone is pale to moderate reddish-brown with a few olive-gray and greenish-gray beds, fine-grained with medium to coarse calcite crystals, medium-bedded, evenly bedded. Shale interbeds near top. Thickness 16 to 40 feet.

Waldron Shale is calcareous shale with thin beds of limestone, light olive-gray and greenish-gray, fossiliferous. Thickness probably 2 to 3 feet.

Sla

Laurel Limestone

Limestone, light olive-gray to brownish- and yellowish-gray, dusky-yellow, and reddish-brown, fine-grained with medium to coarse calcite crystals, medium-bedded, evenly bedded, with some dark yellowish-orange argillaceous partings. Thickness 20 to 40 feet.

So

Osgood Formation

Calcareous shale with thin beds of argillaceous limestone, grayish-red and light to dark reddish-brown, light olive-gray and yellowish-gray. Thickness 20 to 43 feet.

Sbr

Brassfield Limestone

Limestone, light-gray to light olive-gray and pale-olive to dusky-yellow, fine- to coarse-grained, thin- to medium-bedded, glauconitic (especially the basal few feet), with lenses of dense chert, thin partings of greenish-gray shale common. Thickness 17 to 21 feet.

ORDOVICIAN

Of

Fernvale Limestone

Limestone, grayish-yellow and yellowish-orange with pale-orange and pale reddish-orange grains, fine- to medium-grained, some beds coarsely crystalline, thin- to medium-bedded, irregularly bedded. Thickness 25 to 44 feet.

Oh

Hermitage Formation

Shale and limestone, sandy and silty, light- to dark-gray (weathers to pale to dark yellowish-brown siltstone and sandstone); limestone is very fine- to medium-grained, thin-bedded to laminated. Residuum includes large silicified masses and fine-grained siliceous material. Thickness 200 to 300 feet.

Osr

Stones River Group

In the Central Basin of Tennessee the Stones River Group is subdivided, largely on the basis of alternating sequences of thin-bedded and medium- to thick-bedded limestone, into the Carters, Lebanon, Ridley, Pierce, and Murfreesboro Limestones. In Wells Creek Basin the Stones River Group exhibits the same alternation of lithologies, but the number and sequence of units are not the same and the individual formations cannot be recognized at many exposures.

Medium- to thick-bedded limestone is pale to dark yellowish-brown and yellowish- to brownish-gray (weathers light- to medium-gray), cryptograined to coarse-grained, with lenses of chert. Thin-bedded limestone is light- to medium-gray, pale to dark yellowish-brown and brownish-gray, cryptograined to coarse-grained, contains thin shale partings (in subsurface) that are not everywhere apparent in weathered surface exposures.

Thickness of Group about 1,000 feet.

CAMBRIAN

OCk

Knox Dolomite

Dolomite, yellowish- and brownish-gray to light olive-gray, gray and dusky-yellow, thin- to very thick-bedded, micrograined to coarse-grained, with a few partings of grayish-green shale; interbedded with limestone, pale-orange to brownish- and yellowish-gray and yellowish-brown, fine-grained. Formation intensely brecciated. Exposed thickness at least 600 and possibly 2,000 feet.

Contact, dashed where approximate

U/D Fault, dashed where approximate, dotted where concealed; U upthrown side, D downthrown side

Fault, arrow indicates relative movement (shown in cross sections only)

Strike and dip of beds

- Normal
- Overturned
- Vertical
- Horizontal

Figure No.
5

Title
Geologic Map

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

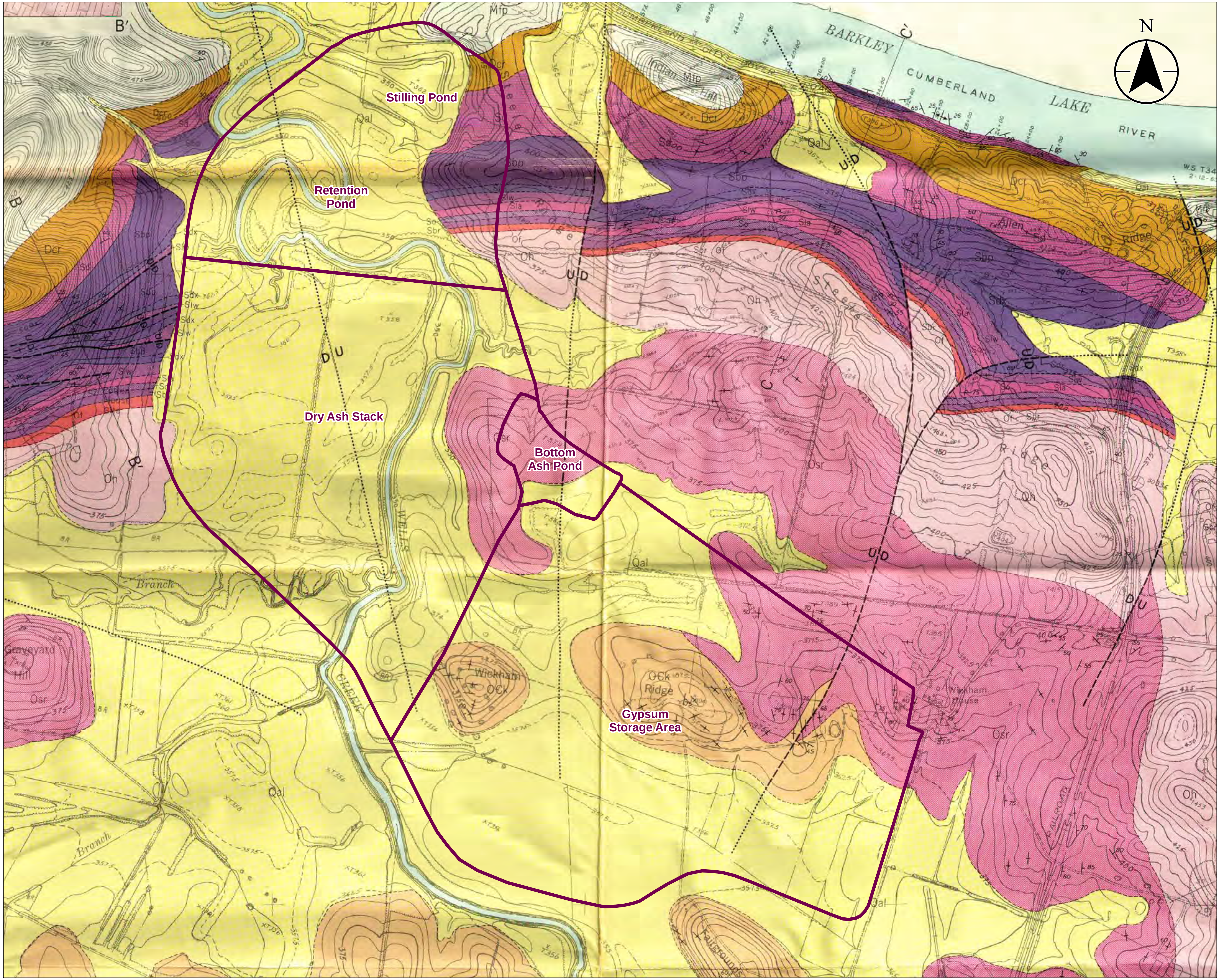
Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-13
Technical Review by EM on 2017-10-13

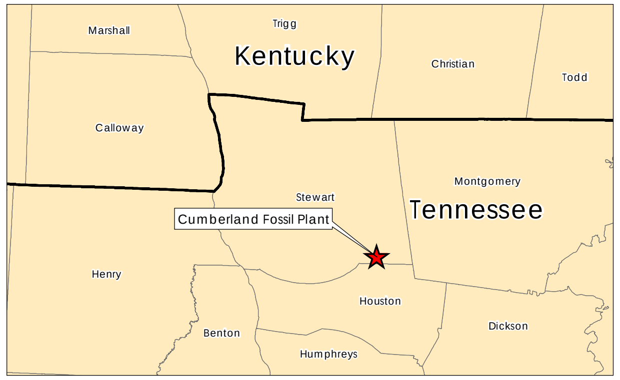
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

CCR Unit Area (Approximate)



Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Geologic map corresponds to Tiedemann, C.W. et al (1968). "Geologic Map of Wells Creek Basin"



Stantec

TVA

Figure No.
6

Title

Topographic Map - USGS (1931)

Client/Project

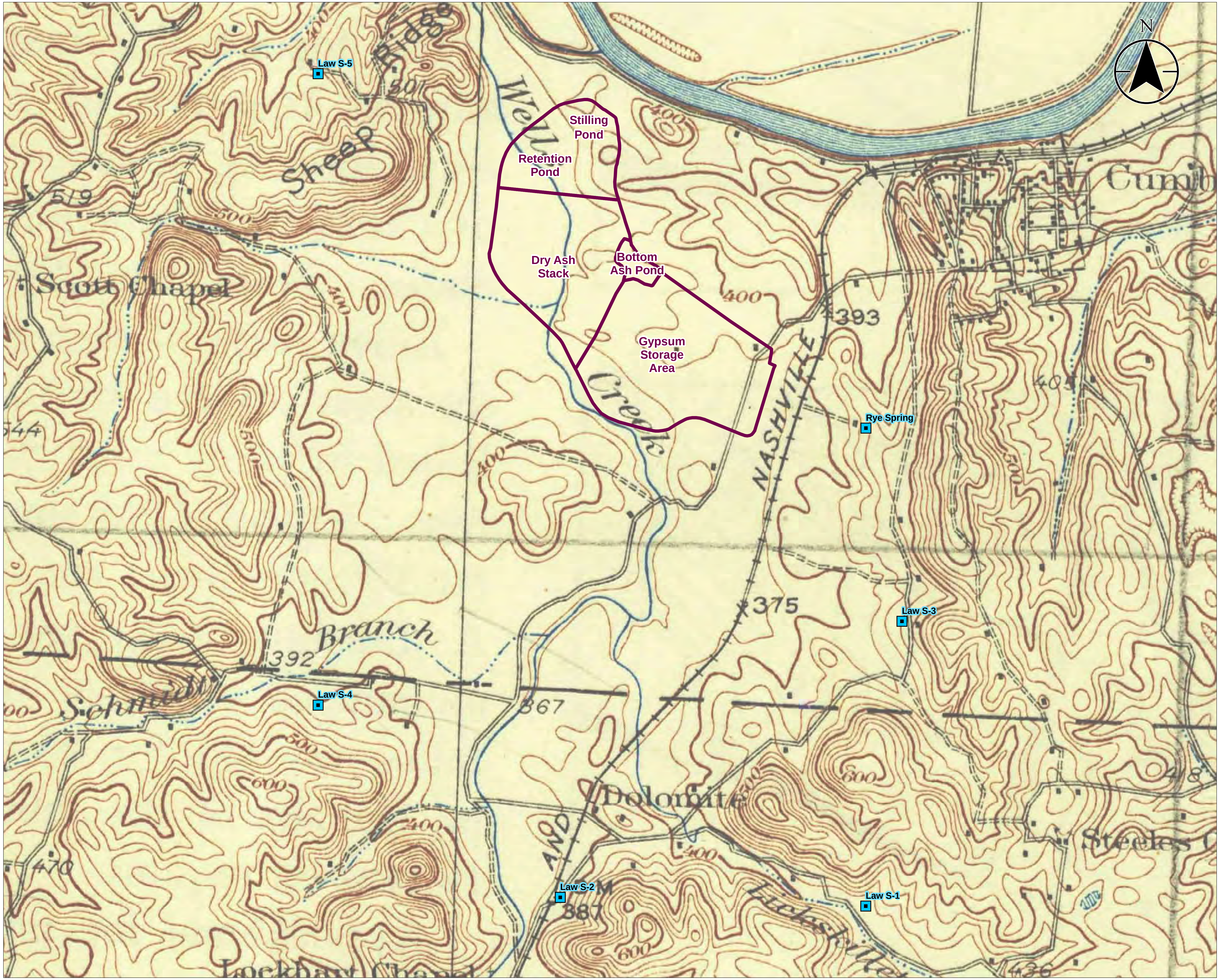
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-13
Technical Review by EM on 2017-10-13

0 800 1,600 2,400 3,200 Feet

1:9,600 (At original document size of 22x34)

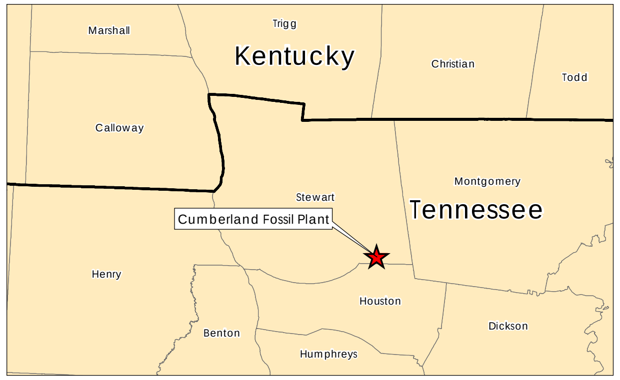


Legend

Reported Spring

CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Topographic mapping corresponds to the Erin Quadrangle (Edition of 1931, Scale 1:62,500)
3. Spring locations are approximate and referenced from Law (1992b)



Stantec

TVA

U:\TVA-EIP\175566329\gis\mxds\REV2104_CUF_Topo_USGS1931.mxd Revised: 2017-10-13 By: trink

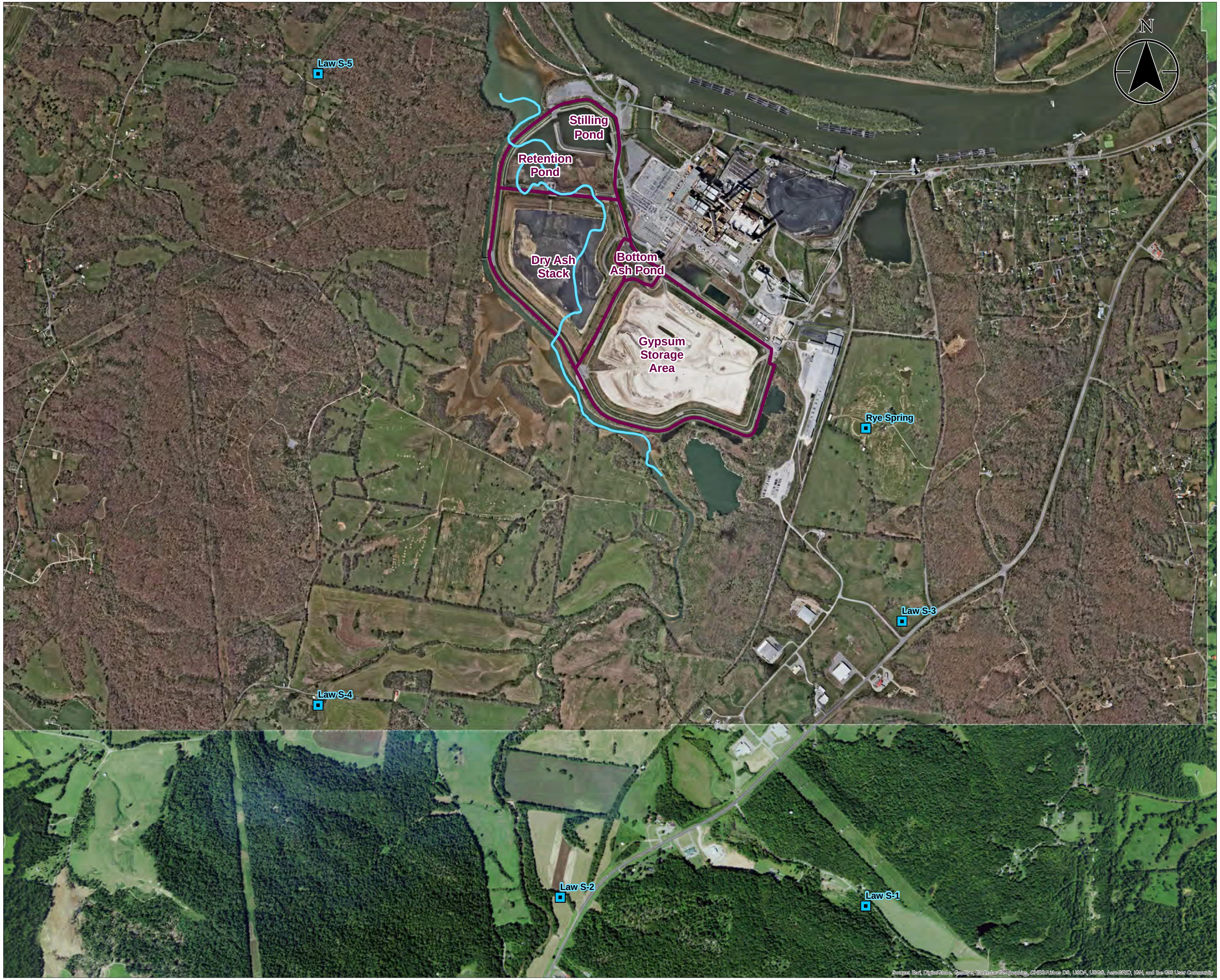


Figure No.
7

Title
Reported Springs and Historic Wells Creek Alignment

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-17
Technical Review by EM on 2017-10-17

0 800 1,600 2,400 3,200 Feet
1:9,600 (At original document size of 22x34)

Legend

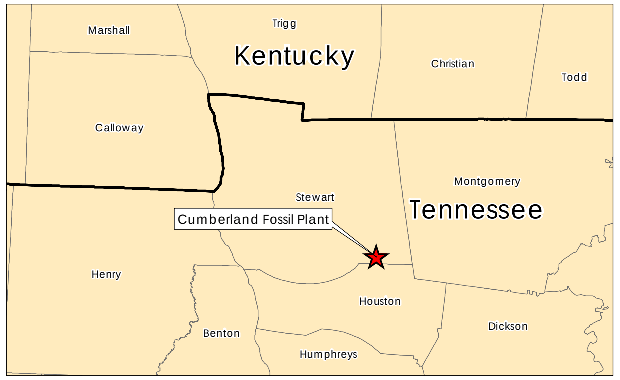
Reported Spring

Historical Wells Creek Alignment (Approximate)

CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017) & ESRI Basemaps
3. Spring locations are approximate and referenced from Law (1992b)
4. Historic Wells Creek alignment digitized from Drawing 10N212



U:\TVA-EIP\175566329\gis\mxds\REV2\05_CUF_Reported_Springs.mxd Revised: 2017-10-17 By: mbough

Figure No.
8

Title

Existing Groundwater Wells

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

Stewart County, Tennessee

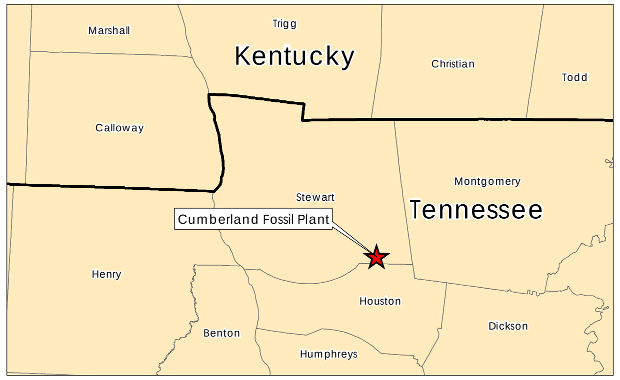
175566329
Prepared by TR on 2017-10-13
Technical Review by JD on 2017-10-13

0 400 800 1,200 1,600 Feet
1:4,800 (At original document size of 22x34)

Legend

- Existing Observation Well
- Existing Groundwater Monitoring Well
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Historical TVA Drawing 10N212R11 (1991) is shown



Stantec
TVA

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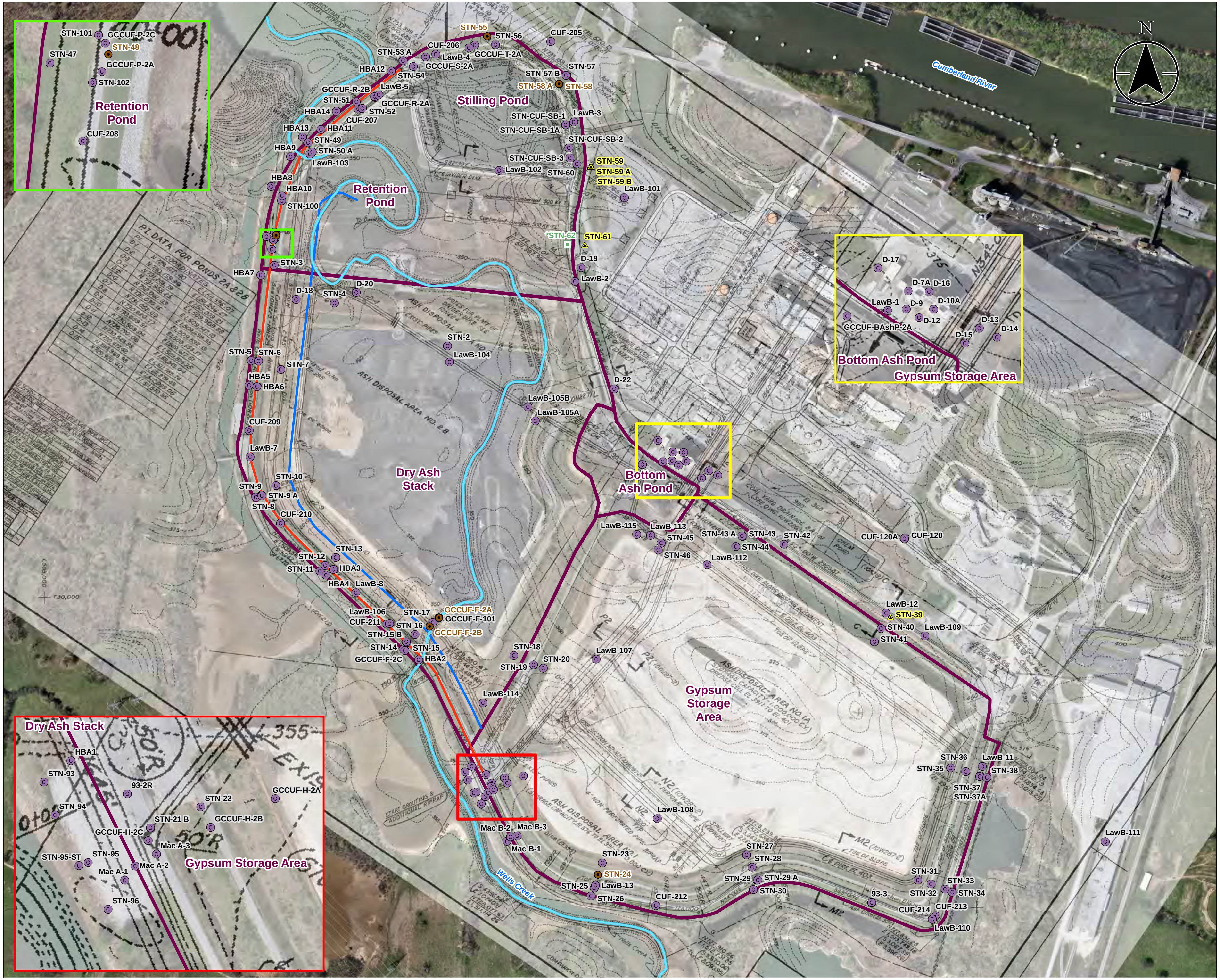


Figure No.

9

Title

Perimeter Dike Seepage Improvements

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

175566329

Stewart County, Tennessee

Prepared by TR on 2017-11-07
Technical Review by JD on 2017-11-07

0 300 600 900 1,200 Feet

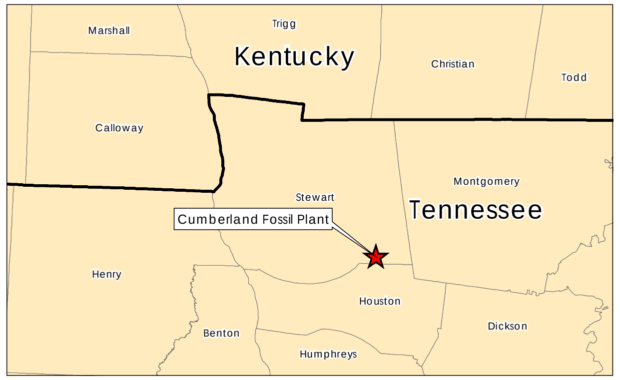
1:3,600 (At original document size of 22x34)

Legend

- Alluvial (Clay)
- Alluvial (Granular)
- Clayey Fill
- Bedrock*
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- Historical Wells Creek Alignment (Approximate)
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Historical TVA Drawing 10N212R11 (1991) is shown
4. * Indicates Constructed Cut-off Trench Extends to Bedrock



Stantec

TVA

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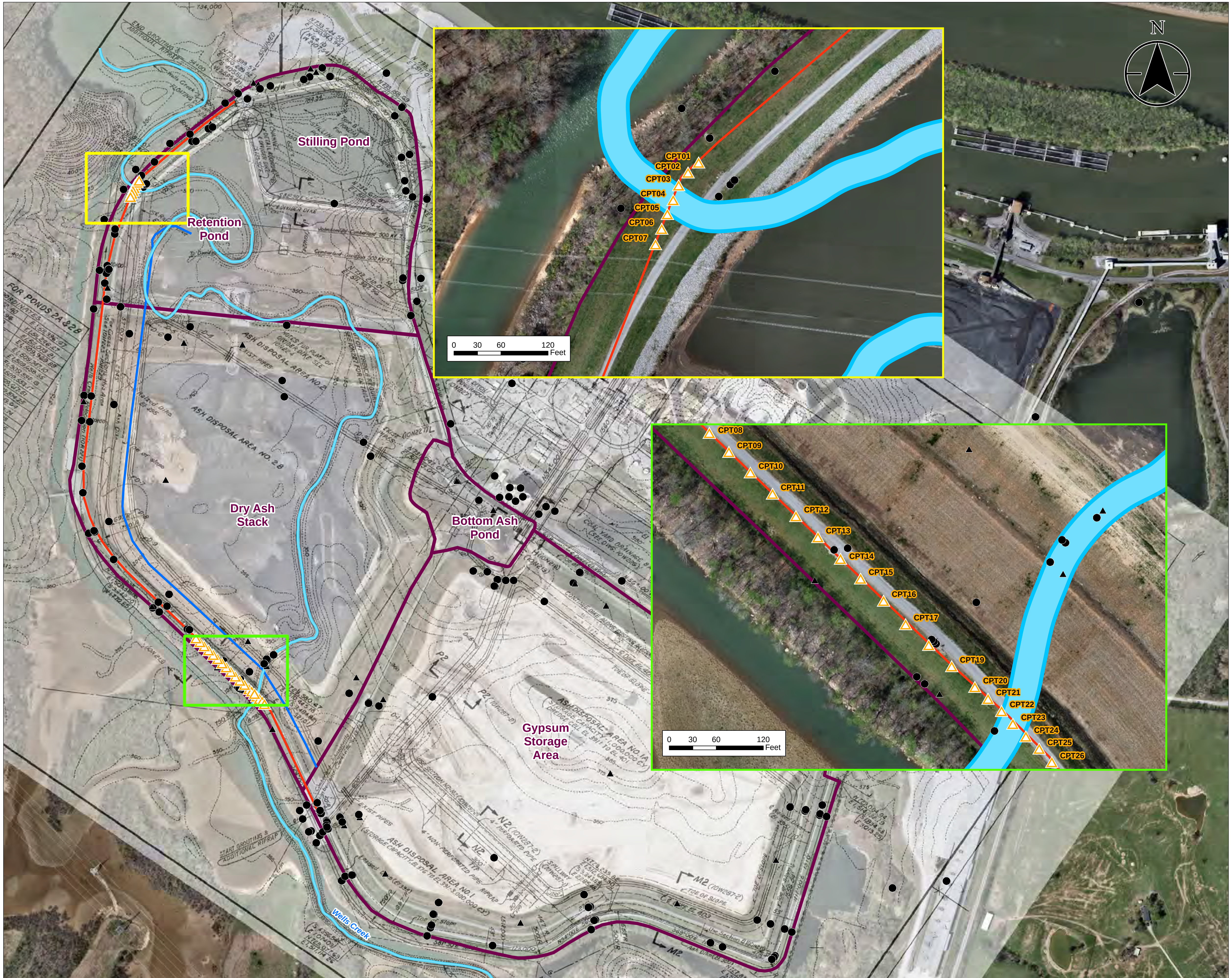


Figure No.
10

Title
Proposed Cone Penetration Testing

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

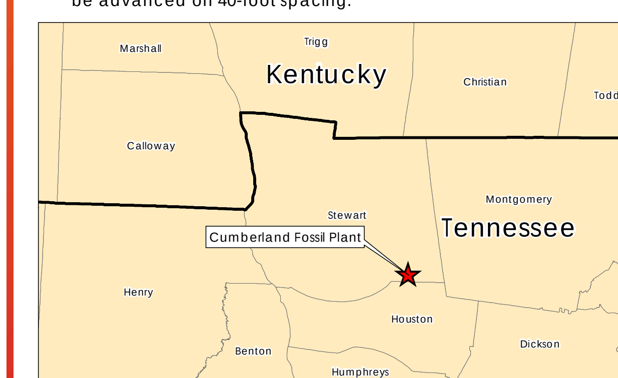
175566329
Prepared by TR on 2018-01-22
Technical Review by JD on 2018-01-22

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Existing Boring
- Existing CPT
- Historical Wells Creek Alignment (Approximate)
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Historical TVA Drawing 10N212R11 (1991) is shown
4. Based on historical mapping, Wells Creek is approximately 40 feet wide. Within 60 feet of the historical Wells Creek centerline, CPT borings will be advanced on 20-foot spacing. Outside of this window, CPT borings will be advanced on 40-foot spacing.



Stantec
TVA

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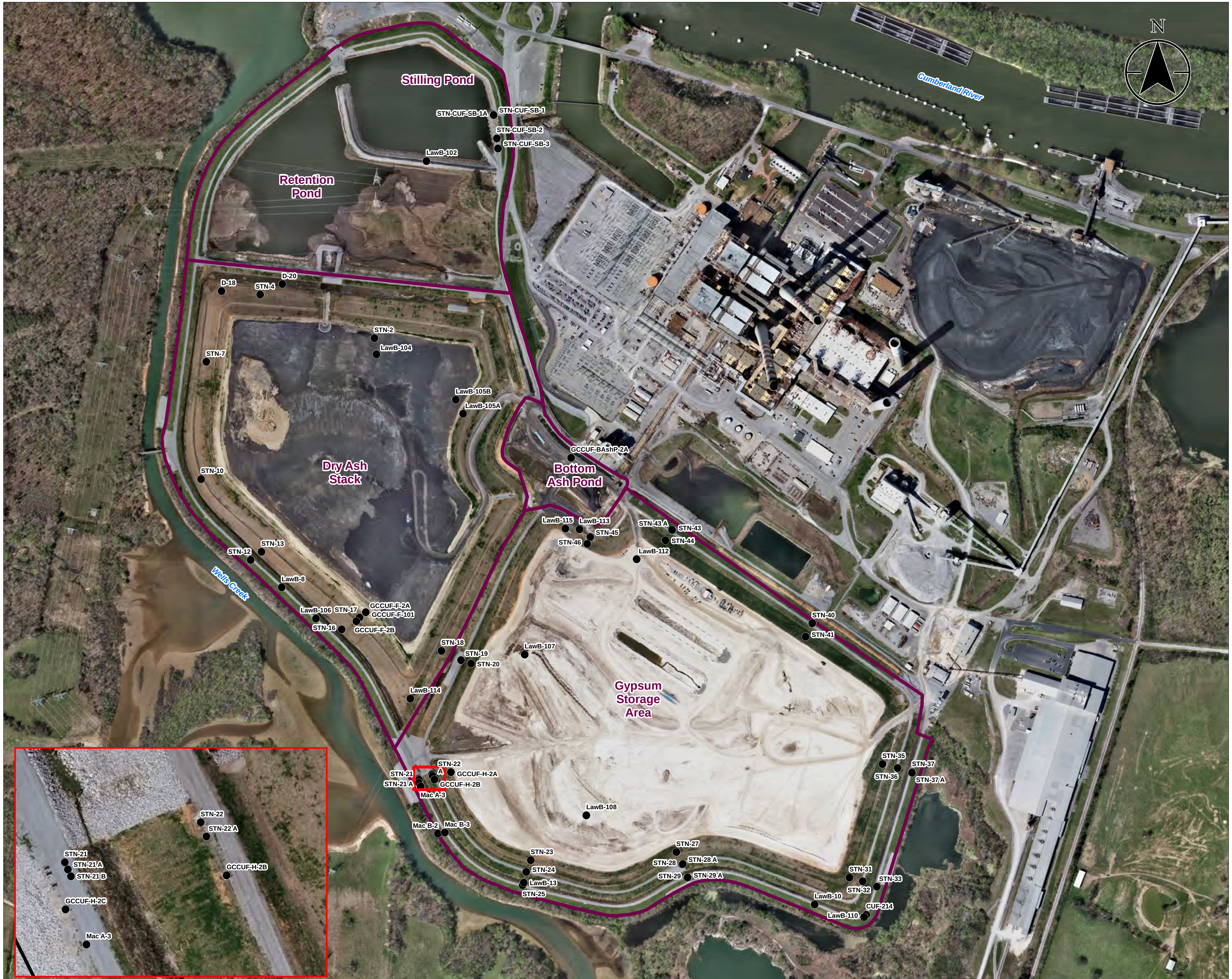


Figure No.
11

Title
Existing CCR Thickness Boring Data

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-13
Technical Review by JD on 2017-10-13

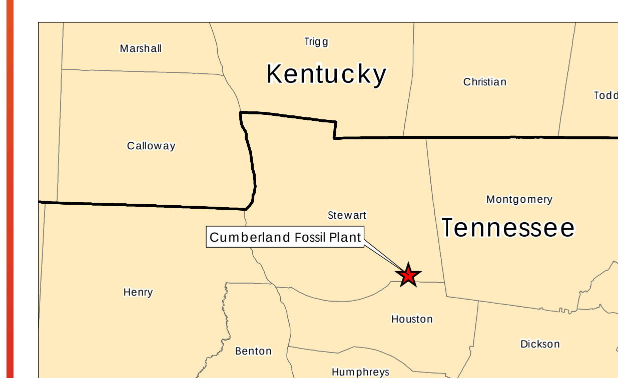
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

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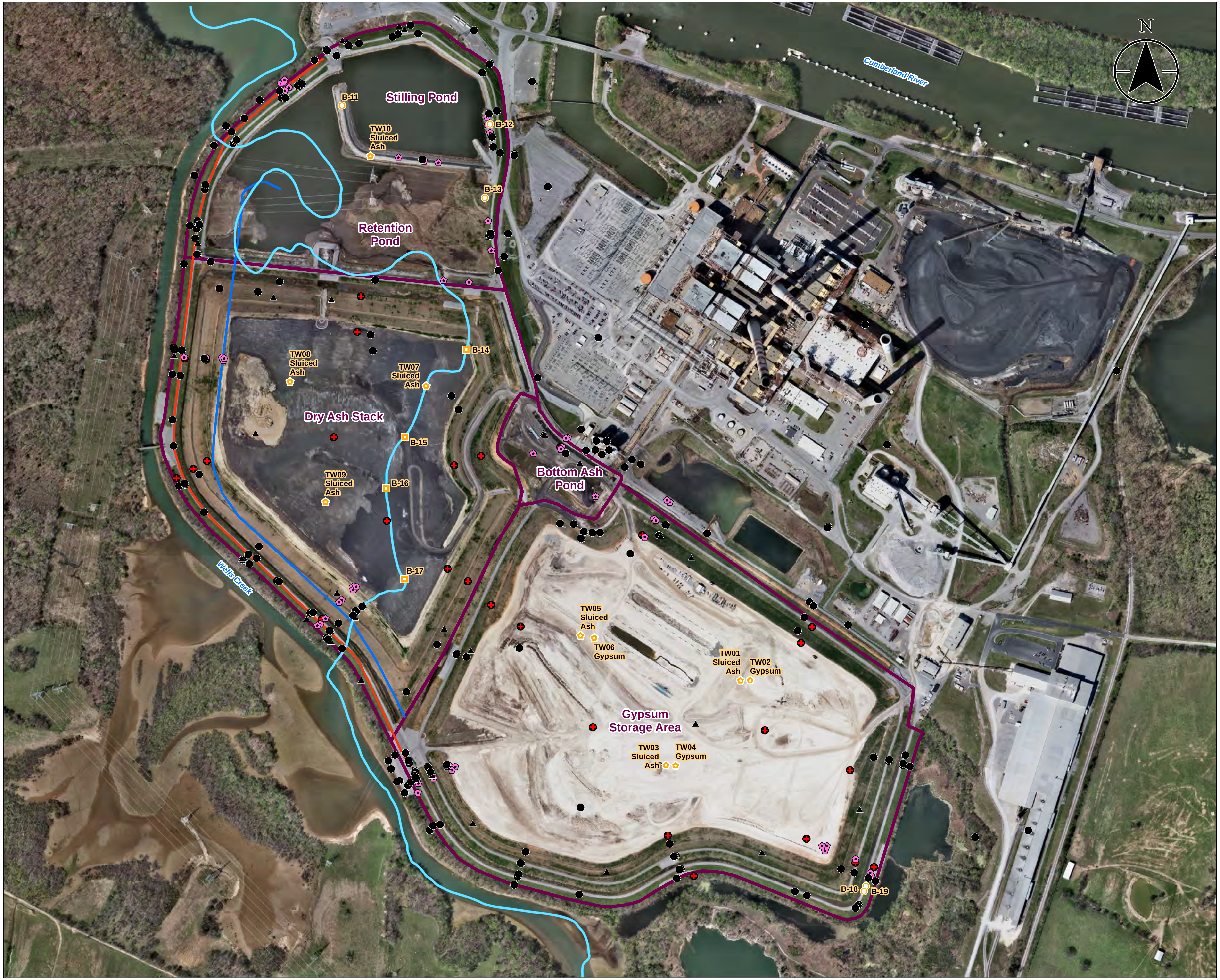


Figure No.
12

Title
Proposed Geotechnical Borings

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location 175566329
Stewart County, Tennessee
Prepared by TR on 2018-01-25
Technical Review by JD on 2018-01-25

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

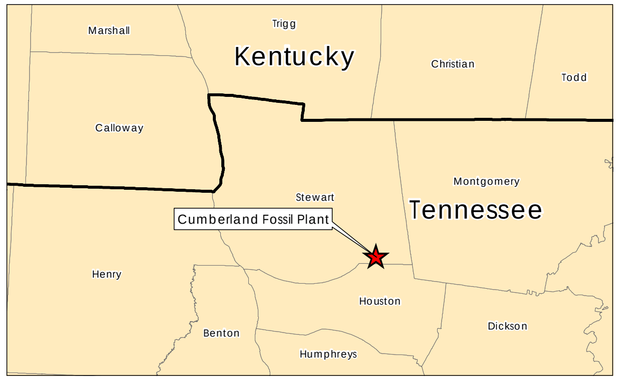
- Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, Geotechnical Data)(Screened Interval)
- Boring (Geotechnical Data)
- Boring with Piezometer Vibrating Wire
- Existing Boring
- Existing CPT

Proposed Boring Locations for Other Ongoing TVA Projects

- Seismic Stability Evaluation Boring or CCR Rule Boring
- Proposed Closure Instrumentation Boring
- Historical Wells Creek Alignment (Approximate)
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Geotechnical data includes CCR thickness, clay foundation soil thickness, top of rock elevation, and rock coring (RQD).



Stantec TVA

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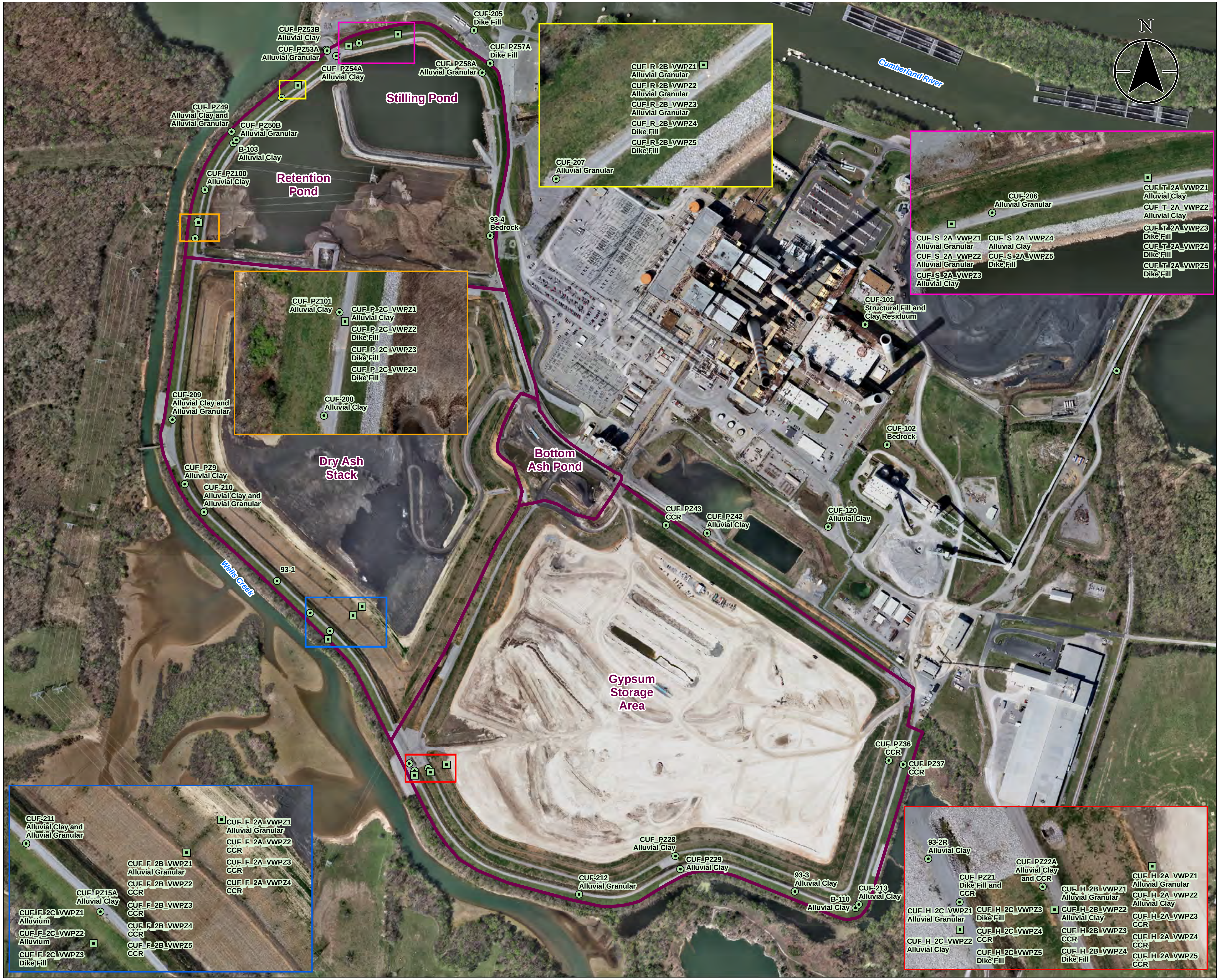


Figure No.
13

Title
Existing Instrumentation

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2018-01-22
Technical Review by EM on 2018-01-22

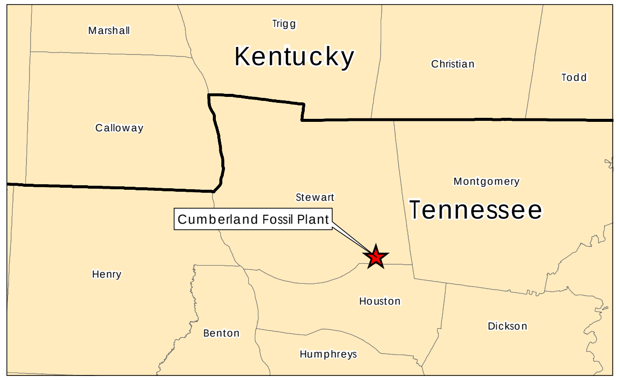
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Active Piezometer Open Standpipe (Screened Interval)
- Active Piezometer Vibrating Wire (Screened Interval)
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec TVA

Revised: 2018-01-22 By: mbough

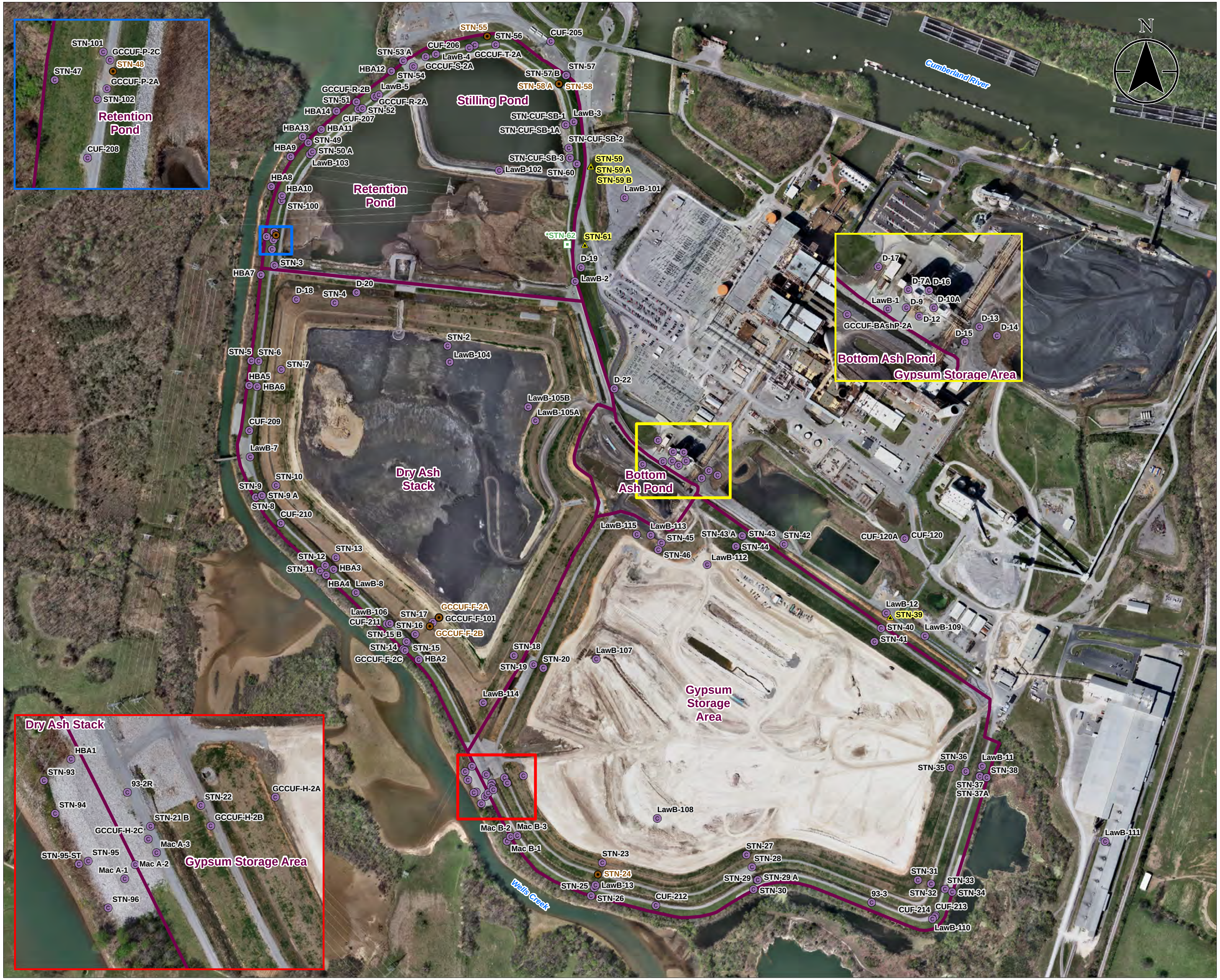


Figure No.
14

Title
Uppermost Foundation Soil Data

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-11-07
Technical Review by JD on 2017-11-07

0 300 600 900 1,200 Feet

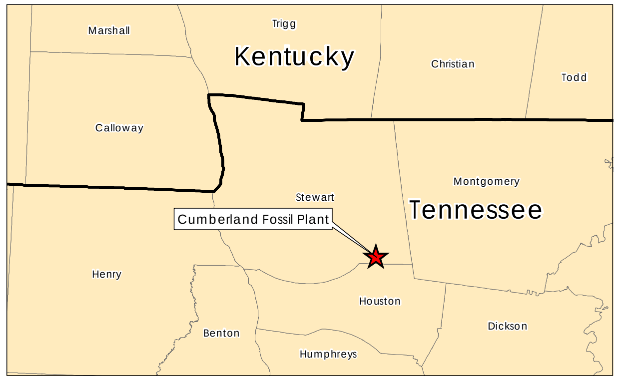
1:3,600 (At original document size of 22x34)

Legend

- Alluvial (Clay)
- Alluvial (Granular)
- Clayey Fill
- Bedrock*
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. * Indicates Constructed Cut-off Trench Extends to Bedrock



Stantec
TVA

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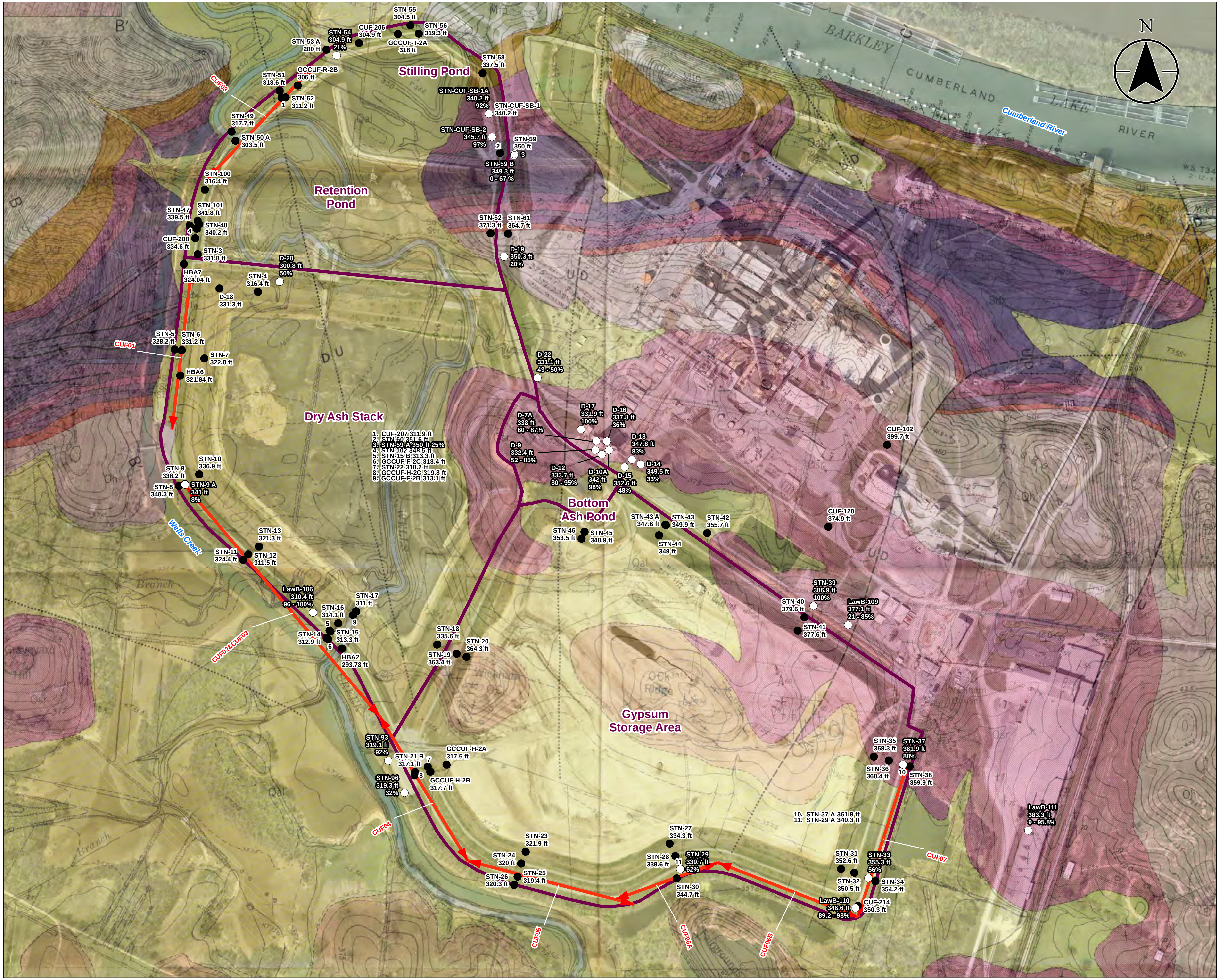


Figure No.
15

Title
Existing Top of Rock Elevation Boring Data

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

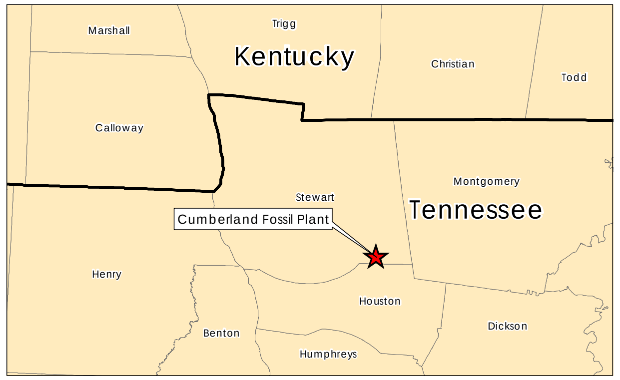
175566329
Prepared by TR on 2017-11-07
Technical Review by JD on 2017-11-07

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Borings without Rock Core Data [ID & TOR Elevation]
- Borings with Rock Core Data [ID, TOR Elevation, RQD]
- ERI Transect
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. RQD value corresponds to upper 20 feet of rock core
4. Geologic map corresponds to Tiedemann, C.W. et al (1968). "Geologic Map of Wells Creek Basin"



Stantec

TVA

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Figure No.
16

Title
Completed Stability Analyses

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-11-07
Technical Review by TG on 2017-11-07

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

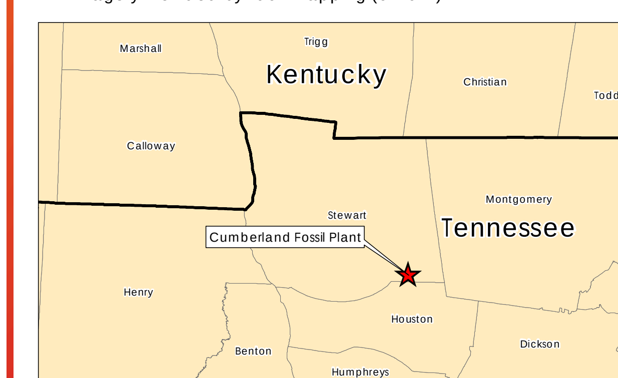
Legend

Stability Cross Section

CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

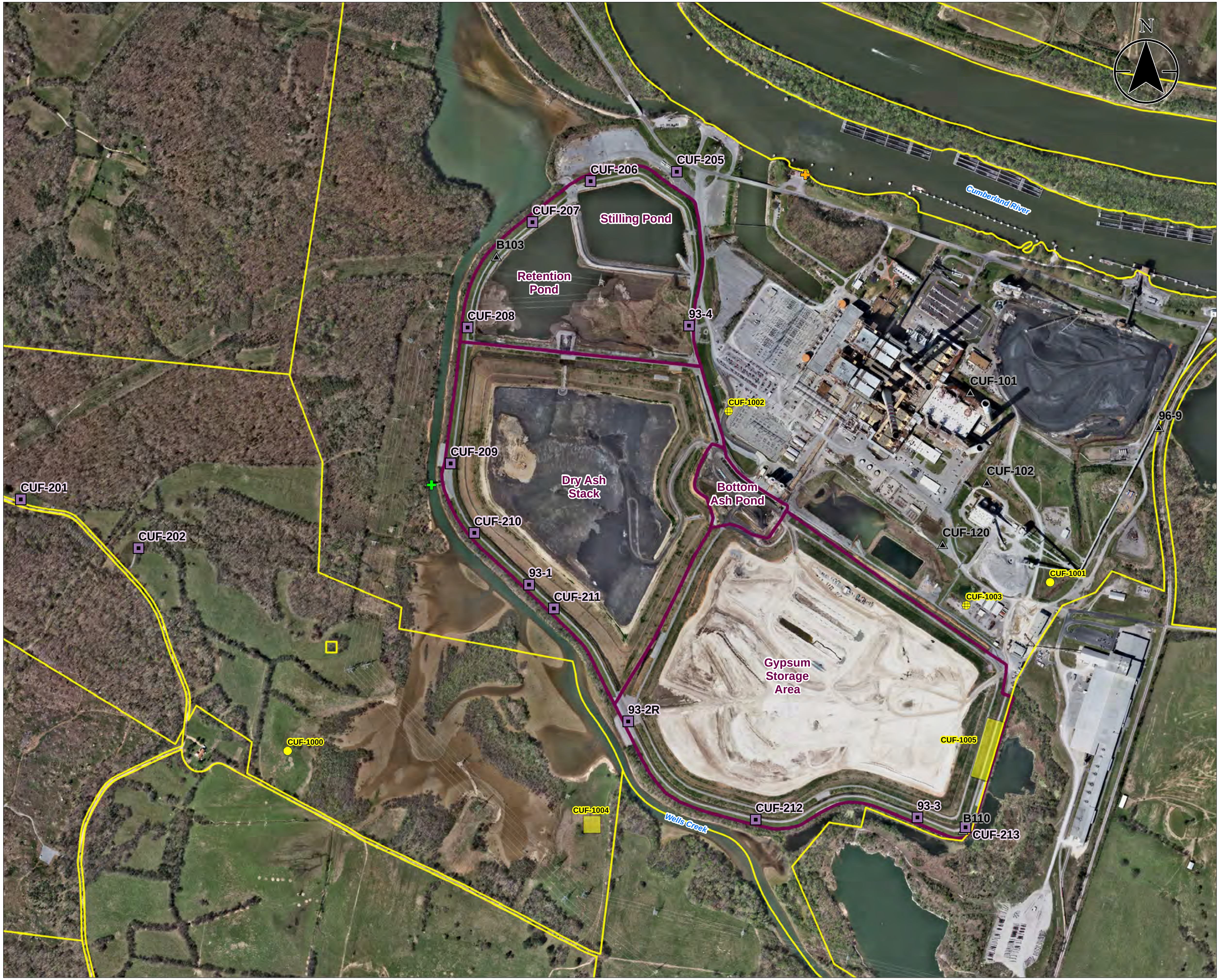


Figure No.
17

Title
Proposed Groundwater Wells

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

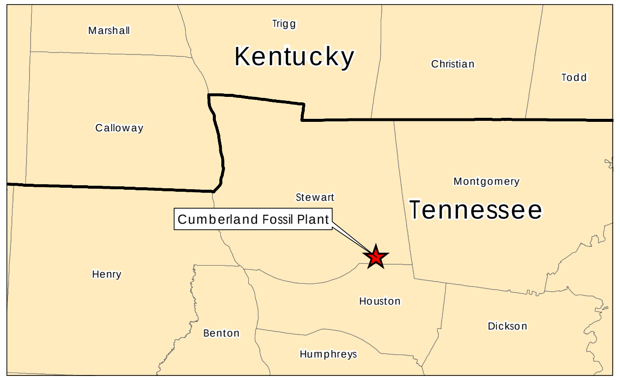
175566329
Prepared by MW on 2018-01-22
Technical Review by JG on 2018-01-22

0 400 800 1,200 1,600 Feet
1:4,800 (At original document size of 22x34)

Legend

- Existing Observation Well
- Existing Groundwater Monitoring Well
- Proposed Monitoring Well
- Proposed Background Monitoring Well
- Proposed Wells Creek Gage
- River Gage
- Proposed Well Area
- TVA Property Boundary
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

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Figure No.
18

Title
Sediment Sampling

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

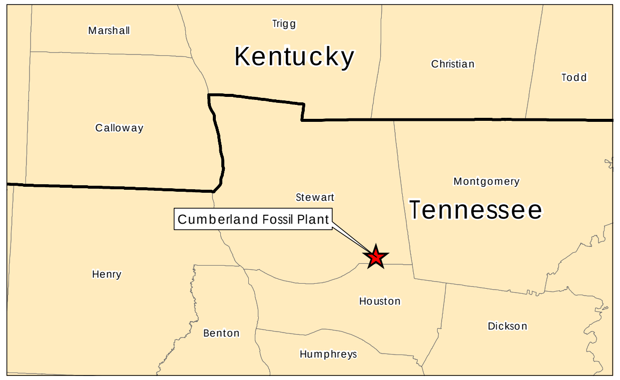
175566329
Prepared by MB on 2018-01-22
Technical Review by JC on 2018-01-22

0 500 1,000 1,500 2,000 Feet
1:6,000 (At original document size of 22x34)

Legend

- Area of Interest
- Historic Seep (Approximate Location)
- Proposed Sediment Sampling Transect
- Stream
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

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Figure No.
19

Title

Benthic Macroinvertebrates Sampling

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

Stewart County, Tennessee

175566329
Prepared by MB on 2017-10-16
Technical Review by JC on 2017-10-16

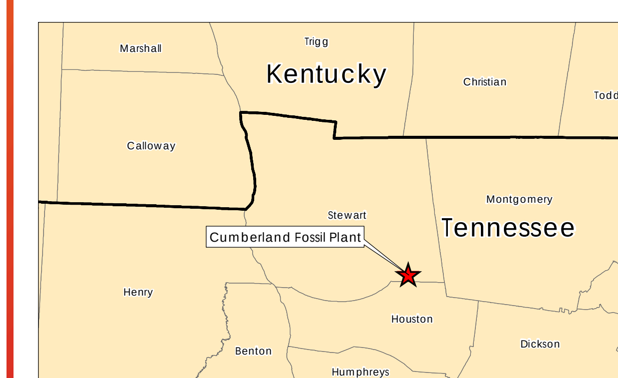
0 400 800 1,200 1,600 Feet
1:4,800 (At original document size of 22x34)

Legend

- Area of Interest
- Historic Seep (Approximate Location)
- Stream
- Transects
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

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Figure No.
20

Title

Off-Site
Benthic Macroinvertebrates Sampling

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by MB on 2017-10-16
Technical Review by JC on 2017-10-16

0 1,000 2,000 3,000 4,000 Feet
1:12,000 (At original document size of 22x34)

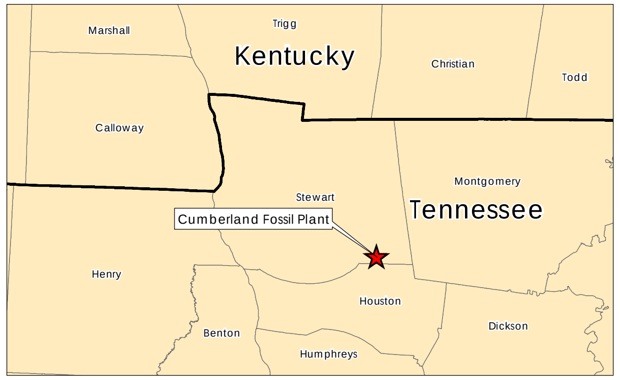
Legend

Transects

CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps (NAIP c. 2016)



Stantec TVA

U:\TVA-EIP\175566329\gis\mxds\REV2\17_CUF_Offsite_Benthic_Transects.mxd Revised: 2017-10-16 By: mbough

Figure No.
21

Title
Mayfly Sampling
Adult Mayflies, Purated Mayfly Nymphs, & Non-Purated Mayfly Nymphs

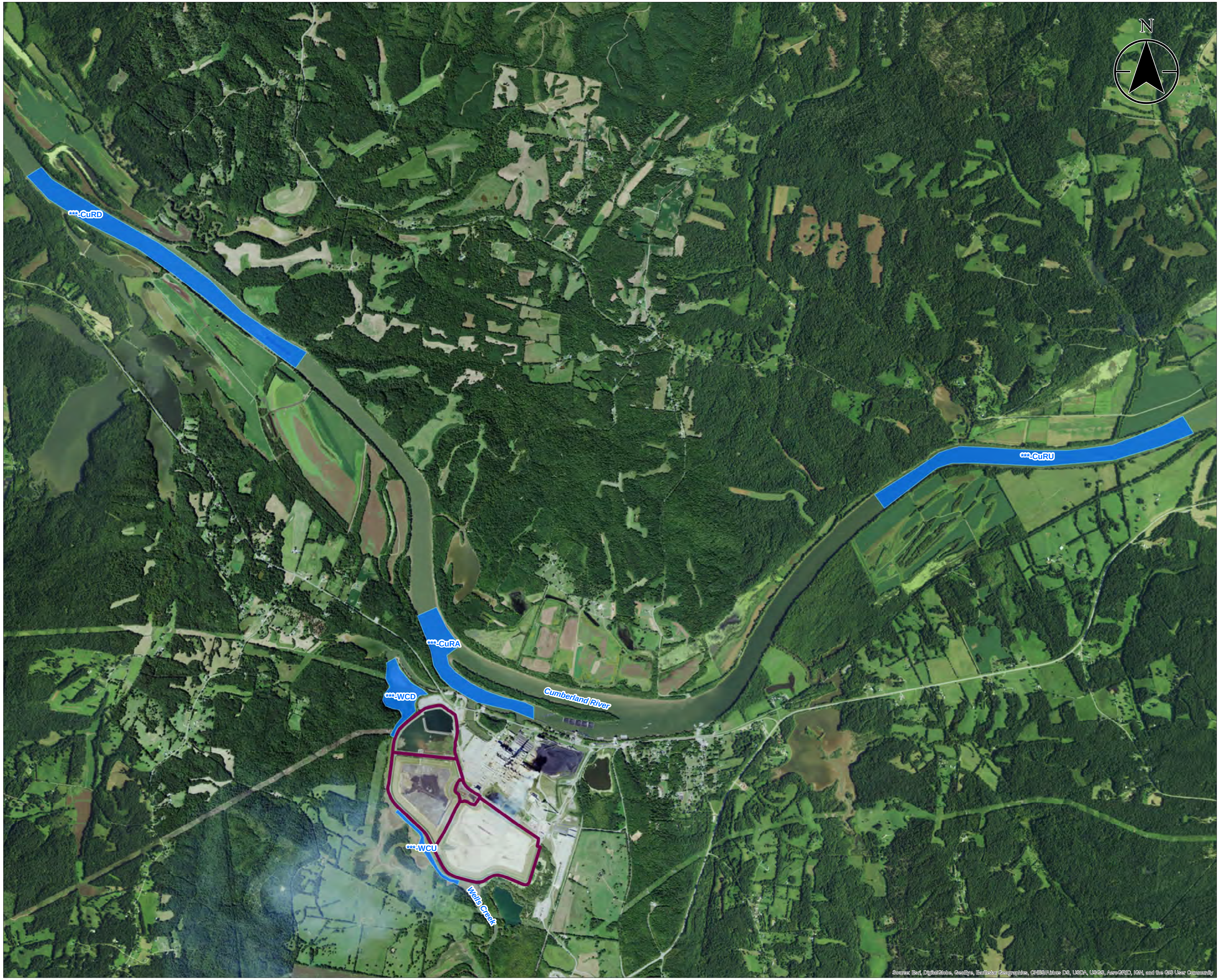
Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-16
Technical Review by RD on 2017-10-16

0 1,500 3,000 4,500 6,000 Feet
1:18,000 (At original document size of 22x34)

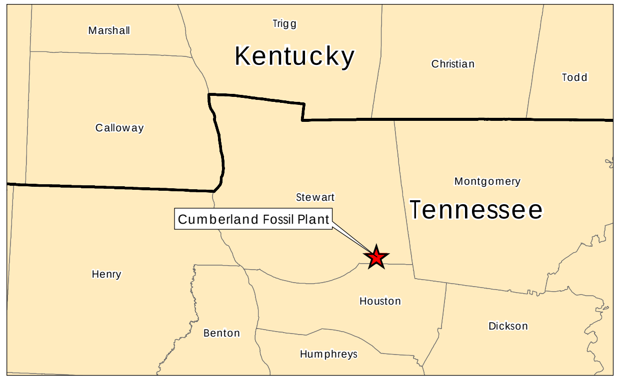


Legend

Mayfly Sample Location

CCR Unit Area (Approximate)

Notes
1. *** Adult Mayflies, Purated Mayfly Numphs, and Non-Purated Mayfly Nymphs; sampled at each location, samples at each location will have a unique ID sample Biota Matrix Code (MFA, MFP, MFN respectively).
2. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
3. Imagery Provided by ESRI Basemaps (NAIP c. 2016)



Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

Figure No.
22

Title

Historic Seepage Areas (Approximate Location)

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2018-01-22
Technical Review by CA on 2018-01-22

0 300 600 900 1,200 Feet

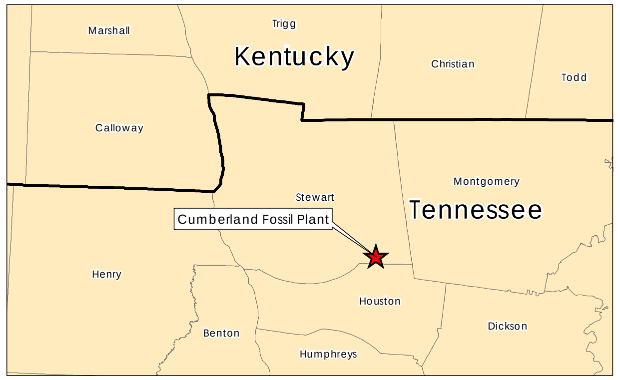
1:3,600 (At original document size of 22x34)

Legend

- Seepage Area Above Perimeter Ditch
- Seepage Area Below Perimeter Ditch
- Area of Interest
- Graded Filter Approximate Location *(Not to Scale)*
- Seep Area
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



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TVA

U:\TVA-EP\175566329\gis\mxds\REV3101_CUF_Historic_Seepage_Areas.mxd Revised: 2018-01-22 By: mbough

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure No.
23

Title
Surface Stream Sampling

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2018-01-22
Technical Review by RD on 2018-01-22

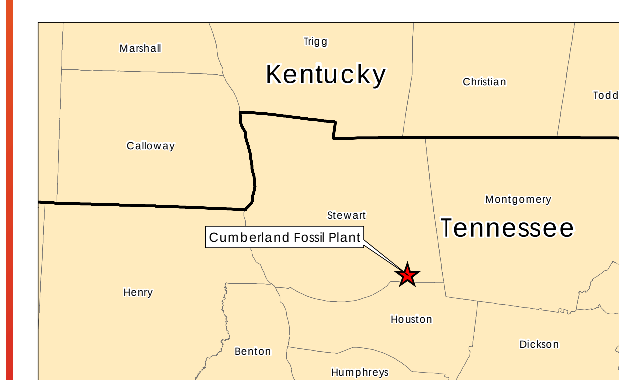
1:15,000 (At original document size of 22x34)

Legend

- Area of Interest
- Historic Seep (Approximate Location)
- Surface Stream Sample Location
- Stream
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemap (NAIP c. 2016)
3. Samples will be collected at the left bank, right bank, and deepest channel location



Stantec
TVA

U:\TVA-EIP\175566329\gis\mxds\REV2\20b_CUF_Surface_Stream_Sampling_Transect.mxd Revised: 2018-01-22 By: mbough

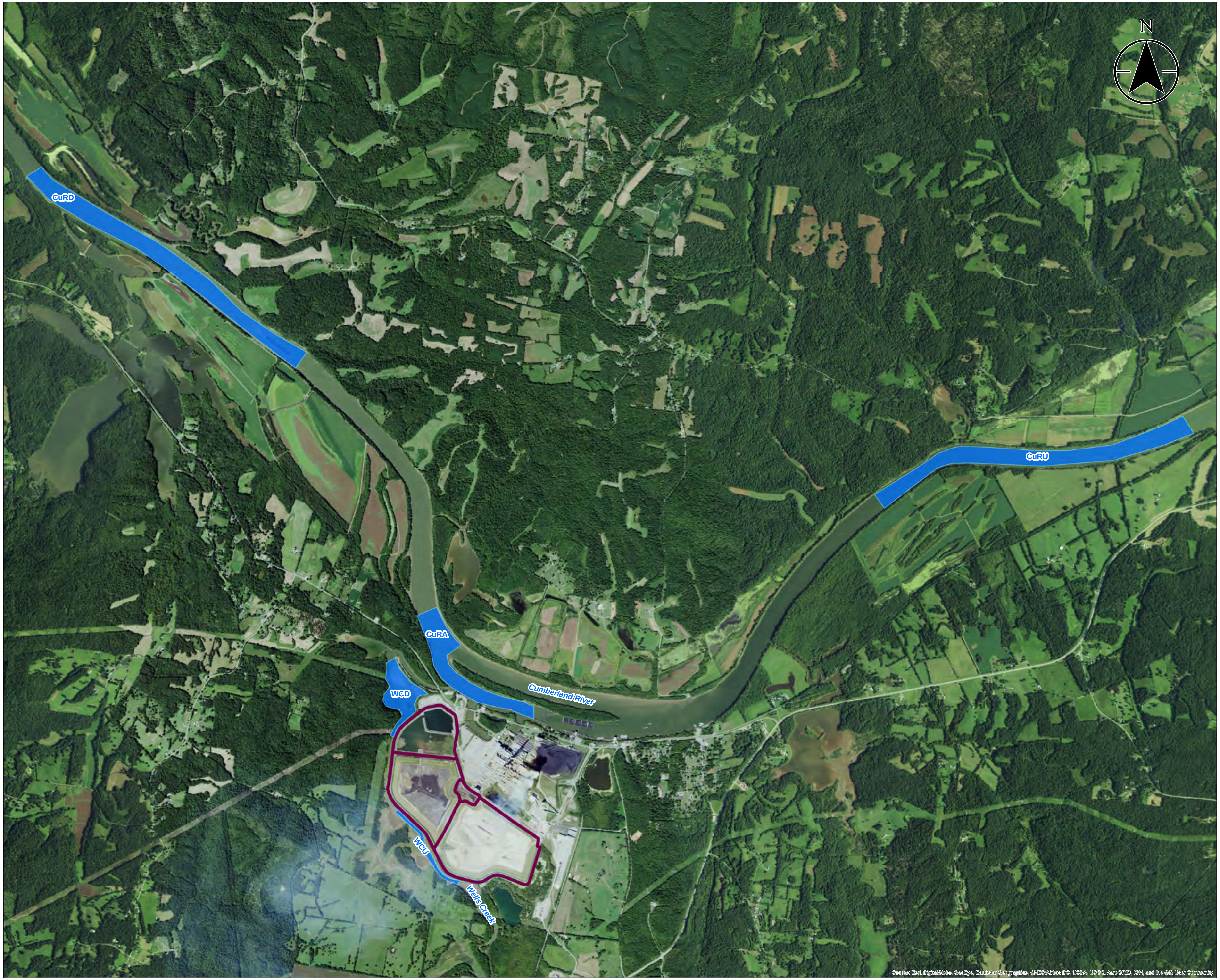


Figure No.
24

Title
Fish Sampling

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-16
Technical Review by RD on 2017-10-16

0 1,500 3,000 4,500 6,000 Feet
1:18,000 (At original document size of 22x34)

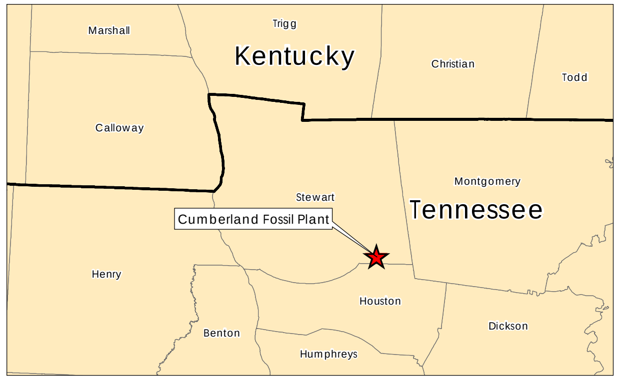
Legend

Fish Sample Location

CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps (NAIP c. 2016)



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TVA

APPENDIX E
BACKGROUND SOIL SAP

Background Soil Sampling and Analysis Plan Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

BACKGROUND SOIL
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Background Soil
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ____________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

Melissa A. Hedgecoth	6/25/18
TVA Investigation Project Manager	Date
[signature]	6/25/18
TVA Investigation Field Lead	Date
David K. Wilson	6/25/18
Health, Safety, and Environmental (HSE) Manager	Date
[signature]	06/25/18
Investigation Consultant Project Manager	Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.06.21 15:58:20 -04'00'	
QA Oversight Manager	Date
Maisadley (JA)	6/22/18
Laboratory Project Manager	Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

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LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, this Background Soil Sampling and Analysis Plan (SAP) has been developed to characterize background soils in the vicinity of the CUF Plant (Plant).

2.0 OBJECTIVES

The objective of this Background Soil SAP is to characterize background soils on TVA property in the vicinity of the Plant. The approach in characterizing the background soils is to identify locations where naturally occurring, in place, native soils are present, yet unaffected by CCR material. Samples will be analyzed for CCR parameters listed in 40 CFR Part 257, Appendices III and IV along with additional parameters required by the state groundwater monitoring program (copper, nickel, silver, vanadium, and zinc). These constituents will be hereafter referred to as "CCR parameters." Additionally, the surficial soil at each location will be collected and analyzed for percent ash, to determine the presence or absence of windblown CCR.

This Background Soil SAP and the Plant-specific Quality Assurance Project Plan (QAPP) will provide the procedures necessary to conduct investigation activities associated with the sampling and analysis of background soils. Proposed field activities will include the following tasks:

- Verify and document proposed sampling locations using global positioning system (GPS) surveying
- Collect background soil samples from proposed locations
- Package and ship soil samples to laboratory for analysis of CCR parameters

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

A map of proposed background soil sampling locations is provided as Figure 1 (Attachment A). The locations were selected based on access, current hydrogeologic knowledge, and the sample location criteria set forth by TDEC. In addition, locations where known or suspected beneficial reuse of CCR has occurred were excluded from consideration as sampling points. Additional considerations in selection of background soil boring locations included: access rights, relative elevation to the Plant, similar geologic units, and/or similar depositional environment (i.e., alluvial or non-alluvial), and when feasible, proximity to existing background groundwater monitoring wells).

Boring advancement through unconsolidated soils to refusal or 20 feet below the groundwater surface, whichever is shallower, will be conducted at locations shown on Figure 1 within a one-mile radius of the Plant. Soil borings will be advanced using a direct-push technology (DPT) drill rig (typically equipped with 5-foot long probe rods or dual tube samplers) or an equivalent technology. The rods will be decontaminated between sampling locations in accordance with Section 5.2.7. In addition to the soil data that will be collected from the twelve proposed sampling locations, TVA will collect soil samples through the well screen interval at locations of proposed background groundwater monitoring wells.

Grab samples will be collected in five-foot intervals during boring advancement from the ground surface to the top of bedrock/partially weathered rock/weathered rock (refusal), or a depth of 20 feet below the groundwater surface, whichever is shallower. Each boring will be logged by a Tennessee-licensed professional geologist.

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, advance soil borings, collect background soil samples, and assist in providing scientifically defensible results.

Background soil sample collection will adhere to applicable United States Environmental Protection Agency (EPA) and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer and a Tennessee-licensed professional geologist
- Complete required health and safety paperwork and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator to ensure that sample bottles and preservatives are ordered, coolers and analyte-free deionized water are obtained, and sampling and sample arrival dates are communicated to the laboratories
- Coordinate activities with the drilling subcontractor
- Clear Access – Proposed boring locations will be marked using a wooden stake or survey flag with the position surveyed using GPS. Suitability of each location will be evaluated for logistical issues including access, grubbing needs, overhead utility clearance, and proximity to Plant features. Access improvements, including clearing and grubbing or road building, will be completed prior to the investigation start date
- Perform Environmental Review – As required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC has a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, plant staff will not issue an excavation permit ahead of the completed environmental review

- Complete Utility Locate(s) / Excavation Permit(s) - Prior to initiating subsurface activities, subsurface utility clearance will be sought via the plant engineering department and/or the TN 811 service. At locations within the Plant, engineering will provide primary utility clearance assurance in addition to TN 811 being notified. At all other drilling locations TVA or 3rd party underground locators will be engaged to clear boring locations. For drilling locations outside the plant (e.g., along public roads and rights-of-way), utility avoidance assurance will be supplemented by the TN 811 service and the TVA or 3rd party underground locators. An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the drilling locations with pertinent TVA staff

- Identify Water Source – During implementation of the EIP, a source of potable water will be required to complete several investigation tasks, including certain drilling methods and decontamination procedures

- Obtain required functional and calibrated field instruments, including health and safety equipment

- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*

- Obtain ice daily prior to beginning work for sample preservation

5.2 SAMPLING METHODS AND PROTOCOL

Drilling activities performed at the Plant during implementation of this SAP will include advancing subsurface boreholes using DPT or other compatible technology based on field conditions and rig availability.

The following sections present drilling and soil sampling procedures required to complete the tasks presented.

5.2.1 Drilling, Logging, and Surveying

5.2.1.1 Background Borings

Probe advancement will be initiated using the static weight of the rig until encountering refusal. Percussion will be used to advance the probe rods further following maximum penetration under the static load. A new two-inch inside diameter one- time use clear, polyvinyl chloride (PVC) sample liner will be placed inside the sample rod before each push to collect continuous soil samples. After the sample rod is pushed to the appropriate depth, it will be retracted and the liner and sample removed and placed on clean plastic sheeting. A new PVC liner will then be placed in the sampler and another rod will be added to the run. DPT sample rods will be driven and retracted in a continuous run until the desired soil boring depth is achieved.

A liner cutter will be used to open the liner for sample retrieval. Soils that are not considered part of the representative sample (e.g., slough as determined by visual inspection of the sample) will be managed in accordance with Section 5.2.8. The core length will be measured to calculate sample recovery. Soils obtained in each PVC liner will be logged by a Tennessee-licensed professional geologist. Samples will be collected in accordance with Section 5.2.4.

Once sample collection is complete at each boring, the boreholes will generally be filled with a bentonite-cement grout mixture using a tremie pipe to within approximately six inches of the surface. The top six inches will be restored to match the existing conditions.

5.2.1.2 Background Groundwater Monitoring Wells

During installation of proposed background monitoring wells, soil samples will be collected to provide additional background soil data. Soil samples collected during the installation of these monitoring wells will either be collected using the same method described in above in Section 5.2.1.1 or by using split spoon samplers driven through the hollow stem augers used to advance the monitoring well boring. Soil samples from these monitoring well locations will be collected through the well screen interval.

5.2.1.3 Borehole Logging

During boring advancement, each borehole will be logged by a Tennessee-licensed professional geologist. At a minimum, the following information will be recorded in accordance with TVA TI ENV-TI-05.80.03, *Field Record Keeping* and *American Society of Testing and Materials (ASTM) Standard D2488* and entered on boring logs for each borehole and each distinct stratum described:

- Name of person completing boring log
- Boring identification and boring date

- Soil color and classification, using Munsell soil color charts and Modified Unified Soil Classification System (USCS), (unconsolidated materials)
- Visual identification of CCR in soil cores, if present
- Moisture content (e.g. dry, moist, or wet)
- Soil consistency or density, size, shape, and angularity of particles (for fine to coarse grained soils)
- Soil pH as determined in the field using field pH test kits
- Depth interval represented by stratum observations
- Additional observations deemed relevant (e.g. presence of groundwater, fractures, GPS survey data, etc.)
- Field boring logs will be collected on field forms and then input to gINT for final production

5.2.1.4 Surveying

Once completed, borings will be surveyed for horizontal and vertical control by survey grade GPS. The final survey of each location will be conducted following completion and abandonment of each individual sampling location. The survey data will be added to the final boring logs once available.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. Boring log forms will be used to document lithologic conditions and field observations at each boring location.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Consultant will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

Sample collection for laboratory analysis at each location will be initiated at the ground surface. An initial grab sample representing the surficial soils (i.e., top 6 inches) will be collected by hand auger and submitted for laboratory analysis of percent ash by polarized light microscopy (PLM) in addition to CCR Parameters.

The additional analysis of percent ash by PLM on the surficial sample is to determine if there have been any windblown CCRs deposited at the boring location. Sampling will continue the length of the boring by collecting grab samples from the mid-point of each five-foot boring interval. The mid-point for grab samples will be the mid-point based on recovery. If soils are expected to be hard to recover during core retrieval core catchers will be used to prevent loss of sample material. No composite samples are proposed. If a change in lithology, such as a change in residuum, colluvium, alluvium, etc. occurs within a core interval separate grab samples will be collected from the mid-point of both lithologies in the core.

Each sample from the recovered core will be collected with a gloved hand, properly decontaminated sample scoop, or certified clean disposable sample scoop, field samplers will wear a new pair of disposable nitrile gloves while handling each sample. The samples will be placed in a new, re-sealable bag and will be homogenized using a gloved hand or decontaminated sample scoop, certified clean disposable sample scoop and/or by kneading the material through the outside of the bag until the physical appearance is consistent over the entire sample.

After homogenization, the sample will be collected from the bag and placed in the appropriate laboratory-supplied sample containers. Each sample will be submitted to the laboratory for CCR parameters (refer to Section 5.2.6).

5.2.5 Preservation and Handling

Prior to placing each soil sample into the laboratory supplied containers, an aliquot of the homogenized soil sample will be tested using a field pH test kit with the results recorded in the daily field notes. Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers (such as 4-ounce or 8-ounce soil jars) will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Gel ice or loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Consultant Project Manager.

5.2.6 Sample Analyses

Samples will be submitted to the TVA-approved laboratory for analysis. These samples will be analyzed for concentrations of CCR parameters in order to evaluate naturally occurring levels and establish a baseline in background soils. Tables 1-3 summarize the constituents requiring analysis. Analytical methods, preservation requirements, container size, and holding times for each chemical analysis is presented in Table 4. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 1. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids – Not Applicable

Table 2. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 3. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 4. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Percent ash	PLM (RJ Lee SOP OPT23.02)	Not Applicable	4 oz. glass	Not Applicable
Metals	SW-846 6020A	Cool to <6° C	4 oz. glass	180 days
Mercury	SW-846 7471B	Cool to <6° C	4 oz. glass	28 days
Radium 226	SW-846 901.1	Cool to <6° C	8 oz. glass	180 days
Radium 228	SW-846 901.1	Cool to <6° C	8 oz. glass	180 days
Chloride	SW-846 9056A Modified	Cool to <6° C	4 oz. glass	28 days
Fluoride	SW-846 9056A Modified	Cool to <6° C	4 oz. glass	28 days
Sulfate	SW-846 9056A Modified	Cool to <6° C	4 oz. glass	28 days
pH	SW-846 9045D Modified	Cool to <6° C	4 oz. glass	Not Applicable*

*Holding time for soil pH samples is 15 minutes following creation of soil paste. Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time.

5.2.7 Equipment Decontamination Procedures

Documented decontamination will be performed for drilling equipment, tooling, and instruments in contact with subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Decontamination pads will be constructed for decontamination of large downhole tooling (augers, drill rods, etc.) using a high-pressure washer/steam cleaner.

Decontamination pads will be constructed at locations designated by TVA personnel using poly sheeting with sufficient berms to contain decontamination fluids and prevent potential runoff to uncontrolled areas. Following decontamination, fluids will be pumped into a drum for storage, transportation, and ultimately disposal in accordance with Section 5.2.8. Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instruments (e.g., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Soil Cuttings
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05 *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to background soil sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Four types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, and field blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One field duplicate sample will be collected for every 20 soil samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected by splitting the homogenized sample volume into two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of soil is already contained in the laboratory supplied soil sample jars for use as the MS/MSD. As such, MS/MSD samples will be collected by the laboratory from the sample containers submitted for standard analysis, allowing matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 soil samples collected. Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book.

The MS/MSD sample will be analyzed for the same analytes as the primary sample, with the exception of parameters that are not amenable to MS/MSD.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for every 20 samples. The equipment blank will be collected at a soil boring location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment (e.g., decontaminated DPT cutting shoe, sample scoops, or other non-disposable decontaminated equipment), then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes, with the exception of pH, as the sample collected from the soil boring location where the equipment blank is prepared.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to ensure the label is not removed. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

PLM data will not be subjected to data validation due to the specialized training and equipment required to accurately visually quantitate ash. PLM data will be subjected to verification including a review of QC analyses and a reasonability assessment based on photomicrographs included in the data package.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 5. Preliminary Schedule for Background Soil SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Background Soil SAP Submittal		Completed
Prepare for Field Activities	25 Days	Following EIP Approval
Conduct Field Activities	35 Days	Following Field Preparation
Laboratory Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Plant-specific safety requirements are anticipated to include TVA specified training and attendance at a safety briefing. Only Investigation Consultant employees and subcontractors performing work activities will be required to meet the above requirements.
- A dedicated Safety Officer will be present for this work.
- Assessment of suitability of areas and access to borings, including clearing and grubbing, will be provided by TVA and will be completed prior to the Investigation start date.

9.0 REFERENCES

Environmental Protection Agency (EPA). 1995. "Engineering Forum Issue; Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites." December.

Environmental Protection Agency (EPA). 2004. "National Functional Guidelines for Inorganic Data Review." October.

Environmental Protection Agency (EPA) Region 4. 2001. "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual." November.

Tennessee Valley Authority (TVA). 2017a. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000. March 31.

ATTACHMENT A
FIGURE

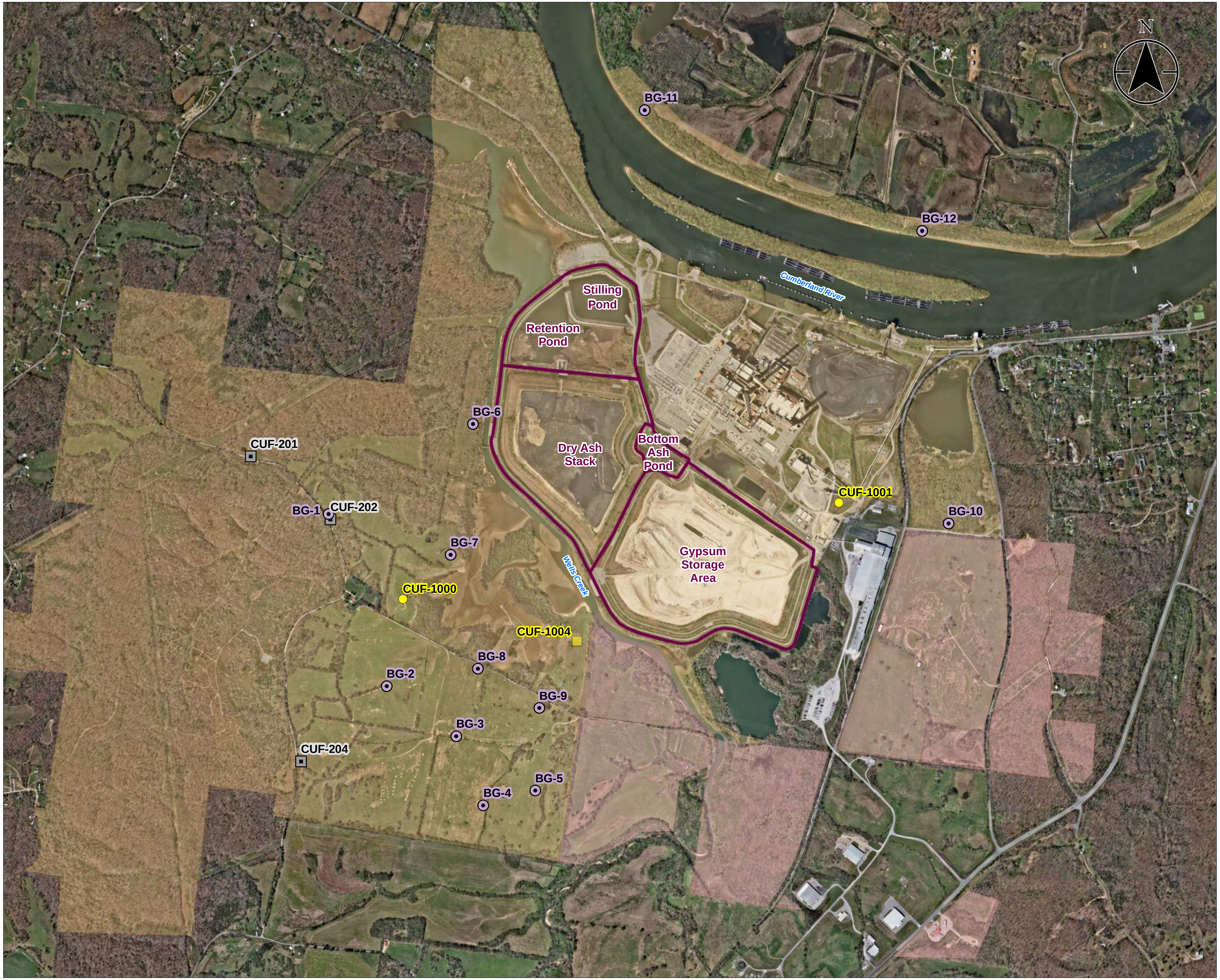


Figure No.
1

Title
Proposed Soil Sample Locations

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

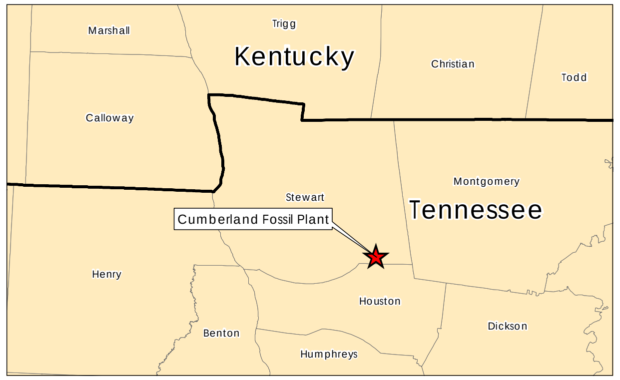
175566329
Prepared by TR on 2018-01-24
Technical Review by EM on 2018-01-24

0 700 1,400 2,100 2,800 Feet
1:8,400 (At original document size of 22x34)

Legend

- Existing Background Groundwater Monitoring Well
- Proposed Background Soil Sample Location
- Proposed Background Monitoring Well
- Proposed Well Area
- TVA Property
- Rye Property - No Access
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Property digitized from Tennessee Property Viewer



Stantec

TVA

u:\TVA-EP\175566329\gis\mxds\REV3\01a_CUF_Proposed_Soil_Sample_Location.mxd Revised: 2018-01-24 By: mbough

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Background Soil Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Photoionization detector (PID)
Water level indicator meter
Field pH Test Kits
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for drilling-specific field equipment

APPENDIX F
EVALUATION OF EXISTING GEOTECHNICAL DATA

Evaluation of Existing Geotechnical Data Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

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1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

2.0 OBJECTIVES AND EVALUATION CRITERIA

Through the various information requests, as well as TDEC comments on the EIP, a need has been identified for an evaluation of existing geotechnical data. This document has been prepared to review the existing data and evaluate its adequacy with respect to responding to the various information requests.

Characterization of geotechnical parameters may differ from one evaluation to the next and can be due to multiple factors, such as:

1. Different loading cases (long-term static, short-term static, seismic, etc.) necessitate different strengths,
2. Spatial variation in subsurface conditions and analyses that consider different locations,
3. New information (field data, laboratory data, etc.) that allows updates to the characterization,
4. Changes in subsurface conditions due to the passage of time and/or geometric/operational changes at the site,
5. Evolution of the standard of practice and differences in professional engineering judgement with respect to geotechnical characterization and/or stability analyses,

Such differences are common within geotechnical engineering practice, particularly over a long period of time, with multiple studies performed by various professionals, and as additional data becomes available through various field and laboratory testing efforts. The relevancy of the above factors, with respect to the existing and upcoming analyses will be included as part of the response in the Environmental Assessment Report (EAR).

Evaluating the adequacy of existing data depends on both the type of data and its use. Existing geotechnical data will be used to support the following subjects addressed within the information requests:

1. Three-dimensional model (including CCR saturation) and volumetric estimates,
2. Stability of bedrock below fill areas,
3. Stability of the waste fill and side-slope berms,
4. CCR and soil shear strengths,
5. Potential for solution channeling, karst features, etc. in the shallow rock formations beneath the CCR units.

2.1 THREE-DIMENSIONAL MODEL (INCLUDING CCR SATURATION) AND VOLUMETRIC ESTIMATES

For evaluating the three-dimensional model and volumetric estimates, existing data to be considered (if available) includes:

1. Ground survey, aerial, and hydrographic surveys which including existing ground surface, upper CCR surface, and dike geometry data,

2. Instrumentation data and/or seepage models that include piezometric levels of saturation in CCR,

3. Borings that included the lower CCR surface, thickness of the clay foundation (or other materials) overlying bedrock, and top of bedrock elevations.

4. Electrical Resistivity Imaging (ERI) data that includes interpreted top of bedrock data.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

- Suitability of methods used to perform topographic surveys, geotechnical borings, and geophysical surveys, as well as the associated documentation. Suitability is evaluated qualitatively, based on how well the methods obtain the necessary data and how the methods compare to the current standard of practice.

- Spatial coverage of borings and geophysical surveys.

- Potential for relevant changes in subsurface conditions since borings or surveys were performed.

2.2 STABILITY OF BEDROCK BELOW FILL AREAS

For evaluating the stability of bedrock below fill areas, existing data to be considered (if available) includes:

1. Geotechnical data from borings that included rock coring,

2. Geophysical surveys that included data below the top of bedrock,

3. Routine visual observations of CCR units, with respect to indicators of structural distress.

4. Geologic mapping and characterization of the site, including descriptions of the shallow rock formations.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Spatial coverage of borings, geophysical surveys, and visual observations,

2. Suitability of methods used to perform rock coring, geophysical surveys, and visual observations, and of the associated documentation. Suitability is evaluated qualitatively, based on how well the methods obtain the necessary data and how the methods compare to the current standard of practice.

3. Potential for relevant changes in subsurface conditions since borings, surveys, or observations were performed.

2.3 STABILITY OF WASTE FILL AND SIDE-SLOPE BERMS

For evaluating stability of the waste fill and side-slope berms, existing data to be considered includes:

1. Slope stability analyses of existing conditions,

2. Slope stability analyses of future (i.e., permitted, "build-out", or closed) conditions.

3. Structural stability assessments performed for CCR Rule compliance.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Representative coverage with stability analysis cross sections,

2. Representative cross section geometry and subsurface characterization,

3. Representative material parameters and phreatic conditions,

4. Representative loads (static loads, seismic loads, etc.),

5. Appropriate stability analysis methods,

6. Potential for relevant changes in conditions since analyses were performed.

2.4 CCR AND SOIL SHEAR STRENGTHS

For evaluating CCR and soil shear strengths, existing data to be considered includes:

1. Shear strengths based on in-situ testing,
2. Shear strengths based on laboratory testing,
3. Shear strengths based on published values for similar materials.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Locations of in-situ tests and/or samples for each material,
2. Suitability of methods used to perform in-situ testing, to collect samples, and to perform laboratory testing. Suitability is evaluated qualitatively, based on how well the methods obtain the necessary data and how the methods compare to the current standard of practice.
3. Potential for relevant changes in subsurface conditions since in-situ testing and/or sampling were performed.

2.5 POTENTIAL FOR SOLUTION CHANNELING AND KARST FEATURES

For evaluating the potential for solution channeling in the shallow rock formations beneath the CCR units, existing data to be considered (if available) includes:

1. Geotechnical data from borings that included rock coring,
2. Geophysical surveys that included data at/below the top of bedrock,
3. Geologic mapping/characterization of the site, including descriptions of the shallow rock formations.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Spatial coverage of borings, geophysical surveys, and geologic mapping,
2. Suitability of methods used to perform rock coring, geophysical surveys, and geologic mapping, and of the associated documentation,
3. Potential for relevant changes in subsurface conditions since borings, surveys, or mapping was performed.

3.0 EXISTING GEOTECHNICAL REPORTS

The following sections review and evaluate existing geotechnical reports with respect to the data necessary to support EIP information request responses. Each evaluation begins with a summary table of the key items, followed by additional details of each report.

3.1 WILSON AND STEARNS (1968)

Table 1. Summary of Evaluation for Wilson and Stearns (1968)

Reference:	Wilson, C. W. Jr. and Stearns, R. G. 1968. "Geology of the Wells Creek Structure, Tennessee." Bulletin 68, Tennessee Division of Geology.	
Purpose:	Detailed observations on the geology (stratigraphy and structure) of the Wells Creek area. Interpretation of the origin of the structure.	
CCR Unit(s):	All units	
Spatial coverage:	Observations and mapping include the CUF property and beyond.	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	Yes	One deep core, total depth of 2,500 feet. Located outside of the CCR unit footprint, southwest of the Gypsum Storage Area.
Other subsurface data:	Yes	Geologic maps, structure contour map, gravity anomaly map
Boring locations surveyed:	N/A	
Data adequate to support three-dimensional model:	Yes	Geologic mapping can be correlated with top of bedrock elevations to evaluate trends
Geometry at time of document representative of 2017 conditions:	Yes	Structural geology and top of bedrock is the same as current
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Information is relevant to bedrock characterization
Other relevant analyses:	No	

3.1.1 Field Activities

Previous investigations of the Wells Creek structure date back as early as 1854 and mapping was published in 1855. Many have visited the Wells Creek Basin since then to map the faulting system, bedding planes, structure, and topography. The most extensive of these studies was performed by the Tennessee Valley Authority and published by Kellberg in 1959. Kellberg published an abstract describing 53 cores that had been drilled on a 200-foot grid covering an area 1,200 by 1,400 feet near the northern edge of the basin on the west end of Allen Ridge.

Mapping of Wells Creek Basin was done with alidade and plane table, topographic maps, and aerial photographs. TVA supplied Wilson and Stearns with the cores from the 53 holes drilled within the west end of Allen Ridge. Additionally, the Tennessee Division of Geology supplied the 2,000-foot core drilled by the Ordman Company in 1947 in the center of Wells Creek Basin. This hole was extended an additional 500 feet as part of this project. The rock cores were analyzed with an emphasis on signs of brecciation along with evidence of shock deformation. Additionally, a gravity survey of the area was performed using a gravity meter.

3.1.2 Analysis

The previous geologic and topographic mapping was combined with research findings obtained during this study. The Wilson and Stearns team provided a generalized stratigraphic column, generalized geologic map, updated cryptoexplosive structure map, and geological interpretation of structural data. Additionally, they provided specific details on the structural fabric, such as faulting trends, bedding orientation, etc. and region specific details on shatter cones and brecciation.

3.1.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Stability of the bedrock below fill areas, top of rock surface
    a. Boring locations and elevations were surveyed,
    b. Boring log documents bedrock stratum descriptions and thicknesses,
    c. Geologic mapping can be correlated to rock cores and top of rock elevations,
    d. Geologic mapping methods meet current standard of practice.

3.2 HALL, BLAKE, AND ASSOCIATES (1986)

Table 2. Summary of Evaluation for Hall, Blake, and Associates (1986)

Reference:	Hall, Blake, and Associates (HBA). 1986. "Site Investigation, Proposed Cumberland Fossil Project Soils Investigation for Ash Pond Dike and Borrow Areas." Prepared for Tennessee Valley Authority. October 3.	
Purpose:	Subsurface characterization of perimeter dike and foundation soils	
CCR Unit(s):	Stilling Pond (including Retention Pond), Dry Ash Stack	
Spatial coverage:	Western and southwestern portion of perimeter dike along Wells Creek	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	14 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Not explicitly stated, but coordinates and elevations are provided and are inferred to have been surveyed.
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, clay thickness, and top of bedrock elevation. Borings did not encounter CCR.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Phreatic surface likely different due to changes in operations (pool now lower, conversion to Dry Ash Stack).
Piezometer installation:	No	
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Index testing appears to follow ASTM standards. CU triaxial testing references an unknown TVA specification.
Shear strength parameters:	Yes	Static drained and undrained strengths (Dike fill)
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	CU triaxial testing was performed, but the testing standard is unknown.
Other relevant analyses:	No	

3.2.1 Field Activities

Fourteen soil borings were advanced in the perimeter dike along the western and southwestern portion of the Stilling Pond (including Retention Pond) and Dry Ash Stack (although the stack footprint was still part of a larger ash pond at the time). The other areas of the interior and perimeter dikes were not investigated within the scope of this exploration. Three of the soil borings were performed from the crest of the raised dike (approximate elevation 395 feet) and the other eleven soil borings were performed from the crest of the original dike (approximate elevation 380 feet). These borings extended to depths ranging from 36.5 feet to 85 feet with the majority being terminated at a depth of 60 feet.

Drilling was performed using hollow stem augers. Soil sampling was performed using standard penetration tests (SPT) and undisturbed (UD) sampling procedures while under the supervision of a TVA inspector. Boring logs show a 5-foot sampling interval for the first 10 feet, then nearly continuous sampling (15.0-16.5, 17.0-18.5, etc.) for the next 10 to 20 feet, and finally back to 5-foot intervals to the bottom of the boring.

Upon completion of the field work, the soil boring locations were surveyed onto the local plant coordinate system (approximate locations are shown in Exhibit 1).

3.2.2 Laboratory Testing

Soil classification and index property testing was performed on twelve Shelby tube samples from the dike. Each tube was tested for Atterberg limits (D4318), moisture content, specific gravity (D854), and unit weight. Additionally, nine CU triaxial strength tests (with pore pressure measurements) were run on Shelby tube samples from the dike. Unless otherwise listed, the standards followed during testing are not documented.

3.2.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike geometry is substantially the same as current.
2. Soil index properties (Atterberg limits, specific gravity)
    a. Testing followed relevant ASTM standards.

3.3 LAW (1992A)

Table 3. Summary of Evaluation for Law (1992A)

Reference:	Law Engineering, Inc. (Law). 1992a. "Report of Subsurface Exploration and Stability Analyses, Proposed Fly Ash/Scrubber Sludge Disposal Facility, Cumberland Fossil Fuel Plant, Cumberland City, Tennessee, Law Project No. 57401442.01." Prepared for Tennessee Valley Authority. January 27.	
Purpose:	Evaluating the suitability of the existing sluiced ash pond footprint for possible subdivision and conversion of portions to a Dry Ash Stack and a Gypsum Storage Area.	
CCR Unit(s):	Stilling Pond (including Retention Pond), Proposed Dry Ash Stack, and Proposed Gypsum Storage Area	
Spatial coverage:	Borings along perimeter dikes at approximately 1,000 ft centers	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	15 borings (13 locations with 2 companion offsets)
Rock coring:	No	
Other subsurface data:	Yes	6 dilatometer probes within CCR units
Boring locations surveyed:	Yes	Not explicitly stated, but local plant coordinates and elevations are provided and are inferred to have been surveyed.
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, clay thickness, CCR thickness, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Phreatic surface likely different due to changes in operations (pool now lower, conversion to Dry Ash Stack).
Piezometer installation:	Yes	12, 1-inch diameter piezometers. Screens may span multiple materials/strata.
In-situ testing:	Yes	SPT and dilatometer probe
Laboratory testing:	Yes	Index and compaction testing are stated to follow ASTM standards. CU triaxial and direct shear tests appear to follow ASTM standards, although not explicitly stated.
Shear strength parameters:	Yes	Static drained and undrained strengths (dike fill, foundation soils, compacted and sluiced ash)
Static slope stability:	Yes	Steady-state case reflecting the maximum design height of the slope.
Seismic slope stability:	Yes	Steady-state, pseudostatic loadings with a horizontal seismic coefficient.

Reference:	Law Engineering, Inc. (Law). 1992a. "Report of Subsurface Exploration and Stability Analyses, Proposed Fly Ash/Scrubber Sludge Disposal Facility, Cumberland Fossil Fuel Plant, Cumberland City, Tennessee, Law Project No. 57401442.01." Prepared for Tennessee Valley Authority. January 27.	
Information adequate to support stability evaluation:	No	CU triaxial testing appears to follow ASTM standards, but is not explicitly documented.
Other relevant analyses:	No	

3.3.1 Field Activities

Fifteen soil borings were advanced in dike areas with another six dilatometer probes advanced in open ash pond areas. Originally, twelve soil borings were planned along the dike on 1,000 foot centers. However, the planned boring layout was modified to include thirteen soil borings with two offset borings due to shallow refusal at those locations (B-9 and B-12). These borings extended to depths ranging from 14 to 45 feet.

The encountered soils were sampled on 2.5 foot centers for the first 10 feet and then on 5 centers thereafter by means of the standard penetration test conducted in accordance with ASTM D1586: Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. Undisturbed soil samples (Shelby tubes) were also retrieved at various depths within each of the distinct stratum for purposes of laboratory testing. This sampling procedure is described by ASTM D1587.

Flat dilatometer testing consists of a stainless-steel blade, 96 mm wide and 15 mm thick, with a thin, flat circular expandable membrane, 60 mm in diameter, on one side. The blade is pushed into the ground by the drilling rig. At 2 foot intervals, penetration is stopped and the membrane inflated using pressurized nitrogen gas. Measurements are obtained of the pressure required to initiate membrane expansion, at a maximum expansion of 1 mm, and again at-rest. Index values for the encountered soils may be correlated empirically with soil composition and elastic properties once corrected for field equipment used to perform the test. The dilatometers were extended to refusal depths ranging from 9 to 33 feet.

Upon completion of the subsurface exploration, the soil boring locations were surveyed onto the local plant coordinate system (approximate locations are shown in Exhibit 1). Additionally, open standpipe piezometers were installed at ten (10) boring locations. Please note that all initial water level readings for this project were read after the completion of drilling.

3.3.2 Laboratory Testing

Limited testing of the obtained soil samples was included in the scope of work. In lieu of an extensive testing program, material properties were obtained from a variety of sources including prior data from HBA (1986), field and laboratory test results performed gathered during this project, published data, and experience with similar soils.

Triaxial shear strength tests were previously conducted by HBA (1986) on over 30 samples (undisturbed and re-molded) obtained from the dike and borrow areas. Law used this data to estimate undrained and drained strength parameters. Law also performed confirmation laboratory testing, including direct shear testing and consolidated-undrained triaxial shear testing on remolded dike material. Although testing standards were not documented for the shear strength testing, the described methods appear to be in general accordance with ASTM standards.

No laboratory testing was performed on the foundation soils (residual or alluvial). The material properties of the sluiced ash were obtained from dilatometer data and published resources. Although compacted ash was not present at the time of drilling, properties were estimated based on results of a standard Proctor test (D698), grain size analyses (D421/D422) and published values. Moisture contents were determined using ASTM D2216.

3.3.3 Analysis

The primary emphasis of this study concerned the stability of the proposed waste disposal facilities (i.e., Dry Ash Stack and Gypsum Storage Area) when constructed atop the existing ash pond footprint, including sluiced ash. Liquefaction triggering of the sluiced ash was considered for the design. Slope stability was evaluated under static, steady state conditions and dynamic, earthquake loading conditions.

Liquefaction triggering of the sluiced ash was evaluated using simplified, stress based methods (e.g., Seed and Idriss 1971) for an idealized soil profile consisting of 40 feet of sluiced ash above a non-liquefiable clay stratum. A peak horizontal acceleration at the ground surface of 0.1 g was assumed. The results of this analysis indicate that liquefaction was likely, particularly near the toe of the proposed stacks. This could cause instability of the lower portions of the slopes. It should be noted that the approach used by Law is now considered outdated. Law's liquefaction assessment has been superseded by more recent analyses that consider additional information and utilize methods that are considered current state of practice (Sections 3.10 through 3.13).

Slope stability analyses were performed on four generalized cross-sections: existing stilling pond, interim interior slope of a stack, and two for the proposed stacks. The two sections for the stacks represented the proposed maximum height and were therefore considered most critical for slope stability. Two different perimeter dike configurations were considered. The first configuration included a starter dike founded on soil, a raised dike over sluiced ash, and stacked ash over sluiced ash. The second configuration included a single, larger starter dike founded on soil and stacked ash over sluiced ash.

Two cases for the phreatic surface were modeled in the analyses, normal and elevated pool. The normal pool case modeled the phreatic surface 20 feet below the top of sluiced ash. The elevated case modeled a phreatic surface at the top of sluiced ash.

Static slope stability was evaluated using both drained and undrained strengths, and both circular and wedge failure surfaces. Pseudostatic slope stability was evaluated using undrained strengths, and both circular and wedge failure surfaces. A pseudostatic coefficient of 0.1 g was assumed.

The results of these analyses of the various slope configurations indicated that the design exterior slope of 3H:1V would be stable under both static and dynamic loading conditions. The interior slope could be as steep as 3H:1V and remain stable under both static and dynamic loads. The stilling basin would also be stable under both static and dynamic loading conditions.

3.3.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike geometry is substantially the same as current.
2. Soil index properties (Atterberg limits, gradation, natural moisture content)
    a. Testing followed relevant ASTM standards.
3. Other soil properties
    a. Triaxial and direct shear strength testing appear to have followed ASTM standard procedures, but this is not explicitly documented. Results can be used for comparison/context to other data, but should not be used directly for analyses.

3.4 LAW (1992B)

Table 4. Summary of Evaluation for Law (1992B)

Reference:	Law Engineering, Inc. (Law). 1992b. "Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility, TVA Cumberland Fossil Plant, Cumberland City, Tennessee, Law Project No. 574-01442.04." Prepared for Tennessee Valley Authority. July 3	
Purpose:	A hydrogeologic assessment of the site, to meet TDEC permitting requirements. Regarding the existing sluiced ash pond footprint, and possible subdivision and conversion of portions to a Dry Ash Stack and a Gypsum Storage Area.	
CCR Unit(s):	Stilling Pond (including Retention Pond), Proposed Dry Ash Stack and Proposed Gypsum Storage Area	
Spatial coverage:	Borings and well installations along interior divider dikes and perimeter dikes, plus two locations east of the CCR units.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	15 borings
Rock coring:	Yes	4 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Not explicitly stated, but local plant coordinates and elevations are provided and are inferred to have been surveyed.
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, clay thickness, CCR thickness, top of bedrock elevation
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Phreatic surface likely different due to changes in operations (pool now lower, conversion to Dry Ash Stack).
Piezometer installation:	Yes	Type 1 installed at one location, screened in bedrock; Type II or Type III were installed at 8 boring locations, screened in CCR, dike fill, alluvium, residuum, and/or bedrock. Screens may span multiple materials/strata.
In-situ testing:	Yes	SPT, packer testing in rock, slug testing in wells
Laboratory testing:	Yes	Hydraulic conductivity tests and corresponding soil index tests were performed on 4 samples. Index testing is stated to follow ASTM standards. Hydraulic conductivity tests appear to follow ASTM standards, although not explicitly stated.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	

Reference:	Law Engineering, Inc. (Law). 1992b. "Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility, TVA Cumberland Fossil Plant, Cumberland City, Tennessee, Law Project No. 574-01442.04." Prepared for Tennessee Valley Authority. July 3	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	Yes	Consideration of sinkhole potential, with respect to structural stability. Consideration of seepage regime.

3.4.1 Field Activities

Fifteen soil borings were advanced along interior divider dikes, exterior perimeter dikes, plus two locations east of the CCR units. The soil boring locations were surveyed onto the local plant coordinate system (approximate locations are shown in Exhibit 1). The encountered soils and CCR were sampled at five and ten foot intervals by SPT per ASTM D1586. Soil borings were typically advanced using the wash boring method. Thus, water level readings could not be taken in boreholes during drilling. Water level readings were collected later after water levels stabilized in the hole or in the well that was installed.

Undisturbed soil samples (Shelby tubes) were also retrieved for purposes of laboratory testing. In addition to soil testing, four borings were advanced up to approximately 100 feet below existing grade by means of rock coring. At these four boring locations, the length of rock core sample obtained ranged from 15 feet to 83.5 feet. These rock core samples were logged in the field, noting the rock type, run recoveries, and rock quality designation (RQD).

In-situ measurements of hydraulic conductivity of the soil were made at four locations via slug testing. The testing methodology or relevant ASTM standard is not documented. These tests were conducted by introducing and then later removing a solid cylinder of known volume which displaces water within the well. During the tests, water levels were measured over time using an electronic data logger. Field data was then processed using the Bouwer and Rice model for unconfined aquifer conditions.

Hydraulic conductivity testing was performed on the bedrock using packer testing in two borings. The testing methodology or relevant ASTM standard is not documented. Three depth intervals were tested in one boring, and one depth interval in the other boring. These locations were chosen outside of mapped fault zones, and likely tested less fractured/weathered rock than is present in fault zones.

Upon completion of the subsurface exploration, water level observation wells were installed at seven boring locations. Type II observation wells were installed at five locations to assess in-situ hydraulic conductivity and two double-cased Type III wells were installed to isolate water within the residual/alluvial soil zones from the process water in the ash pond.

3.4.2 Laboratory Testing

Vertical hydraulic conductivity testing was performed in the laboratory on undisturbed soil samples. Unit weight, gradation, and natural moisture content tests were also performed on the samples. Where applicable, anisotropy ratios were calculated based on the laboratory derived vertical hydraulic conductivity and the slug test derived horizontal hydraulic conductivity.

3.4.3 Analysis

Two aspects of structural stability of the proposed stacks were considered:

1. Sinkhole potential – solution channels in bedrock leading to subsurface erosion and surface dropouts.

2. Stability of Sluiced Ash – static and dynamic slope stability, as it relates to the proposed stacks being constructed over existing sluiced ash deposits.

Sinkhole potential was evaluated qualitatively. Carbonate rock formations, such as those underlying portions of the project site, can be subject to solutioning. The potential for sinkhole development is dependent on several factors including prevalence of pre-existing voids, hydraulic gradients in the bedrock, and seepage rates through the soil layers overlying the bedrock. Law Engineering concluded that the potential for sinkhole development was low at the site, based on the following factors:

- Soils overlying bedrock are clayey and thus more resistant to internal erosion,

- Hydraulic gradients in bedrock are quite low and seepage velocities should be low, such that significant soil movement is unlikely.

- No open voids or cavities were observed in the borings. Clay-filled solution features were observed.

- The existing pond has operated for 20 years without observed sinkholes. Conversion from ponds to stacks should reduce the hydraulic forces on the subsurface.

Regarding slope stability of the proposed stacks, Law Engineering refers to their earlier analyses (Law 1992a, Section 3.3). They also note that the static and seismic analyses should be updated as needed after final plans have been developed.

3.4.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike geometry is substantially the same as current.
2. Characterization of the hydraulic conductivity in the soil and bedrock at the site.
    a. Slug testing (soil), packer testing (rock), and laboratory testing (soil) appeared to follow conventional procedures, but testing standards are not documented. Results can be used for comparison/context to other data, but should not be used directly for analyses.
3. Soil index properties (Atterberg limits, gradation, natural moisture content)
    a. Testing appeared to follow conventional procedures, but testing standards are not documented. Results can be used for comparison/context to other data, but should not be used directly for analyses.

3.5 UNITED ENGINEERS AND CONSTRUCTORS (1993)

Table 5. Summary of Evaluation for United Engineers and Constructors (1993)

Reference:	United Engineers and Constructors. (UEC). 1993. "Geotechnical Investigation Report, TVA Flue Gas Desulfurization (FGD) Retrofit/Dry Ash Conversion Project, Cumberland Fossil Plant." Prepared for Tennessee Valley Authority. Project 6314.009. June.	
Purpose:	Evaluation of the stability of the proposed Fly Ash and Gypsum Disposal Facilities based upon proposed design and construction sequence	
CCR Unit(s):	Dry Ash Stack and Gypsum Storage Area	
Spatial coverage:	Perimeter dikes and proposed interior divider dike along boundary of Dry Ash Stack and Retention Pond	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	20 borings
Rock coring:	Yes	19 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed in local plant coordinate system
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, clay thickness, top of bedrock elevation
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike similar. Stacks had yet to be constructed.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	Yes	Index tests on soil. Strength tests on soil and rock. Testing followed ASTM standards.
Shear strength parameters:	Yes	Strength parameters were derived from Law (1992a) and published literature values.
Static slope stability:	Yes	4 cross-sections for existing conditions along dike perimeter plus proposed interior divider dike and proposed stacks.
Seismic slope stability:	Yes	4 cross-sections (3 along dike perimeter and 1 along interior divider dike)
Information adequate to support stability evaluation:	Yes	Stability evaluation can compare proposed construction conditions to existing conditions.
Other relevant analyses:	No	

3.5.1 Field Activities

Note that only excerpts of the report were available for review. Field activities were documented based on boring logs and test results found in an appendix of TVA (1998).

A geotechnical drilling program was developed that consisted of 20 soil borings, 19 of which also included rock coring. The borings were advanced using 3.25-inch (inside diameter) hollow stem augers. The boring locations were surveyed onto a local plant coordinate system, and converted to State Plane coordinates (approximate locations are shown in Exhibit 1).

Ten soil borings were advanced along the perimeter dikes. Three soil borings were advanced within the impoundment for a proposed interior divider dike. Seven borings were advanced to the northeast of the CCR units near the middle of the power plant footprint; thus, they are not relevant to the CCR units. However, the boring logs for these seven borings are included in Appendix B of TVA (1998). The encountered soils and CCR were sampled continuously via SPT for the first 12 feet and then on 5 foot centers thereafter. Water level readings were collected after the water level stabilized in the hole.

Nineteen borings were advanced up to approximately 90 feet below existing grade by means of rock coring using an NX sized core bit. At these nineteen boring locations, the length of rock core sample ranged from 2 feet to 18.5 feet. These rock core samples were logged in the field, noting the rock type, run recoveries, and rock quality designation (RQD).

3.5.2 Laboratory Testing

Note that only excerpts of the report were available for review. Laboratory testing results were documented based on boring logs and test results found in an appendix of TVA (1998).

Soil classification and index property testing was performed on both SPT samples and Shelby tube samples. Select samples were tested for Atterberg limits (D4318), gradation (D422, sieve only), and moisture content (D2216). Additionally, selected Shelby tube samples were tested for unconfined compressive strength (D2166) and unconsolidated undrained triaxial shear strength (D2850). Finally, selected rock core samples were tested for unconfined compressive strength (D7012).

3.5.3 Analysis

Note that only excerpts of the report were available for review. Documentation of slope stability analyses was found in an appendix of TVA (2003).

Evaluation of the stability of the proposed fly ash and gypsum disposal facilities was based on available boring logs, lab test data, existing site conditions, and proposed construction sequence. Four critical cross-sections were analyzed for seismic loading.

The calculation was based on several design assumptions:

- Slopes no steeper than 3:1 (horizontal:vertical);
- Design peak acceleration of 0.1g;
- Installation of drainage blanket at surface of sluiced fly ash to expedite consolidation while aiding in dissipation of pore pressures for stacked, dry CCR;
- Phreatic surface less than or equal to elevation of drainage blanket;
- Shear strength parameters from Law (1992a) report with applicable reductions for seismic loading.

Stability analyses considered both wedge failures and circular failures. Both the Dry Ash Stack and Gypsum Storage Area perimeters were designed to have a minimum factor of safety for static loading and pseudostatic loading of 1.5 and 1.1, respectively.

3.5.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Soil properties
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current, except that stacks have now been constructed on the interior of the perimeter dikes.
3. Static and seismic slope stability analyses
    a. Allows for comparison of design versus as-built conditions from later reports.
    b. Material parameters are representative of current.

3.6 TVA (1998)

Table 6. Summary of Evaluation for TVA (1998)

Reference:	Tennessee Valley Authority (TVA). 1998. "Cumberland Fossil Plan Groundwater Assessment." Prepared by TVA.	
Purpose:	Collect and interpret hydrogeologic information from previous site studies, conduct additional aquifer testing to estimate hydraulic properties of subsurface horizons, and assess groundwater quality at the site to assist in management of CCR.	
CCR Unit(s):	All units	
Spatial coverage:	Existing wells across the site were tested.	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Geology is similar. Phreatic conditions likely different due to changes in operations (pool now lower).
Piezometer installation:	No	
In-situ testing:	Yes	Pump testing, borehole flowmeter testing in monitoring wells. Pump testing in SynMat production wells.
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	Yes	Groundwater conceptual modeling

3.6.1 Field Activities

In-situ measurements of hydraulic conductivity of the soil were made at 3 locations via single well pumping and 4 locations via borehole flowmeter testing. The testing methodology or relevant ASTM standard is not documented. These tests were performed on existing monitoring wells for redevelopment of the well. Pump testing was performed on two production wells at the SynMat facility.

3.6.2 Analysis

After reviewing the existing information and performing the additional well tests, the authors evaluated the following topics: subsurface hydraulic properties, recharge and water levels, groundwater occurrence and conceptual model, and groundwater quality.

3.6.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Hydraulic conductivity of site soils and bedrock
    a. Support hydrogeologic site characterization and associated material parameters.

3.7 TVA (2003)

Table 7. Summary of Evaluation for TVA (2003)

Reference:	Tennessee Valley Authority (TVA). 2003. "Operations Manual, Dry Ash and Gypsum Stacking Facility, Tennessee Valley Authority, Cumberland Fossil Plant." Revision 1, dated September. Sealed and Signed by TVA in October.	
Purpose:	Updated operations manual to reflect current conditions, types and quantities of materials generated and contained at the site, and provides the daily operations and permits to continue operations within the environmental and structural standards established for the site.	
CCR Unit(s):	Dry Ash Stack and Gypsum Storage Area	
Spatial coverage:	Dry Ash Stack and Gypsum Storage Area	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	Yes	Written description of drainage or bridging layers constructed in the units.
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	Yes	Written description of drainage or bridging layers can serve as basis for geometry.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry conditions similar. Phreatic conditions are similar or more conservative (gypsum no longer wet stacked).
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Soil and CCR strengths are referenced from Law (1992a)
Static slope stability:	Yes	4 cross-sections from United Engineers and Constructors (1993) for the proposed FGD retrofit/dry ash conversion.
Seismic slope stability:	Yes	4 cross-sections, pseudostatic analyses from United Engineers and Constructors (1993) for the proposed FGD retrofit/dry ash conversion.
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.7.1 Analysis

Refer to Section 3.5 for summary of analyses by United Engineers and Constructors (1993).

3.7.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations
2. Written descriptions of internal drainage layers/trenches and bridging layers.

3.8 MACTEC (2004)

Table 8. Summary of Evaluation for MACTEC (2004)

Reference:	MACTEC Engineering and Consulting. (MACTEC). 2004. "Laboratory Testing Results: Samples from Gypsum Pond at Cumberland Fossil Plant, MACTEC Project 3043041009/0001". Prepared for Tennessee Valley Authority. May 13.	
Purpose:	Laboratory testing to characterize sedimented gypsum.	
CCR Unit(s):	Gypsum Storage Area	
Spatial coverage:	Gypsum Storage Area interior	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	Shelby tubes to collect shallow, "relatively undisturbed" samples of gypsum. Boring locations were not surveyed.
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	N/A	
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	Yes	All testing appears to follow ASTM standards, although not explicitly stated.
Shear strength parameters:	Yes	CU triaxial testing on "relatively undisturbed" gypsum samples
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Laboratory results can support material parameter derivation for gypsum, to support stability evaluation.
Other relevant analyses:	No	

3.8.1 Field Activities

A total of seven shallow samples were collected from three different areas within the Gypsum Pond. Tubes were pushed (five samples) or driven with a hammer (two samples). Two samples were obtained from the area near the discharge to obtain a coarser sample. Three samples were obtained from the opposite side of the pond from the discharge to obtain a finer sample. Finally, two samples were obtained from the cross dike to obtain a sample of the material used to construct the dike. Attempts at two locations within the interior of the pond to sample sedimented material that had been allowed to dry were not successful.

3.8.2 Laboratory Testing

The laboratory testing program included specific gravity, Atterberg limits, grain size analysis, hydraulic conductivity (flexible wall, falling head test), and consolidated undrained (CU) triaxial compression tests. Three samples (one from each area) had a unit weight and natural moisture content test in conjunction with the associated hydraulic conductivity test. Additionally, three CU tests (one sample from each area) had associated specific gravity, moisture content, and unit weight testing. Finally, four samples had grain size analyses performed. Unless otherwise listed, the standards followed during testing are not documented.

3.8.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Characterization of sedimented gypsum

    a. Testing appeared to follow conventional procedures, but testing standards are not documented. Results can be used for comparison/context to other data, but should not be used directly for analyses.

2. Soil index properties (Atterberg limits, Gradation, Specific Gravity)

    a. Testing appeared to follow conventional procedures, but testing standards are not documented.

3.9 MACTEC (2007)

Table 9. Summary of Evaluation for MACTEC (2007)

Reference:	MACTEC Engineering and Consulting, Inc. (MACTEC). 2007. "Report of Geotechnical Exploration: Gypsum Area Seepage Study, Cumberland Fossil Plant, Cumberland City Tennessee, MACTEC Project 3043-06-1041-01". Prepared for Tennessee Valley Authority. May 1.	
Purpose:	Geotechnical exploration, laboratory testing, and monitoring well installation to support seepage study of an existing perimeter dike for the Gypsum Storage Area. No analysis was performed.	
CCR Unit(s):	Gypsum Storage Area	
Spatial coverage:	Two perimeter cross sections at the southwestern corner of the Gypsum Storage Area. Borings at outside toe of starter dike, crest of starter dike, crest of raised dike.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 borings (3 borings x 2 cross sections)
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA after drilling
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, CCR thickness, and clay thickness. Top of rock was not encountered.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Stone filter (for seep repair) has since been added to outslope of starter dike at one of the two cross section locations.
Piezometer installation:	Yes	7 Type II monitoring wells, screened in dike fill, CCR, and alluvium. Screens may span multiple materials/strata.
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	All testing follows relevant ASTM standards.
Shear strength parameters:	Yes	Static drained and undrained strengths (dike fill and foundation clay)
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Material parameters can be used to support stability analyses.
Other relevant analyses:	No	

3.9.1 Field Activities

The scope of work for this project included drilling six soil borings, including continuous SPT sampling to pre-determined termination depths. The borings were drilled using hollow-stem augers and SPTs were performed with an automatic hammer. SPTs were conducted in general accordance with ASTM D1586. Representative portions of the soil samples obtained from the split-barrel sampler were sealed in glass jars and transported to the laboratory, where an engineer examined them to verify the driller's field classifications. Water levels were obtained within the soil borings at the time of drilling, at termination of boring, and at 12-hour readings. Soil borings were backfilled via tremie method to full depth with cement-bentonite grout.

After encountering the pre-determined termination depths or auger refusal, offset borings were drilled to install Type II monitoring wells. A total of seven wells were installed ranging in depth from 23.5 feet to 53.9 feet. Each well consisted of a 2-inch diameter, Schedule 40 PVC pipe with 0.01-inch slotted screen. Wells were screened approximately full depth (with MWA-3 being an exception) and installed in accordance with the procedure provided by TVA and GeoSyntec. Well installation included No. 2 filter sand and 2-foot (min.) bentonite seal above the filter sand. Well development was performed for each of the installed wells. Long-term water level readings were taken in the monitoring wells.

Upon completion of the field work performed, the soil boring locations were surveyed onto the Tennessee state plane coordinate system (approximate locations are shown in Exhibit 1).

3.9.2 Laboratory Testing

The laboratory testing program consisted of 10 Atterberg limit (D4318), 17 grain size distribution (prepared per D421 or D2217, tested per D422), 17 natural moisture content (D2216), 7 specific gravity (D854), 6 falling head permeability (on undisturbed samples; D5084), 3 constant head permeability (on remolded samples; D2434), and 7 triaxial consolidated undrained (CU) shear strength tests (on undisturbed samples; D4767). Soil classification (D2487) was performed on both disturbed and undisturbed samples.

3.9.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike geometry is substantially the same as current.

2. CCR and soil properties (including shear strengths)

    a. Sampling and testing followed relevant ASTM standards.

    b. Subsurface conditions are substantially the same as current.

3.10 STANTEC (2010A)

Table 10. Summary of Evaluation for Stantec (2010A)

Reference:	Stantec Consulting Services Inc. (Stantec). 2010A. "Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond, Cumberland Fossil Plant, Stewart County, Tennessee." Prepared for Tennessee Valley Authority. March.	
Purpose:	Geotechnical exploration and static slope stability evaluation of the Stilling Pond (including Retention Pond). This study was performed to evaluate slope stability and seepage for existing conditions.	
CCR Unit(s):	Stilling Pond (including Retention Pond)	
Spatial coverage:	Perimeter dike around the Stilling Pond and Retention Pond. Excludes the interior divider dike between the Retention Pond and the Dry Ash Stack.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	30 borings
Rock coring:	Yes	4 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, clay thickness, and top of bedrock elevation. Borings did not encounter CCR.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Phreatic conditions likely different due to changes in operations (pool now lower).
Piezometer installation:	Yes	Seven piezometers, screened in dike fill or alluvium
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	All testing follows ASTM standards
Shear strength parameters:	Yes	Static drained strengths (CCR and soils)
Static slope stability:	Yes	Eight sections around perimeter
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long term, static stability of perimeter.

Reference:	Stantec Consulting Services Inc. (Stantec). 2010A. "Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond, Cumberland Fossil Plant, Stewart County, Tennessee." Prepared for Tennessee Valley Authority. March.	
Other relevant analyses:	Yes	Seepage analyses performed to support slope stability modeling and to evaluate critical exit gradients and associated piping factors of safety.

3.10.1 Field Activities

A geotechnical drilling program was developed that consisted of 30 soil borings at 16 locations. Four of these soil borings included rock coring. The boring locations were chosen by Stantec and surveyed by TVA after drilling was completed (approximate locations are shown in Exhibit 1).

The borings were drilled using hollow-stem augers powered by either a truck-mounted or an ATV-mounted drilling rig. In the soil borings, continuous SPTs were performed in accordance with ASTM D1586 until original (foundation) soils were encountered, after which SPTs were continued at 2.5-foot intervals. If applicable, an offset boring was performed after completion of a SPT boring to obtain Shelby tube samples in a targeted soil layer at specific depths. Shelby tube samples were obtained in accordance with ASTM D1587. Additional disturbed bulk samples (auger cuttings) were obtained from the borehole during the drilling process. Rock coring was performed using NQ2-size wire-line coring equipment. Core runs began at the top of weathered rock with the obtained rock length varying from 7.0 feet to 12.3 feet. Upon retrieval, the core was extracted and sequentially placed in a core storage box and labeled. An onsite representative logged the rock core upon retrieval for visual classification, core recovery, RQD, and other physical characteristics.

Upon completion of drilling, the boreholes without instrumentation were backfilled using a mixture of Portland cement and bentonite clay. Boreholes with piezometers received a quartz sand filter pack around the piezometer, a bentonite seal above the sand, and then backfill with the cement-bentonite mixture. Boreholes with slope inclinometers were backfilled with high-solids cement-bentonite grout placed by tremie pipe to displace cuttings and drilling fluid. Piezometers were installed at 7 locations and slope inclinometer casings were installed at 3 locations.

3.10.2 Laboratory Testing

Laboratory tests were performed in accordance with ASTM standard testing procedures, as noted below.

Natural moisture content (D2216) tests were performed on all SPT, bag, and Shelby tube samples. Soil Index classification testing was performed on 24 soil samples. These tests included particle size analyses (D422), Atterberg limits (D4318), and specific gravity (D854). In addition to soil index classification testing, unit weight (D7263) and standard Proctor (D698) tests were performed on selected samples. Please note that the standard Proctor tests were used to compare the theoretical maximum dry density to in-situ unit weights from Shelby tube samples within the same soil horizon for the dikes only. Consolidated undrained triaxial compression (D4767) and falling head permeability (D5084) tests were performed on both in-situ and remolded samples.

3.10.3 Analysis

The drilling program had 30 soil borings at 16 locations, to support development of eight cross-sections for slope stability analyses of the dikes surrounding the retention and stilling ponds. The cross-sections were selected because they are representative of the facilities as a whole, are along the most critical slopes, and are spaced at regular intervals along the dike alignment. These analyses incorporated available historic information, results of the geotechnical field exploration, and the results of the laboratory testing.

The stability of the ash pond dike slopes was analyzed using limit equilibrium methods. Analyses were performed for static, long-term conditions with steady-state seepage. Steady-state pore pressures were obtained from the seepage analysis and the phreatic surface was determined from the water level monitoring program (i.e. - borehole visual readings, piezometer readings, and noted elevations of surface water, such as in the nearby Wells Creek). Material parameters were determined by soil index classification testing along with laboratory-derived material properties for modeling the soil horizons in the dikes and foundation soils. Shallow, surficial failures were neglected as they would not cause a failure of the entire embankment. The minimum failure depth for this analysis was set to 10 feet. Failures shallower than 10 feet were assumed to be repairable before any progressive failures occurred.

3.10.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice,
    b. Locations and elevations were surveyed,
    c. Instruments are adequate to provide current water level readings.
3. CCR and soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.
4. Static slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar or more conservative than current.
    d. Analysis methods meet current standard of practice.

3.11 STANTEC (2010B)

Table 11. Summary of Evaluation for Stantec (2010B)

Reference:	Stantec Consulting Services Inc. (Stantec). 2010b. "Report of Geotechnical Exploration, Dry Fly Ash Stack and Gypsum Disposal Complex, Cumberland Fossil Plant, Stewart County, Tennessee." Prepared for Tennessee Valley Authority. June.	
Purpose:	Geotechnical exploration and static slope stability evaluation of the Dry Ash Stack and Gypsum Storage Area. This study was performed to evaluate slope stability and seepage for existing conditions.	
CCR Unit(s):	Dry Ash Stack and Gypsum Storage Area	
Spatial coverage:	Perimeter dikes and CCR slopes of the Dry Ash Stack and Gypsum Storage Area. A smaller number of borings and CPTs on the stack interiors.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	74 borings
Rock coring:	Yes	6 borings
Other subsurface data:	No	17 CPTs
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support drainage layer and dike geometry, CCR thickness, clay thickness, top of bedrock elevation
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike and CCR slope geometry similar, except where CCR was regraded per Stantec (2011). Phreatic conditions likely different due to changes in operations (conversion to dewatering and stacking of gypsum).
Piezometer installation:	Yes	19 piezometers, screened in dike fill or alluvium
In-situ testing:	Yes	SPT, CPT with Pore Pressure Dissipation (PPD), 8 slope inclinometer casings installed
Laboratory testing:	Yes	All testing follows ASTM standards
Shear strength parameters:	Yes	Static drained strengths (CCR and soils)
Static slope stability:	Yes	Twelve sections around perimeter and 3 on interior divider dikes
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long term, static stability of perimeter.
Other relevant analyses:	Yes	Seepage analyses performed to support slope stability modeling and to evaluate critical exit gradients and associated piping factors of safety.

3.11.1 Field Activities

A geotechnical drilling program was developed that consisted of 74 soil test/sample boring locations and advancing 17 cone penetrometer test (CPT) borings. Six of these soil boring locations had rock coring performed. The boring locations were chosen by Stantec to be along or near pre-determined cross-section alignments and at locations where dike materials were believed to be deepest. TVA surveyed the boring locations after drilling was completed (approximate locations are shown in Exhibit 1).

The borings were drilled using both 3.25" and 4.25" inside diameter hollow-stemmed augers powered by a truck-mounted drill rig. A 6" diameter roller bit was also used with a mud-rotary technique to drill certain borings to obtain undisturbed tube samples. In the soil borings, continuous SPTs were performed in accordance with ASTM D1586 until original (foundation) soils were encountered, after which SPTs were continued at 2.5-foot intervals. If applicable, an offset boring was performed after completion of a SPT boring to obtain Shelby tube samples in particular materials at specific depths. Shelby tube samples were obtained in accordance with ASTM D1587. Additional disturbed bulk samples (auger cuttings) were obtained from the borehole during the drilling process. These bulk samples consisted of gypsum, gypsum rejects, fly ash, bottom ash, "original dike" material, and "raised dike" material. Rock coring was performed using NQ2-size wire-line coring equipment. Core runs began at the top of weathered rock with the obtained rock length varying from 4.5 feet to 10.0 feet. Upon retrieval, the core was extracted and sequentially placed in a core storage box and labeled. An onsite representative logged the rock core upon retrieval for visual classification, core recovery, RQD, and other physical characteristics.

Upon completion of drilling, the boreholes without instrumentation were backfilled using a mixture of Portland cement and bentonite clay. Boreholes with piezometers received a quartz sand filter pack around the piezometer, a bentonite seal above the sand, and then backfilled with the cement-bentonite mixture. Boreholes with slope inclinometer casing were backfilled with high-solids cement-bentonite grout placed by tremie pipe to displace cuttings and drilling fluid. Piezometers were installed at 19 locations and slope inclinometer casings were installed at 8 locations.

3.11.2 Laboratory Testing

Soil and rock samples from the field exploration were returned to a Stantec (or certified vendor's) materials laboratory. The laboratory tests were performed in accordance with ASTM standard testing procedures.

Natural moisture content (D2216) tests were performed on all SPT, bag, and Shelby tube samples. Soil Index classification testing was performed on 30 soil samples. These tests included particle size analyses (D421 and D422), Atterberg limits (D4318 Method A), and specific gravity (D854). In addition to soil index classification testing, unit weight (D7263) and standard Proctor tests (D698) were performed on selected samples. Please note that the standard Proctor tests were used to compare the theoretical maximum dry density to in-situ unit weights from Shelby tube samples for the respective soil horizon. Consolidated undrained triaxial compression tests (D4767) were performed on both in-situ and remolded samples.

3.11.3 Analysis

Fifteen cross-sections were developed for slope stability analyses of the "original" and "raised" perimeter dikes, the "bottom ash" dike, the Dry Ash Stack, and the Gypsum Storage Area. The cross-sections were selected because they are representative of the facilities, are along the most critical slopes, and are spaced at regular intervals along the dike alignment. These sections were based on available historic information, results of the geotechnical field exploration, and the results of the laboratory testing.

The stability of the ash pond dike slopes was analyzed using two-dimensional cross sections and limit equilibrium methods. Analyses were performed for static, long-term conditions with steady-state seepage and for undrained conditions within the saturated ash materials. Steady-state pore pressures were modeled using a piezometric line based on water level monitoring (i.e., borehole visual readings, piezometer readings, and noted elevations of surface water, such as in the nearby Wells Creek). Soil index classification testing and laboratory-derived material properties were used to model the dike fill, foundation soils, and CCR materials. Shallow, surficial failures were neglected as they would not cause a failure of the entire embankment. The minimum failure depth for this analysis was set to 10 feet. Failures shallower than 10 feet were considered repairable before any additional instabilities would occur.

In addition to the long-term stability analysis, stability analyses were conducted for a partially undrained (i.e., short-term) condition to consider slope failures developing from undrained conditions within the CCR materials.

3.11.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs

    a. Boring locations and elevations were surveyed,

    b. Boring logs document material descriptions and thicknesses,

c. Perimeter dike, foundation, and CCR outslope (except areas of regrading per Stantec (2011)) geometry is substantially the same as current.

2. Piezometers

    a. Installation methods meet current standard of practice,

    b. Locations and elevations were surveyed,

    c. Instruments are adequate to provide current water level readings.

3. CCR and soil properties (including shear strengths)

    a. Sampling and testing followed relevant ASTM standards.

    b. Subsurface conditions are substantially the same as current.

4. Static slope stability analyses

    a. Material parameters are representative of current.

    b. In areas of critical failure surfaces, surface and subsurface geometry is substantially the same at present, except as regraded per Stantec (2011). Additional/future CCR stacking on interior (i.e., at top of stack) does not affect critical failure surfaces near perimeter.

    c. Phreatic conditions are similar or more conservative than current.

    d. Analysis methods meet current standard of practice.

3.12 STANTEC (2010C)

Table 12. Summary of Evaluation for Stantec (2010C)

Reference:	Stantec Consulting Services Inc. (Stantec). 2010c. "Report of Geotechnical Exploration, Slope Repair Project – Gypsum Stack Complex, Cumberland Fossil Plant, Cumberland City, Tennessee." Prepared for Tennessee Valley Authority. November.	
Purpose:	Exploration and testing program to characterize the soils near a shallow slope failure of the starter dike outslope. Also, to provide excavation recommendations associated with a stone buttress to repair the slope.	
CCR Unit(s):	Gypsum Storage Area	
Spatial coverage:	Outslope of starter dike along Wells Creek, in the southwestern corner of Gypsum Storage Area	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	5 borings
Rock coring:	Yes	2 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, clay thickness, top of bedrock elevation. Borings did not encounter CCR.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar, although slope has since been repaired with stone buttress. Phreatic conditions likely different due to changes in operations (pool now lower).
Piezometer installation:	No	
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	All testing follows ASTM standards (moisture, index properties, soil classification, unconfined compressive strength)
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	
Other relevant analyses:	No	

3.12.1 Field Activities

A geotechnical exploration was performed at the toe of Dike 1 (i.e., starter dike) at the southwest corner of the Gypsum Stack Complex. A geotechnical program of five borings, two that included rock coring, was executed. The borings were drilled using 3.25" inside diameter hollow-stem augers following a carbide-tipped tooth auger. In the soil borings, continuous SPTs were performed in accordance with ASTM D1586 in the first 15 feet on one boring and the first 10 feet of three borings, after which SPTs were continued at 2.5-foot intervals. Bag samples from the observed dominant horizons were also obtained for testing. One boring was drilled solely to obtain Shelby tube samples in accordance with ASTM D1587. In two of the five borings, rock coring was performed using NQ2-size wire-line coring equipment. Core runs began at the top of weathered rock with the obtained core lengths of 6.7 feet and 6.5 feet. Upon retrieval, the core was extracted and sequentially placed in a core storage box and labeled. An onsite representative logged the rock core upon retrieval for visual classification, core recovery, RQD, and other physical characteristics.

Upon completion of drilling, the boreholes were backfilled with a Portland cement/bentonite grout. TVA surveyed the boring locations after drilling was completed (approximate locations are shown in Exhibit 1).

3.12.2 Laboratory Testing

The SPT samples, Shelby tubes and bulk bag samples were transported to Stantec's materials laboratory for testing. The samples were tested for natural moisture content (D2216), particle size analysis (D421 and D422), and Atterberg limits (D4318). Select undisturbed Shelby tube samples were subjected to unconfined compressive strength testing (D2166).

3.12.3 Analysis

Although no slope stability analyses were within the scope of this project, the information gained from the geotechnical exploration and laboratory testing adds to the repository of available geotechnical data at this site to aid in subsurface characterization.

3.12.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
   a. Boring locations and elevations were surveyed,
   b. Boring logs document material descriptions and thicknesses,
   c. Perimeter dike and foundation geometry is substantially the same as current (except for the slope repair discussed above, which is limited in extent).
2. Soil properties
   a. Sampling and testing followed relevant ASTM standards.
   b. Subsurface conditions are substantially the same as current.

3.13 STANTEC (2011)

Table 13. Summary of Evaluation for Stantec (2011)

Reference:	Stantec Consulting Services Inc. (Stantec). 2011. "Cumberland Fossil Plant, Stewart County, Tennessee, Dry Fly Ash Stack and Gypsum Disposal Complex Grading and Drainage Improvements (Work Plan 11)." Prepared for Tennessee Valley Authority. March 10.	
Purpose:	Engineering study to review the operating plans of the stacks and compare as-permitted geometry to as-constructed geometry. Develop grading and drainage improvements to reduce differences from the Class II landfill permitted design.	
CCR Unit(s):	Dry Ash Stack and Gypsum Storage Area	
Spatial coverage:	Perimeter slopes along Dry Ash Stack and Gypsum Storage Area	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	Yes	Data support regraded CCR slopes.
Geometry at time of document representative of 2017 conditions:	Yes	Proposed geometry represents regraded CCR slopes. Perimeter dike geometry similar. Phreatic conditions likely different due to changes in operations (pool now lower).
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	Yes	Two cross sections of the Dry Ash Stack
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Represents static stability of regraded slopes.
Other relevant analyses:	No	

3.13.1 Analysis

Two cross-sections were developed for slope stability analyses of the existing conditions and proposed regrading and drainage improvements for the Dry Ash Stack. The cross-sections were selected because they are representative of the facilities and are along the most critical slopes. These sections were based on available historic information, results of the geotechnical field exploration, and the results of the laboratory testing.

The stability of the slopes was analyzed using two-dimensional cross sections and limit equilibrium methods. Analyses were performed for static, long-term conditions with steady-state seepage within the saturated ash materials. Steady-state pore pressures were modeled using a piezometric line based on water level monitoring (i.e., borehole visual readings, piezometer readings, and noted elevations of surface water, such as in the nearby Wells Creek). Soil index classification testing and laboratory-derived material properties were used to model the dike fill, foundation soils, and CCR materials. Shallow, surficial failures and deeper, global failures were considered.

3.13.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Static slope stability analyses
    a. Material parameters are representative of current.
    b. In areas of critical failure surfaces, surface and subsurface geometry is substantially the same at present. Additional/future CCR stacking on interior (i.e., at top of stack) does not affect critical failure surfaces near perimeter.
    c. Phreatic conditions are similar or more conservative than current.
    d. Analysis methods meet current standard of practice.

3.14 STANTEC (2013)

Table 14. Summary of Evaluation for Stantec (2013)

Reference:	Stantec Consulting Services Inc. (Stantec). 2013. "Instrumentation Installation and Updated Seepage Analyses, Ash Pond, Cumberland Fossil Plant." Prepared for Tennessee Valley Authority. January 9.	
Purpose:	Refine seepage analyses for perimeter dike cross sections at the Retention Pond (including Stilling Pond)	
CCR Unit(s):	Stilling Pond (including Retention Pond)	
Spatial coverage:	Southwestern corner of Retention Pond, near Cross Section P	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	3 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, clay thickness, and top of bedrock elevation. Borings did not encounter CCR.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Phreatic conditions likely different due to changes in operations (pool now lower).
Piezometer installation:	Yes	2 piezometers, screened in alluvium
In-situ testing:	Yes	SPT
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	Yes	Updated seepage analyses performed to evaluate critical exit gradients and associated piping factors of safety after spillway modifications.

3.14.1 Field Activities

Following the work described in Stantec (2010a), additional seepage studies required three soil borings and the installation of two additional piezometers along the perimeter dike of the Ash Pond (approximate locations are shown in Exhibit 1). Soil samples were obtained at selected intervals to confirm subsurface stratigraphy in the area. Upon completion of drilling, piezometers were installed with a screened interval in the foundation clay just above the top of rock.

3.14.2 Analysis

Spillway modifications had been made to the Ash Pond, which lowered the new pool elevation to approximately 378.2 feet. Based on the new pool elevation and water levels observed in the new piezometers, the Stantec (2010a) seepage models were updated. Critical exit gradients and associated piping factors of safety were also updated.

3.14.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice,
    b. Locations and elevations were surveyed,
    c. Instruments are adequate to provide current water level readings.
3. Updated seepage analyses
    a. Material parameters are representative of current and sufficient to support slope stability analysis.
    b. Pool elevations and phreatic conditions are similar to (or more conservative than) current.
    c. Analysis methods meet current standard of practice.

3.15 GEOCOMP (2013)

Table 15. Summary of Evaluation for Geocomp (2013)

Reference:	Geocomp Consulting, Inc. 2013. "Tennessee Valley Authority, EPA Seismic Assessment, Supplemental Site Exploration, Cumberland Fossil Plant." Prepared for Tennessee Valley Authority. March 29.	
Purpose:	Field exploration, laboratory testing, and analysis to evaluate the seismic performance of the Dry Ash Stack and Gypsum Storage Area	
CCR Unit(s):	Dry Ash Stack and Gypsum Storage Area	
Spatial coverage:	Dry Ash Stack Section F-F' and Gypsum Storage Area Section H-H', sections are adjacent to one another and both are through the perimeter dike along Wells Creek.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	14 borings
Rock coring:	No	
Other subsurface data:	Yes	3 CPT soundings
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, clay thicknesses, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Phreatic conditions likely similar.
Piezometer installation:	Yes	6 borings instrumented with strings of vibrating wire piezometers; up to 5 sensors per boring (26 sensors total); sensing zones in alluvium, CCR, and dike fill.
In-situ testing:	Yes	SPT, vane shear testing, CPT with shear wave velocity
Laboratory testing:	Yes	All testing follows ASTM standards
Shear strength parameters:	Yes	Static drained, static undrained, seismic, and post-earthquake strengths (CCR and soils)
Static slope stability:	Yes	2 sections (F-F', H-H')
Seismic slope stability:	Yes	2 sections (F-F', H-H')
Information adequate to support stability evaluation:	Yes	Analyses are representative of static, post-earthquake and pseudostatic stability of existing dike perimeter and CCR stack outslopes.
Other relevant analyses:	Yes	Liquefaction triggering analyses; seismic displacement analysis (without liquefaction)

3.15.1 Field Activities

Based on previous work at the site, a supplemental evaluation of expected seismic performance of the Dry Ash Stack and Gypsum Storage Area was requested. A subsurface exploration program was designed that consisted of eight borings (five with SPT and three with vane shear testing (VST)) for Section F-F' at the Dry Ash Stack and six borings (three with SPT and three with VST) and three seismic CPT soundings for Section H-H' at the Gypsum Storage Area. The approximate locations are shown in Exhibit 1.

The borings were drilled using either a truck-mounted or ATV-mounted drilling rig with mud rotary equipment using a 4-inch rotary bit. In the soil borings, SPTs were performed in accordance with ASTM D1586 at 2.5-foot intervals. Shelby tube samples were obtained in accordance with ASTM D1587 at depths determined by Geocomp personnel within cohesive soil layers. Upon completion of drilling, a multi-level vibrating wire piezometer (VWPZ) string was installed into selected boreholes. Each VWPZ string was lowered into the open boring and then fully grouted into place with a cement/bentonite grout that simulates the compressive strength of a very stiff to hard clay.

Following the completion of a conventional boring, an offset boring was advanced to targeted depths without sampling, where VSTs could be performed in general accordance with ASTM D2573. After peak torque was reached, the vane is rotated rapidly for five revolutions to remold the soil at the failure plane of the test. The slow rotation rate process is repeated to obtain a remolded shear strength. Thirty-two field VSTs were performed at Section F-F' and 40 field VSTs were performed at Section H-H'.

Seismic CPT soundings were advanced approximately 5 feet away from the companion conventional boring. Tip resistance, sleeve friction, and dynamic pore pressure was recorded approximately every two inches as the cone was advanced into the ground. Shear wave velocity measurements were taken at approximately one meter intervals.

3.15.2 Laboratory Testing

The disturbed (SPT) and undisturbed (Shelby tube) soil samples obtained during conventional drilling were subjected to the following laboratory tests: natural moisture content (D2216), Atterberg limits (D4318), specific gravity (D854), USCS classification (D2487), gradation (D422), CU triaxial with pore pressure measurements (D4767), direct shear (D3080), and one-dimensional consolidation (D2435).

3.15.3 Analysis

Historical boring information along with the new data gathered from this geotechnical exploration were used to establish subsurface geometry and material parameters of the different soils and CCR at each cross section. The phreatic conditions were modeled based on the pore pressure data from the VWPZ.

Limit equilibrium slope stability analyses were performed for each cross-section for static undrained, pseudostatic, and post-earthquake conditions. The design earthquake had a return period of 2,500 years. Pseudostatic strengths were a reduced version of the static undrained strengths. Liquefaction triggering was assessed and residual shear strengths were applied to the liquefied materials in the post-earthquake slope stability analyses.

3.15.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice,
    b. Locations and elevations were surveyed,
    c. Instruments are adequate to provide current water level readings.
3. CCR and soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.
4. Static and pseudostatic slope stability analyses
    a. Material parameters are representative of current.
    b. In areas of critical failure surfaces, surface and subsurface geometry is substantially the same at present. Additional/future CCR stacking on interior (i.e., at top of stack) does not affect critical failure surfaces near perimeter.
    c. Pool elevations and phreatic conditions are similar or more conservative than current.
    d. Analysis methods meet current standard of practice.

3.16 GEOCOMP (2016A)

Table 16. Summary of Evaluation for Geocomp (2016A)

Reference:	Geocomp Consulting, Inc. 2016a. "Initial Seismic Safety Factor Assessment, EPA Final CCR Rule, Cumberland Fossil Plant – Bottom Ash Pond, Cumberland City, Tennessee." Prepared for Tennessee Valley Authority. October 16.	
Purpose:	Demonstrate adequate seismic performance (pseudostatic stability, post-liquefaction stability considering liquefaction) of the Bottom Ash Pond at CUF	
CCR Unit(s):	Bottom Ash Pond	
Spatial coverage:	One cross-section through the Bottom Ash Pond	
Item	**Yes/No**	**Remarks**
Soil borings:	No	This report leverages prior field and lab work (Geocomp 2016c) instead of performing new work.
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static undrained strengths, seismic strengths for soils/CCR that do not liquefy, residual strengths for soils/CCR that do liquefy
Static slope stability:	Yes	1 cross-section through the Bottom Ash Pond and perimeter dike
Seismic slope stability:	Yes	1 cross-section through the Bottom Ash Pond and perimeter dike
Information adequate to support stability evaluation:	Yes	Analyses are representative of pseudostatic stability and post-earthquake stability of existing Bottom Ash Pond, including perimeter dike.
Other relevant analyses:	Yes	Liquefaction triggering assessment potential analyses in support of post-earthquake slope stability evaluation.

3.16.1 Analysis

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation for seismic loading was required by October 17, 2016 and must include initial assessments of the seismic factor of safety (i.e., pseudostatic slope stability) and liquefaction factor of safety (i.e., post-earthquake slope stability, considering liquefaction) for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

1. Has a height of five feet or more and a storage volume of 20 acre-feet or more, or
2. Has a height of 20 feet or more.

The seismic and liquefaction factor of safety assessments must document whether the calculated factors of safety for the critical cross-sections of each existing CCR surface impoundment achieve the minimum factors of safety specified in paragraphs (e)(1)(iii) and (e)(1)(iv) of §257.73 in the EPA Final CCR Rule.

As part of the EPA Final CCR Rule requirements, a site-specific seismic study was conducted on the design response spectra developed by USGS. The site-specific seismic amplification analyses (i.e., ground response analyses) used seven spectrally-matched ground motion time histories. Spectral matching was performed relative to the uniform hazard response spectrum. Site-specific two-dimensional amplification analyses were performed to model the seismic response of cross-section BAshP-BAshP'. This cross-section had been developed previously based on a subsurface exploration and laboratory testing by Geocomp (2016c).

The results of the analyses were used to determine displacement-compatible accelerations used in the seismic slope stability analyses to calculate the seismic factor of safety. The results of these analyses were also used to determine cyclic shear stresses for laboratory testing to measure post-shaking residual strengths in evaluating the liquefaction factor of safety.

The seismic factor of safety was evaluated under seismic loading using a phreatic surface developed from existing pond levels and piezometric data. The pseudostatic loading conditions were determined from applied displacement-compatible accelerations derived from the sliding block analyses from Geocomp, 2016c.

Liquefaction triggering was assessed using the stress-based methodology of Idriss and Boulanger. The cyclic resistance ratio (CRR) is based on in-situ penetration resistance (SPT and/or CPT) or cyclic laboratory testing. The results of the site-specific two-dimensional analysis were used to obtain the Cyclic Stress Ratio (CSR) imposed by the design earthquake on the soil. Liquefaction triggering was based on a comparison of the CRR to the CSR. If a layer was deemed potentially liquefiable, then its residual undrained shear strength was assigned in the post-earthquake slope stability analysis.

The slope stability results were obtained with a two-dimensional limit equilibrium program. The minimum factors of safety correspond to slip surfaces that could potentially result in the release of water and CCR materials from within the impoundment. Based upon the analysis performed for the Bottom Ash Pond, the impoundment meets or exceeds the minimum factor of safety for both seismic factor of safety and liquefaction factor of safety.

3.16.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Pseudostatic and post-earthquake slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to current.
    d. Analysis methods meet current standard of practice.

3.17 GEOCOMP (2016B)

Table 17. Summary of Evaluation for Geocomp (2016B)

Reference:	Geocomp Consulting, Inc. 2016b. "Initial Seismic Safety Factor Assessment, EPA Final CCR Rule, Cumberland Fossil Plant – Stilling Pond (including Retention Pond), Cumberland City, Tennessee." Prepared for Tennessee Valley Authority. October 16.	
Purpose:	Demonstrate adequate seismic performance (pseudostatic stability, post-liquefaction stability considering liquefaction) of the Stilling Pond (including Retention Pond) at CUF	
CCR Unit(s):	Stilling Pond (including Retention Pond)	
Spatial coverage:	One cross-section through the perimeter dike of the Stilling Pond (including Retention Pond)	
Item	**Yes/No**	**Remarks**
Soil borings:	No	This report leverages prior field and lab work (Geocomp 2016c) instead of performing new work.
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static undrained strengths, seismic strengths for soils/CCR that do not liquefy, residual strengths for soils/CCR that do liquefy
Static slope stability:	Yes	1 cross-section through the perimeter dike
Seismic slope stability:	Yes	1 cross-section through the perimeter dike
Information adequate to support stability evaluation:	Yes	Analyses are representative of pseudostatic stability and post-earthquake stability of the perimeter dike.
Other relevant analyses:	Yes	Liquefaction triggering assessment potential analyses in support of post-earthquake slope stability evaluation.

3.17.1 Analysis

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation for seismic loading was required by October 17, 2016 and must include initial assessments of the seismic factor of safety (i.e., pseudostatic slope stability) and liquefaction factor of safety (i.e., post-earthquake slope stability, considering liquefaction) for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

1. Has a height of five feet or more and a storage volume of 20 acre-feet or more, or
2. Has a height of 20 feet or more.

The seismic and liquefaction factor of safety assessments must document whether the calculated factors of safety for the critical cross-sections of each existing CCR surface impoundment achieve the minimum factors of safety specified in paragraphs (e)(1)(iii) and (e)(1)(iv) of §257.73 in the EPA Final CCR Rule.

As part of the EPA Final CCR Rule requirements, a site-specific seismic study was conducted on the design response spectra developed by USGS. The site-specific seismic amplification analyses (i.e., ground response analyses) used seven spectrally-matched ground motion time histories. Spectral matching was performed relative to the uniform hazard response spectrum. Site-specific two-dimensional amplification analyses were performed to model the seismic response of cross-section R-R'. This cross-section had been developed previously based on a subsurface exploration and laboratory testing by Geocomp (2016c).

The results of the analyses were used to determine displacement-compatible accelerations used in the seismic slope stability analyses to calculate the seismic factor of safety. The results of these analyses were also used to determine cyclic shear stresses for laboratory testing to measure post-shaking residual strengths in evaluating the liquefaction factor of safety.

The seismic factor of safety was evaluated under seismic loading using a phreatic surface developed from existing pond levels and piezometric data. The pseudostatic loading conditions were determined from applied displacement-compatible accelerations derived from the sliding block analyses from Geocomp, 2016c.

Liquefaction triggering was assessed using the stress-based methodology of Idriss and Boulanger. The cyclic resistance ratio (CRR) is based on in-situ penetration resistance (SPT and/or CPT) or cyclic laboratory testing. The results of the site-specific two-dimensional analysis were used to obtain the Cyclic Stress Ratio (CSR) imposed by the design earthquake on the soil. Liquefaction triggering was based on a comparison of the CRR to the CSR. If a layer was deemed potentially liquefiable, then its residual undrained shear strength was assigned in the post-earthquake slope stability analysis.

The slope stability results were obtained with a two-dimensional limit equilibrium program. The minimum factors of safety correspond to slip surfaces that could potentially result in the release of water and CCR materials from within the impoundment. Based upon the analysis performed for the Bottom Ash Pond, the impoundment meets or exceeds the minimum factor of safety for both seismic factor of safety and liquefaction factor of safety.

3.17.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Pseudostatic and post-earthquake slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to (or more conservative than) current.
    d. Analysis methods meet current standard of practice.

3.18 GEOCOMP (2016C)

Table 18. Summary of Evaluation for Geocomp (2016C)

Reference:	Geocomp Consulting, Inc. 2016c. "Tennessee Valley Authority, EPA Seismic Assessment, Supplemental Site Exploration, Cumberland Fossil Plant, Stilling Pond (including Retention Pond) and Bottom Ash Pond, Final Report." Prepared for Tennessee Valley Authority. October.	
Purpose:	Geotechnical exploration and evaluation of seismic performance of the Stilling Pond (including Retention Pond) and Bottom Ash Pond at CUF	
CCR Unit(s):	Stilling Pond (including Retention Pond), Bottom Ash Pond	
Spatial coverage:	Geotechnical exploration of 4 cross-sections through the perimeter dike of the Stilling Pond (including Retention Pond) and 1 cross-section through the Bottom Ash Pond and perimeter dike. Analysis of 2 cross-sections of the Stilling Pond (including Retention Pond) and 1 cross-section of the Bottom Ash Pond.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	8 borings
Rock coring:	No	
Other subsurface data:	Yes	13 CPT soundings with shear wave velocity and pore pressure dissipation testing
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, clay thickness, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry similar. Phreatic surface similar or more conservative (i.e., higher) at time of exploration.
Piezometer installation:	Yes	4 borings instrumented with strings of vibrating wire piezometers; up to 5 sensors per boring (19 sensors total); sensing zones in alluvium and dike fill.
In-situ testing:	Yes	SPT, CPT with shear wave velocity and pore pressure dissipation
Laboratory testing:	Yes	All testing follows ASTM standards, except laboratory measurement of shear wave velocity using bender elements, which does not have an ASTM standard.
Shear strength parameters:	Yes	Static drained, static undrained, seismic, and post-earthquake strengths (CCR and soils)
Static slope stability:	Yes	2 cross-sections (P-P', R-R') for the Stilling Pond (including Retention Pond), 1 cross-section (BAshP-BAshP') for the Bottom Ash Pond.

Reference:	Geocomp Consulting, Inc. 2016c. "Tennessee Valley Authority, EPA Seismic Assessment, Supplemental Site Exploration, Cumberland Fossil Plant, Stilling Pond (including Retention Pond) and Bottom Ash Pond, Final Report." Prepared for Tennessee Valley Authority. October.	
Seismic slope stability:	Yes	2 cross-sections (P-P', R-R') for the Stilling Pond (including Retention Pond), 1 cross-section (BAshP-BAshP') for the Bottom Ash Pond
Information adequate to support stability evaluation:	Yes	Analyses are representative of static, post-earthquake and pseudostatic stability of existing dike perimeter.
Other relevant analyses:	Yes	Liquefaction triggering analyses; seismic displacement analysis (without liquefaction)

3.18.1 Field Activities

The geotechnical exploration program included soil borings (with disturbed and undisturbed sampling) and SCPTu soundings (approximate locations are shown in Exhibit 1). A total of seven borings and nine SCPTu soundings were performed along the crest of the raised perimeter dike of the Stilling and Retention Ponds. An additional boring and four SCPTu soundings were performed at the crest of the interior dike of the Bottom Ash Pond.

The borings were performed using a truck-mounted drill rig with either hollow stem augers with drilling mud or mud rotary drilling methods in accordance with ASTM D5783. Split spoon sampling was performed at approximately 2.5 feet intervals in accordance with ASTM D1586. SPT hammer energy verification was performed on one borehole in accordance with ASTM D4633. The SCPTu soundings were performed using both a CPT track rig and a CPT truck rig in general accordance with ASTM D5778.

Undisturbed samples were obtained with an Osterberg sampler in accordance with ASTM D6519. In material too stiff for an Osterberg sampler, Shelby tube sampling was used in accordance with ASTM D1587. Split spoon and undisturbed samples were transported in a wooden crate designed to limit disturbance.

SCPTu soundings were advanced at 13 locations. Tip resistance, sleeve friction, and dynamic pore pressure was recorded approximately every two inches as the cone was advanced into the ground. Shear wave velocity measurements were taken at approximately 2.5 foot intervals.

Upon completion of drilling, a multi-level vibrating wire piezometer (VWPZ) string was installed into selected boreholes at each of the four cross-sections. Each VWPZ string was then lowered into the open boring and then fully grouted into place with a cement/bentonite grout that simulates the compressive strength of a very stiff to hard clay.

3.18.2 Laboratory Testing

The disturbed (SPT) and undisturbed (Osterberg or Shelby tube) soil samples obtained during conventional drilling were subjected to the following laboratory tests: natural moisture content (D2216), Atterberg limits (D4318), specific gravity (D854), USCS classification (D2487), gradation (D422), unit weight (D7263), CU triaxial with pore pressure measurements (D4767), direct shear (D3080), direct simple shear (D6528), cyclic direct simple shear (D6528), resonant column (D4015), and one-dimensional consolidation using controlled-strain loading (D4186). Select direct simple shear samples were subjected to shear wave velocity measurement using bender element sensors. Prior to tube extrusion, tubes were x-rayed (D4452) to evaluate sample disturbance and to select intervals for testing.

3.18.3 Analysis

Several representative critical cross sections were subjected to a preliminary evaluation to estimate seismic slope stability. From this preliminary evaluation, three cross-sections were chosen for further evaluation.

Historical boring information along with the new data gathered from this geotechnical exploration were used to establish subsurface geometry and material parameters of the different soils and CCR at each cross section. The phreatic conditions were modeled based on the pore pressure data from the VWPZ.

A site-specific seismic study was conducted on the design response spectra developed by USGS. The site-specific seismic amplification analyses (i.e., ground response analyses) used seven spectrally-matched ground motion time histories. Spectral matching was performed relative to the uniform hazard response spectrum. Site-specific two-dimensional amplification analyses were performed to model the seismic response of each analysis cross-section.

The results of the analyses were used to determine displacement-compatible accelerations used in the seismic slope stability analyses to calculate the seismic factor of safety. The results of these analyses were also used to determine cyclic shear stresses for laboratory testing to measure post-shaking residual strengths in evaluating the liquefaction factor of safety.

Liquefaction triggering was assessed using the stress-based methodology of Idriss and Boulanger. The cyclic resistance ratio (CRR) is based on in-situ penetration resistance (SPT and/or CPT) or cyclic laboratory testing. The results of the site-specific two-dimensional analysis were used to obtain the Cyclic Stress Ratio (CSR) imposed by the design earthquake on the soil. Liquefaction triggering was based on a comparison of the CRR to the CSR. If a layer was deemed potentially liquefiable, then its residual undrained shear strength was assigned in the post-earthquake slope stability analysis.

Limit equilibrium slope stability analyses were performed for each cross-section for static undrained, pseudostatic, and post-earthquake conditions. The design earthquake had a return period of 2,500 years. Pseudostatic strengths were a reduced version of the static undrained strengths. Liquefaction triggering was assessed and residual shear strengths were applied to the liquefied materials in the post-earthquake slope stability analyses.

3.18.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice,
    b. Locations and elevations were surveyed,
    c. Instruments are adequate to provide current water level readings.
3. CCR and soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.
4. Static and pseudostatic slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to (or more conservative than) current.
    d. Analysis methods meet current standard of practice.

3.19 STANTEC (2016B)

Table 19. Summary of Evaluation for Stantec (2016B)

Reference:	Stantec Consulting Services Inc. (Stantec). 2016b. "Initial Static Safety Factor Assessment, Bottom Ash Pond, EPA Final CCR Rule, TVA Cumberland Fossil Plant, Stewart County, Tennessee." Prepared for Tennessee Valley Authority. October 12.	
Purpose:	Demonstrate adequate static slope stability (long-term pool and short-term surcharge) for EPA Final CCR Rule initial safety factor assessment for the Bottom Ash Pond.	
CCR Unit(s):	Bottom Ash Pond	
Spatial coverage:	One cross-section through Bottom Ash Pond and perimeter dike.	
Item	**Yes/No**	**Remarks**
Soil borings:	No	This report leverages prior field and lab work (Stantec 2016d, Geocomp 2016c) instead of performing new work.
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static drained and static undrained strengths for soils/CCR
Static slope stability:	Yes	1 cross-section through the Bottom Ash Pond and perimeter dike
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of both long-term, drained and short-term, undrained static stability of existing Bottom Ash Pond, include perimeter dike.
Other relevant analyses:	No	

3.19.1 Analysis

Stantec did not identify previous slope stability analyses for the Bottom Ash Pond that met the criteria of §257.73(e). Thus, an additional geotechnical exploration and laboratory testing (Stantec 2016d) was performed on the southwestern and northeastern internal dikes of the Bottom Ash Pond to assist in characterizing subsurface geometry and soil parameters.

Stantec used historical data near the Bottom Ash Pond to supplement the additional subsurface data gathered from Stantec 2016d. One recent boring by Geocomp (2016c) was also used. This data was compiled with the new exploration to determine the material properties and subsurface geometry used to model cross-sections within the Bottom Ash Pond. This subsurface data, along with recently updated topographic mapping, one critical cross-section was developed for slope stability analysis.

Static slope stability was analyzed for both long-term, drained conditions (normal pool) and short-term, undrained conditions (surcharge pool). The slope stability assessments were focused on the potential for slope failures of significant mass, which could directly influence potential release of water and CCR materials from the Bottom Ash Pond. The search for a critical slip surface in the slope stability assessments is thus restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than 10 feet vertically below the ground surface and causes a release of CCR materials. Based upon these criteria, the Bottom Ash Pond meets or exceeds the minimum factor of safety required by the EPA Final CCR Rule for static slope stability.

3.19.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Static slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to current.
    d. Analysis methods meet current standard of practice.

3.20 STANTEC (2016C)

Table 20. Summary of Evaluation for Stantec (2016C)

Reference:	Stantec Consulting Services Inc. (Stantec). 2016c. "Initial Static Safety Factor Assessment, Stilling Pond (including Retention Pond), EPA Final CCR Rule, TVA Cumberland Fossil Plant, Stewart County, Tennessee." Prepared for Tennessee Valley Authority. October 6.	
Purpose:	Demonstrate adequate static slope stability (long-term pool and short-term surcharge) for EPA Final CCR Rule initial safety factor assessment for the Stilling Pond (including Retention Pond).	
CCR Unit(s):	Stilling Pond (including Retention Pond)	
Spatial coverage:	2 cross-sections through the perimeter dike	
Item	**Yes/No**	**Remarks**
Soil borings:	No	This report leverages prior field and lab work (Stantec 2010a, 2013) instead of performing new work.
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static drained and static undrained strengths for soils/CCR
Static slope stability:	Yes	2 cross-sections through the perimeter dike
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of both long-term, drained and short-term, undrained static stability of existing Stilling Pond (including Retention Pond)
Other relevant analyses:	No	

3.20.1 Analysis

Two recent geotechnical explorations had been performed to characterize the perimeter dike of the Stilling Pond (including Retention Pond). Stantec performed drilling and sampling around the perimeter dike of the Stilling Pond and Retention Pond (Stantec, 2010a). Additional soil borings were performed along the southwest perimeter of the Retention Pond (Stantec, 2013). These prior reports were used as the basis for this analysis. Recent topographic and bathymetric data were provided for the Stilling Pond (including Retention Pond). Based on this data, two critical cross-sections (P-P', Q-Q') were developed for slope stability analysis.

Static slope stability was analyzed for both long-term, drained conditions (normal pool) and short-term, undrained conditions (surcharge pool). The slope stability assessments were focused on the potential for slope failures of significant mass, which could directly influence potential release of water and CCR materials from the Stilling Pond (including Retention Pond). The search for a critical slip surface in the slope stability assessments is thus restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than 10 feet vertically below the ground surface and causes a release of CCR materials. Based upon these criteria, the Stilling Pond (including Retention Pond) meets or exceeds the minimum factor of safety required by the EPA Final CCR Rule for static slope stability.

3.20.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Static slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to (or more conservative than) current.
    d. Analysis methods meet current standard of practice.

3.21 STANTEC (2016D)

Table 21. Summary of Evaluation for Stantec (2016D)

Reference:	Stantec Consulting Services Inc. (Stantec). 2016d. "Report of Geotechnical Exploration, Cumberland Fossil Plant, Bottom Ash Pond, Stewart County, Tennessee." Prepared for Tennessee Valley Authority. October 12.	
Purpose:	To analyze the Structural Integrity Criteria for the CUF Bottom Ash Pond and to evaluate compliance with EPA Final CCR Rule	
CCR Unit(s):	Bottom Ash Pond	
Spatial coverage:	Northeastern and southwestern internal dikes	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	2 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	Field located and horizontally approximated to the nearest 10 feet, vertically approximated to the nearest foot
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, CCR thickness, clay thickness, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	All testing follows ASTM standards
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.21.1 Field Activities

The exploration consisted of two soil borings along the northeastern and southwestern dike crests (approximate locations are shown in Exhibit 1). Drilling was performed by a Stantec two-man drill crew and an ATV-mounted drill rig with supervision being provided by a Stantec geotechnical engineer. The borings were advanced utilizing hollow-stem augering techniques (ASTM D6151) to comply with the guidelines presented in ER 1110-1-1807, "Procedures for Drilling in Earth Embankments" (USACE, 2006) and protect the integrity of the embankments and foundation materials. The borings were advanced with 3.25-inch hollow-stem augers until auger refusal.

Standard Penetration Tests (SPTs) (ASTM D1586) were conducted at 2.5- to 5-foot intervals beginning at the ground surface. Following the field exploration, the SPT samples and bag samples were transported to Stantec's laboratory for testing.

Upon completion of drilling, temporary slotted PVC observations wells were installed in the borings to observe groundwater levels the following day. The temporary wells were then removed and backfilled.

3.21.2 Laboratory Testing

The laboratory tests were performed in accordance with ASTM standard testing procedures. Testing included natural moisture content (D2216), particle size analyses (D422), and Atterberg limits (D4318). Samples were classified in accordance with the Unified Soil Classification Soil System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) method.

3.21.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions and thicknesses from boring logs
    a. Boring logs document material descriptions and thicknesses,
    b. Perimeter dike and foundation geometry is substantially the same as current.
2. CCR and soil properties
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.

3.22 STANTEC (2016E)

Table 22. Summary of Evaluation for Stantec (2016E)

Reference:	Stantec Consulting Services Inc. (Stantec). 2016e. "Initial Structural Stability Assessment, Bottom Ash Pond, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Cumberland City, Tennessee." Prepared for Tennessee Valley Authority. October 12.	
Purpose:	Demonstrate adequate structural stability for EPA Final CCR Rule initial structural stability assessment for the Bottom Ash Pond.	
CCR Unit(s):	Bottom Ash Pond	
Spatial coverage:	Perimeter and divider dikes	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	Yes	Qualitative assessment of perimeter dike foundations and abutments, slope protection, compaction, outflow condition and capacity, and sudden drawdown potential.

3.22.1 Analysis

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation was required by October 17, 2016 and must include an initial structural stability assessment for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

1. Has a height of five feet or more and a storage volume of 20 acre-feet or more, or

2. Has a height of 20 feet or more.

The Bottom Ash Pond requires a multi-faceted approach to the analysis of embankments, spillways, and hydraulic structures for long-term durability (i.e., erosion resistance), construction standards (i.e., compaction records of the dikes) and short-term impacts (i.e., sudden drawdown). The EPA Final CCR Rule requires each facility to document whether the unit has been designed, constructed, operated and maintained per the following criteria at the Bottom Ash Pond:

1. Per §257.73(d)(1)(i), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with stable foundations and abutments.

2. Per §257.73(d)(1)(ii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown.

3. Per §257.73(d)(1)(iii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.

4. Per §257.73(d)(1)(v), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with a single spillway or combination of spillways that meet the condition and capacity requirements as outlined in this section of the CCR Rule. The combined capacity of all spillways are to be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in this section.

5. Per §257.73(d)(1)(vii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with downstream slopes that can be inundated by an adjacent water body (such as a river, stream, or lake) to determine if structural stability is maintained during low pool or sudden drawdown of the adjacent water body.

Based upon the criteria used for evaluation of the existing conditions at the site in conjunction with historical documentation of design, construction, and inspection of the Bottom Ash Pond, the criteria listed above have been met for this facility.

3.22.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Structural integrity, with respect to the following factors:
    a. Stability of foundations and abutments,
    b. Slope protection against surface erosion, wave action, and adverse effects of sudden drawdown,
    c. Sufficient compaction of dikes,
    d. Spillway conditions and capacity,
    e. Performance of slopes subjected to sudden drawdown.

3.23 STANTEC (2016F)

Table 23. Summary of Evaluation for Stantec (2016F)

Reference:	Stantec Consulting Services Inc. (Stantec). 2016f. "Initial Structural Stability Assessment, Stilling Pond (including Retention Pond), EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Cumberland City, Tennessee." Prepared for Tennessee Valley Authority. October 12.	
Purpose:	Demonstrate adequate structural stability for EPA Final CCR Rule initial structural stability assessment for the Stilling Pond (including Retention Pond).	
CCR Unit(s):	Stilling Pond (including Retention Pond)	
Spatial coverage:	Perimeter and divider dikes	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	Yes	Sudden drawdown stability of perimeter dike outslope along Wells Creek
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	Yes	Qualitative assessment of perimeter dike foundations and abutments, slope protection, and compaction. Quantitative assessment of primary and emergency spillway hydraulic and structural capacity.

3.23.1 Analysis

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation was required by October 17, 2016 and must include an initial structural stability assessment for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

1. Has a height of five feet or more and a storage volume of 20 acre-feet or more, or
2. Has a height of 20 feet or more.

The Stilling Pond (including Retention Pond) requires a multi-faceted approach to the analysis of embankments, spillways and hydraulic structures for long-term durability (i.e., erosion resistance), construction standards (i.e., compaction records of the dikes) and short-term impacts (i.e., sudden drawdown). The EPA Final CCR Rule requires each facility to document whether the unit has been designed, constructed, operated and maintained per the following criteria at the Stilling Pond (including Retention Pond):

1. Per §257.73(d)(1)(i), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with stable foundations and abutments.
2. Per §257.73(d)(1)(ii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown.
3. Per §257.73(d)(1)(iii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.
4. Per §257.73(d)(1)(iv), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection.
5. Per §257.73(d)(1)(v), the initial structural stability assessment must document whether the unit has been designed, constructed, operated and maintained with a single spillway or combination of spillways that meet the condition and capacity requirements as outlined in this section of the CCR Rule. The combined capacity of all spillways are to be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in this section.

6. Per §257.73(d)(1)(vii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with downstream slopes that can be inundated by an adjacent water body (such as a river, stream, or lake) to determine is structural stability is maintained during low pool or sudden drawdown of the adjacent water body.

Based upon the criteria used for evaluation of the existing conditions at the site in conjunction with historical documentation of design, construction, and inspection of the Stilling Pond (including Retention Pond), the criteria listed above have been met for this facility.

3.23.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Structural integrity, with respect to the following factors:
    a. Stability of foundations and abutments,
    b. Slope protection against surface erosion, wave action, and adverse effects of sudden drawdown,
    c. Sufficient compaction of dikes,
    d. Sufficient vegetation on dike slopes,
    e. Spillway conditions and capacity,
    f. Performance of slopes subjected to sudden drawdown.

3.24 STANTEC (2017A)

Table 24. Summary of Evaluation for Stantec (2017a)

Reference:	Stantec Consulting Services Inc. (Stantec). 2017a. "Geotechnical Field Services for Well Installations and Closures, Groundwater Monitoring Optimization – Phase 3, Cumberland Fossil Plant, Cumberland City, Tennessee." Prepared for Tennessee Valley Authority. February 10.	
Purpose:	Document implementation of well installations and closures, per the Groundwater Monitoring Optimization (GMO) for CCR units at CUF.	
CCR Unit(s):	Stilling Pond (including Retention Pond), Dry Ash Stack, and Gypsum Storage Area	
Spatial coverage:	10 borings along perimeter dike, 2 borings north of Gypsum Storage Area, and 8 borings southwest to west of Wells Creek	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	20 borings
Rock coring:	Yes	6 borings
Other subsurface data:	Yes	Downhole video logging of existing wells
Boring locations surveyed:	Yes	Surveyed by Stantec after field work
Data adequate to support three-dimensional model:	Yes	Data support CCR thickness, clay thickness, top of bedrock elevation
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	Yes	Twelve monitoring wells, one observation well
In-situ testing:	Yes	SPT
Laboratory testing:	No	Analytical testing of soil only
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.24.1 Field Activities

Phase 3 recommendations, per AECOM (2016), include twelve new monitoring wells, one new observation well, fifteen well closures and the redevelopment of eight existing wells. Twenty soil borings with associated offset borings were performed to obtain thirteen developable well locations. The work was performed by qualified Stantec and subcontractor drill crews using rotary and sonic drill units. The monitoring wells were installed using current industry and regulatory protocols to prevent introducing contaminants during the drilling and installation process. These procedures include the decontamination of the drilling equipment and tools before and after each well by washing with hot, potable water delivered under high pressure, using new well screen and riser that have been cleaned and sealed in plastic at the factory, and placing washed filter pack sand.

The wells were installed using truck and track-mounted rotary drill rigs equipped with hollow stem augers or a track-mounted sonic unit. At locations with wells screened in soil, the wells were first advanced using 4.25-inch inside diameter (ID) hollow stem augers (HSAs). Standard penetration tests (SPT) were conducted at 2.5-foot intervals through the soil overburden. Wells installed in bedrock were first advanced with a 9-inch sonic casing. The subsurface materials were logged by a Tennessee licensed professional geologist or engineer for material type, color, consistency, and other notable composition characteristics. The split-spoon samples were placed into glass jars with lids and transported to Stantec's Lexington, Kentucky laboratory.

New wells were installed through 8.25-inch ID HSAs (offset from the 4.25-inch boring) or 9-inch diameter sonic casing. The new wells consist of a 4-inch diameter by 10-foot long Schedule 40 PVC pre-packed well screen with 0.01-inch slots and associated PVC risers. The PVC risers extended to approximately forty-five inches above the ground surface. The annular space was backfilled with a sand filter pack to approximately two to three feet above the screened interval. Then a minimum of a two feet layer of bentonite was used as a seal. The annular space from the bentonite seal to the ground surface was backfilled with a bentonite grout.

Upon completion of the field work performed, the soil borings and well locations were surveyed onto the Tennessee state plane coordinate system (approximate locations are shown in Exhibit 1).

3.24.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,

c. Perimeter dike and foundation geometry is substantially the same as current.

2. Monitoring and Observation Wells

    a. Locations and elevations were surveyed,

    b. Installation methods meet current standard of practice,

    c. Instruments are adequate to provide current water level readings.

3.25 STANTEC (2017B)

Table 25. Summary of Evaluation for Stantec (2017b)

Reference:	Stantec Consulting Services Inc. (Stantec). 2017b. "Basis of Design Report: Gypsum Disposal Complex and Dry Ash Stack Drainage Improvements Project, TVA Project No. 607600, TVA Cumberland Fossil Plant, Cumberland City, Stewart County, Tennessee." Prepared for Tennessee Valley Authority. May 25.	
Purpose:	Engineering study to develop grading and drainage improvements in the lower perimeter ditches and design a cap system for partial closure of select existing perimeter slopes for the Dry Ash Stack and Gypsum Storage Area.	
CCR Unit(s):	Dry Ash Stack and Gypsum Storage Area	
Spatial coverage:	Perimeter slopes along Dry Ash Stack and Gypsum Storage Area	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	Yes	Data support regraded CCR slopes.
Geometry at time of document representative of 2017 conditions:	Yes	Proposed geometry represents construction of final cap system over existing surface. Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Drained and undrained shear strengths (final cap system)
Static slope stability:	Yes	Veneer stability of final cap system; critical section representing longest slope

Reference:	Stantec Consulting Services Inc. (Stantec). 2017b. "Basis of Design Report: Gypsum Disposal Complex and Dry Ash Stack Drainage Improvements Project, TVA Project No. 607600, TVA Cumberland Fossil Plant, Cumberland City, Stewart County, Tennessee." Prepared for Tennessee Valley Authority. May 25.	
Seismic slope stability:	Yes	Veneer stability of final cap system; critical section representing longest slope (seismic and post-earthquake)
Information adequate to support stability evaluation:	Yes	Represents static veneer stability of proposed partial closure geometry.
Other relevant analyses:	No	

3.25.1 Analysis

One cross-section was developed for shallow, translation (veneer) stability analyses of the final cap system for the Dry Ash Stack and Gypsum Storage Area as part of the proposed partial closure design. The critical cross-section was selected as the longest length for the proposed partial closure slope configuration.

The veneer stability of the cap system was analyzed using limit equilibrium methods. Analyses were performed for static, long-term conditions (drained, undrained, and post-earthquake residual strength conditions in the cover soil) and pseudostatic loading conditions. Shear strength of the potential cover soil borrow were assumed as the shear strength results from Stantec 2010b, as the borrow materials were deemed similar to the Dike 1 soil. The project-specific materials mentioned above must have laboratory tests performed to verify that the calculated strength requirements are reasonable and achievable.

3.25.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Static and seismic veneer slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to (or more conservative than) current.
    d. Analysis methods meet current standard of practice.

4.0 TDEC SITE INFORMATION REQUEST NO. 4

4.1 PREFERENTIAL SEEPAGE PATHWAYS

In TDEC's CUF EIP Revision 1 comments (see Appendix B), additional information is requested regarding the potential for preferential seepage pathways through the foundation soils via stream channels that were present prior to development of the Dry Ash Stack and the Stilling Pond (including Retention Pond). Additional information is also requested regarding historical grouting of the foundation soils beneath the perimeter dike along the current alignment of Wells Creek. Exhibit 2 shows the pre-construction channel of Wells Creek crossing the CCR unit perimeters at two different locations and also shows the grouting alignment (based on TVA Drawing 10N212).

There is limited information available on how the foundation was prepared during original perimeter dike construction. It is unclear if more pervious stream deposits were present, and if so whether they were excavated or otherwise treated prior to placing fill. In addition, TVA Drawing 10N213 indicates a design section for the perimeter dike that included an option to place an initial layer of rockfill to begin the starter dike in areas where the existing ground was below water. However, no documentation is available to indicate if this option was ever employed. Finally, available documentation of the grouting program indicates that seepage was believed to be occurring along a pervious layer in the foundation soils beneath the perimeter dike. A more detailed review of the available information for these three potential seepage pathways is presented below.

Pre-construction Stream Channel Crossings

Exhibit 2 shows the pre-construction Wells Creek channel crossing the CCR unit perimeters at two different locations. A review was performed of the available historical documentation (construction records, etc.), existing borings advanced within or near the pre-construction Wells Creek channel, and available geophysical results.

Based on the available TVA mapping (Drawing 10N212R11), the pre-construction Wells Creek channel crosses the Retention Pond perimeter dike and the Dry Ash Stack perimeter dike (Exhibit 2). Between 1986 and 2016, twenty-seven borings have been advanced at or adjacent to these pre-construction channel crossings (Exhibit 2). Twenty-five of these borings encountered clay as the uppermost foundation soil. Two borings, GCUF-F-2A and GCUF-F-2B, encountered silty sand as the uppermost foundation soil. These two borings are located within 80 feet of one another.

Perimeter Dike Rockfill Foundation

Available TVA drawings (Drawing 10N213R6) depict two typical perimeter dike cross section designs. Typical Section A was to be used when existing ground was above the water surface, and the earthfill for the starter dike was placed directly on the foundation soils. Typical Section B (see Figure 1) was to be used when existing ground was below the water surface, and included small toe berms made of rock. The purpose of the rock berms appears to be to allow dewatering of the dike footprint such that earthfill could be placed directly on the foundation soils. A variation of Section B is designated Section B1 (see Figure 1). Section B1 calls from a continuous "bridge" layer of rockfill to the same height as the rock berms. The criteria to employ Section B1 is not documented, nor is it clear if Section B1 was actually employed during construction. Presumably, it would be used when the dike footprint could not be dewatered sufficiently to place earthfill.

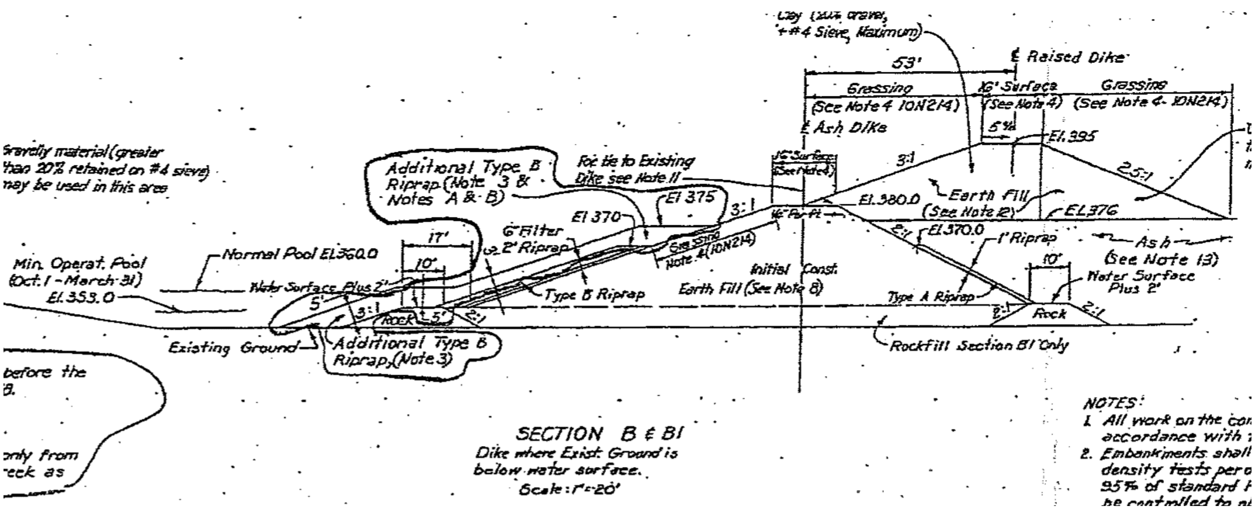


Figure 1. Typical Perimeter Dike Cross Section when Existing Ground was Below the Water Surface (TVA Drawing No. 10N213R6)

The segments of the perimeter dike requiring the use of Typical Section B or B1 would have been dependent on the adjacent creek elevation during construction; however, data regarding the creek elevations during perimeter dike construction is unknown. Available subsurface data from borings advanced between 1986 and 2016 were reviewed to provide a more detailed understanding of the dike-foundation interface. Borings advanced at the centerline of the original perimeter dike typically encountered clay fill immediately followed by foundation soils. However, at STN-14 and GCCUF-F-2C, located within the pre-construction Wells Creek stream channel, gravel and clayey gravel were encountered at elevations that may have been above the foundation soils. During original construction, these two locations correspond to lower portions of the site where the foundation may have been below water. Although not definitive, the rockfill bridge layer may be present at these locations.

Pervious Foundation Layer

Beginning in 1973 and continuing through 1990, seepage was observed along the perimeter dike adjacent to the re-located Wells Creek channel. In 1974, a geotechnical investigation was undertaken to determine the cause of the seepage through the perimeter dike (TVA 1974). It was concluded that a continuous, soft, and saturated topsoil layer was present, and the water levels observed indicated the possibility of seepage through this soft layer. In 1978, prior to construction of the raised dike, a segment of the inboard slope of the original perimeter dike was lined with bottom ash (Exhibit 2). This was an attempt to lengthen the seepage pathway and lower the gradients across the perimeter dike. (TVA 1979)

In the 1988 inspection report, a recommendation was made to consider reducing seepage through the perimeter dike by constructing a slurry trench. A slurry trench was not constructed, but pressure grouting was performed in 1991 to mitigate the seepage (TVA 1991a). The grouting program was performed along the crest of the starter dike, between Stations 0+00 and 54+26 (Exhibit 2). TVA Drawing 10N213R6 provides a typical design cross section for grouting, as shown in Figure 2. The holes were typically advanced to a depth of 30 feet, and as deep as 40 feet from the crest of the starter dike in order to target the pervious soil layer identified during the 1974 geotechnical investigation. Primary grout holes were spaced on 14-foot centers; however, if grout takes exceeded 100 cubic feet in one hole or 150 cubic feet in any two adjacent holes, then secondary grout holes were placed halfway between the primary holes (i.e., on 7-foot centers). Where necessary, tertiary grout holes were placed on 3.5-foot centers.

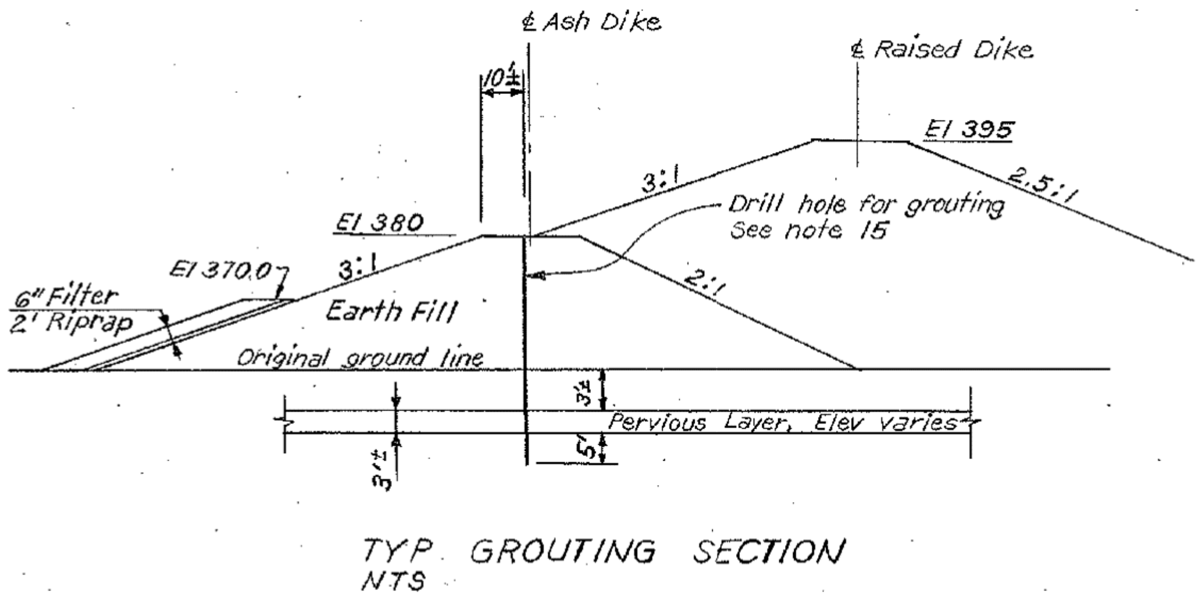


Figure 2. Typical Cross Section with Grout Design (TVA Drawing No. 10N213 R6)

Observed Seepage and Pond Conditions

Seepage has been observed on the outslopes of the perimeter dikes or through the foundation soils since 1973. During periods of consistent operations and no significant dike modifications, inspection reports note observed seepage areas appeared to be remain relatively consistent. However, differences in wet areas or flow was observed when the ash pond water level was altered from typical operations as detailed in the following inspection reports:

- In 1980, observed seepage was decreased from previous inspections; it was noted that the seepage decreased following the lining of the inboard slopes with bottom ash, in preparation for dike raising.
- In 1994, the water level was increased to elevation 384 feet. During the May 1995 annual inspection the seepage was noted to be greater than recent observations. This increased seepage continued until May 1999.
- The 1999 inspection report notes that the seepage appeared less than the previous year. It was noted that decreased seepage could be due to dry stacking rather than sluicing in the immediate area.

Recent modifications have been made to the unit including lowering the pond water level and stacking of dry fly ash (instead of sluicing). These modifications reduce the hydraulic head on the perimeter dikes thereby reducing the seepage potential.

Proposed Exploration

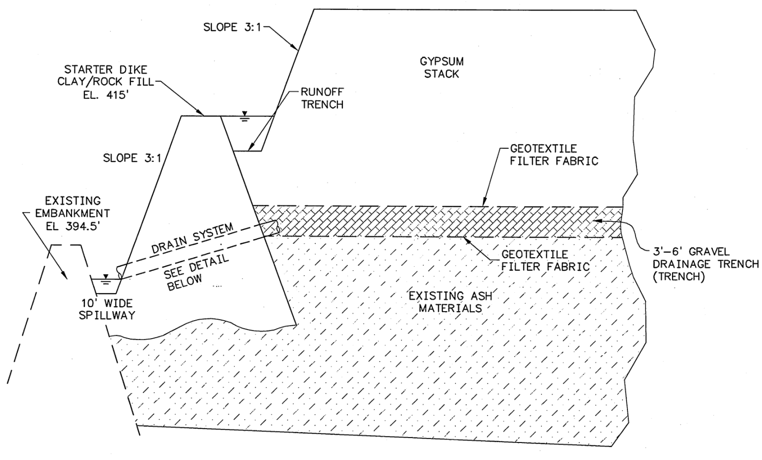
The location of the preconstruction stream channel is known with a reasonable degree of certainty. The locations of more significant grout takes and the suspected rockfill bridge layer tend to align with the preconstruction stream channel crossings. Considering all of this information, a supplemental field exploration to target these areas is the preferred approach to characterize the base of the perimeter dike and the uppermost foundation soils at or near each perimeter stream crossing. This supplemental field exploration will consist of lines of closely spaced CPTs performed in the vicinity of the pre-construction stream channel crossings and an adjacent area of historical grouting. For additional details regarding the CPT locations and the exploration plan, refer to the Exploratory Drilling SAP (Appendix H) and Exhibit 3.

In addition to the proposed exploration, seep sampling (Seep SAP) and surface stream sampling (Surface Stream SAP) will be performed along Wells Creek. These sampling programs serve as additional means to evaluate seepage potential through the foundation soils.

4.2 DRY ASH STACK UNDERDRAIN SYSTEM

In TDEC's CUF EIP Revision 2 comments (see Appendix B), additional information is requested regarding the underdrain system in the Dry Ash Stack. In 1992, Law Engineering performed a study (Law 1992a, see Section 3.3) to evaluate the suitability of the existing sluiced ash pond footprint for possible subdivision and conversion of portions to a Dry Ash Stack and a Gypsum Storage Area. As a means to mitigate the potential for liquefaction of the existing sluiced ash, Law Engineering presented a concept of dewatering the upper portion of the sluiced ash by constructing deep perimeter trenches backfilled with bottom ash and containing collection pipes. The water collected in the pipes would be pumped or otherwise directed to the remaining portion of the ash pond. Based on the available information, this approach did not evolve beyond the concept level and is not discussed further herein.

In October 2003, the Cumberland Fossil Plant Operations Manual and corresponding design drawings (10W302 series) were issued. The 10W302 drawings included stacking plans for developing the Gypsum Storage Area and the Dry Ash Stack. The design included underdrain systems, to be installed on top of the existing sluiced ash, following by stacking of gypsum or dry ash. The design of the underdrain systems for the two landfills differed slightly (See Figure 5 for design details from Drawing 10W302-25), but in general both included pervious collection trenches or a pervious layer beneath the stacked material. The pervious trenches or layer drained towards the perimeter, where drainage pipes would discharge to perimeter ditches.



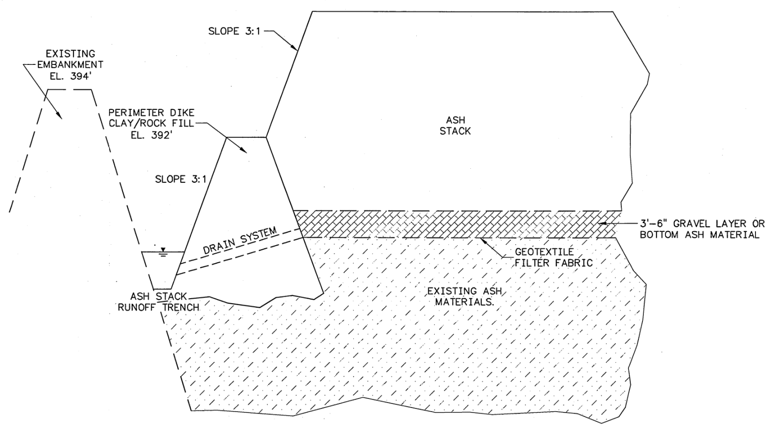


Figure 3. Design Details for Underdrain System of Gypsum Storage Area (top) and Dry Ash Stack (bottom) as depicted on TVA Drawing No. 10W302-25 (2003)

However, based on revised text in the Cumberland Fossil Plant Operations Manual (Revision 1, October 10, 2003), the constructed underdrain systems for each unit did vary somewhat from the design drawings, as described below.

According to the Operations Manual and other supporting information, the underdrain system for the Gypsum Storage Area was constructed as follows:

- Excavate a series of parallel drainage trenches (in the existing sluiced ash), line trenches with appropriate filter material (the design drawing indicates geotextile filter fabric), backfill trenches with free-draining stone or washed bottom ash. This is consistent with the design drawings, except that washed bottom ash may also have been permitted.

- Trenches drain to a perimeter drain system (i.e., pipes) that penetrate a perimeter starter dike made of clay or rockfill. This is consistent with the design drawings, and the pipes are present around the perimeter of the unit.

- The entire footprint of the unit was then covered with a blanket drain, constructed by placing a non-woven geotextile on the surface, spreading a minimum of 2 feet of free-draining gravel over the geotextile, placing another geotextile over the gravel, and spreading a 6-inch layer of coarse sand. This blanket drain is not indicated on the design drawings.

According to the Operations Manual and other supporting information, the underdrain system for the Dry Ash Stack was constructed as follows:

- A "blanket drain of free-draining bottom ash" was placed, ranging in thickness from 4 feet near the perimeter to 7.5 feet at the center of the unit. This is thicker than indicated on the design drawings.

- The perimeter drainage pipes are not mentioned. This is consistent with observed conditions; no pipes are present around the perimeter, and it appears that the bottom ash blanket drain discharges directly into the "ash stack runoff trench" (this term is used on the drawing for the perimeter ditch). This configuration allows for discharge without the need for pipes.

- Installation of a geotextile below the blanket drain is not mentioned.

- Finally, the "perimeter dike, clay/rock fill" was not constructed; instead stacked ash was placed starting along the inside edge of the runoff trench.

During the Stantec 2010 Geotechnical Exploration (see Section 3.11), borings were advanced along the Dry Ash Stack perimeter and within the stacked ash. These borings further corroborate the text in the 2003 Operations Manual that a drainage system described as a "blanket drain of free-draining bottom ash" was installed in the Dry Ash Stack. As shown on a typical Dry Ash Stack cross section developed from the 2010 borings (Figure 6), layer of a bottom ash layer separates the sluiced and stacked ash.

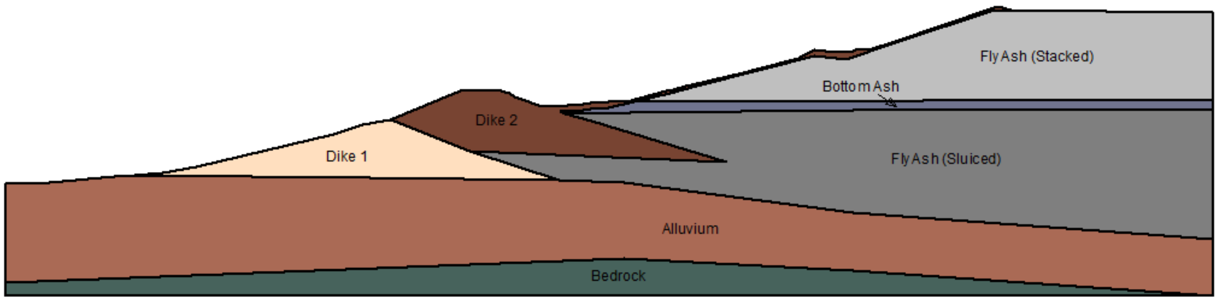


Figure 4. Typical Cross Section of Dry Ash Stack (Stantec 2010b)

5.0 ASSUMPTIONS AND LIMITATIONS

In preparing this document, assumptions are as follows:

- The summaries presented herein cannot fully communicate the information contained in each document. Refer to the individual reference documents for additional context and detail.

6.0 REFERENCES

References are provided in the summary table for each document discussed herein.

TVA (1974). “Cumberland Steam Plant – Ash Disposal Area – Soils Investigation.” August 7.

TVA (1979). “Cumberland Steam Plant – Annual Ash Disposal Area Inspection.” September 26.

TVA (1980). “Cumberland Steam Plant – Annual Ash Disposal Area Inspection.” October 2.

TVA (1988). “Cumberland Steam Plant – Annual Ash Disposal Area Inspection.” April 6.

TVA (1991a). “Cumberland Fossil Plant – Ash Pond Grouting.”

TVA (1991b). “Main Plant, Ash Disposal Areas Sheet No. 1.” Drawing 10N212 Rev. 11. May 20.

TVA (1991c). “Main Plant, Ash Disposal Areas Sheet No. 2.” Drawing 10N213 Rev. 6. May 20.

TVA (1994). “Cumberland Steam Plant – Inspection of Waste Disposal Areas.” August 8.

TVA (1995). “Cumberland Fossil Plant – Inspection of Waste Disposal Areas.” March 28.

TVA (1996). “Cumberland Fossil Plant – Inspection of Waste Disposal Areas.” April 2.

TVA (1997). “Cumberland Fossil Plant – Inspection of Waste Disposal Areas.” March 27.

TVA (1998). “Cumberland Fossil Plant –Inspection of Waste Disposal Areas.” April 17.

TVA (1999). “Cumberland Fossil Plant – Inspection of Waste Disposal Areas.” May 24.

ATTACHMENT A
EXHIBITS

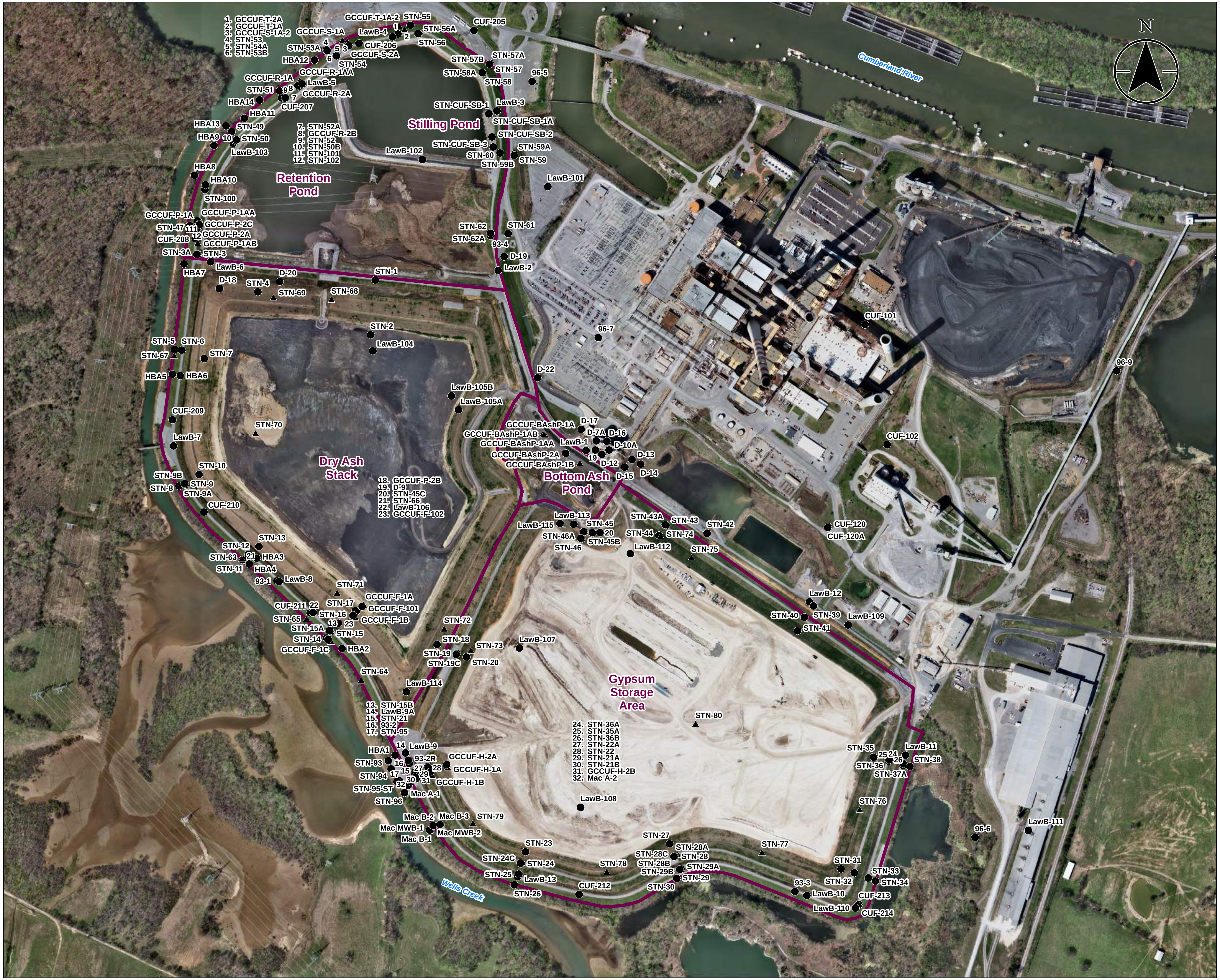


Exhibit No.
1

Title
Existing Borings

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

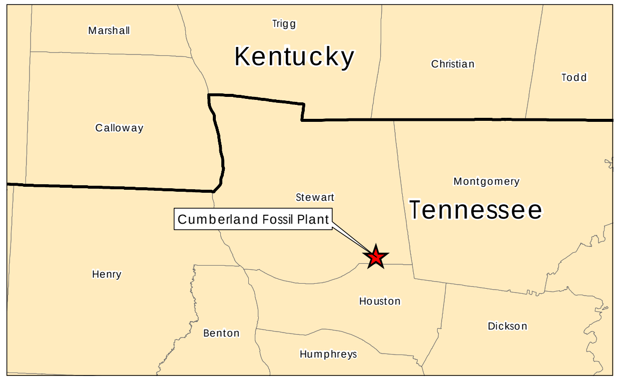
Project Location 175566329
Stewart County, Tennessee
Prepared by MW on 2018-01-22
Technical Review by JD on 2018-01-22

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Existing Boring
- Existing CPT
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec TVA

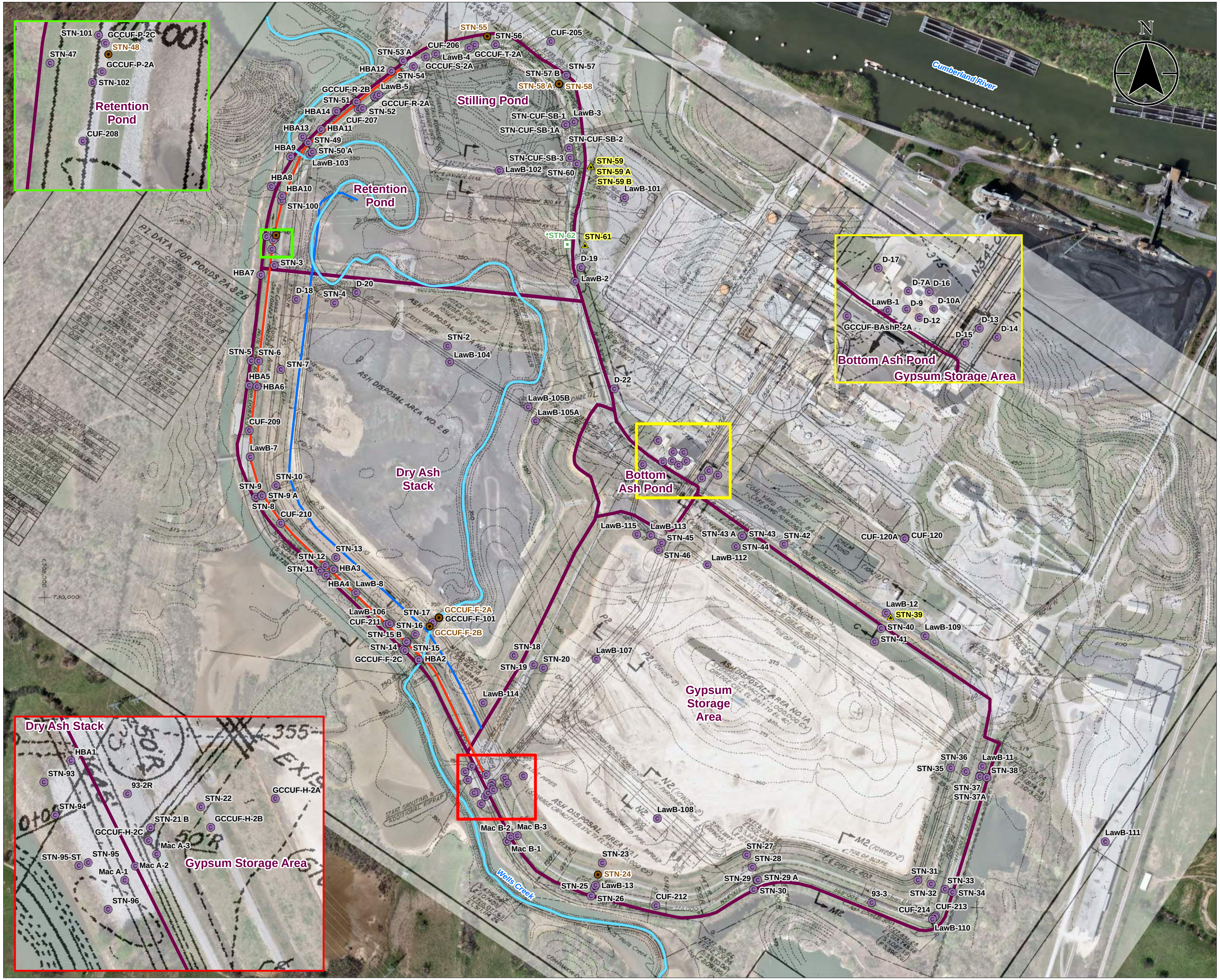


Exhibit No.
2

Title
Perimeter Dike Seepage Improvements

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
175566329
Stewart County, Tennessee
Prepared by TR on 2017-11-07
Technical Review by JD on 2017-11-07

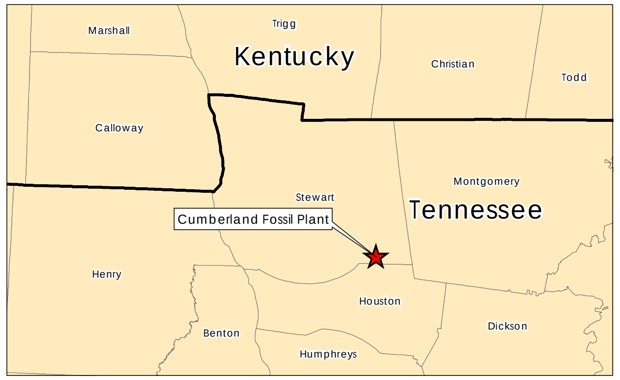
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Alluvial (Clay)
- Alluvial (Granular)
- Clayey Fill
- Bedrock*
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- Historical Wells Creek Alignment (Approximate)
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Historical TVA Drawing 10N212R11 (1991) is shown
4. * Indicates Constructed Cut-off Trench Extends to Bedrock



Stantec

TVA

U:\TVA-EP\175566329\gis\mxds\REV2\1000_CUF_Dike_Improvements.mxd Revised: 2017-11-07 By: mbough

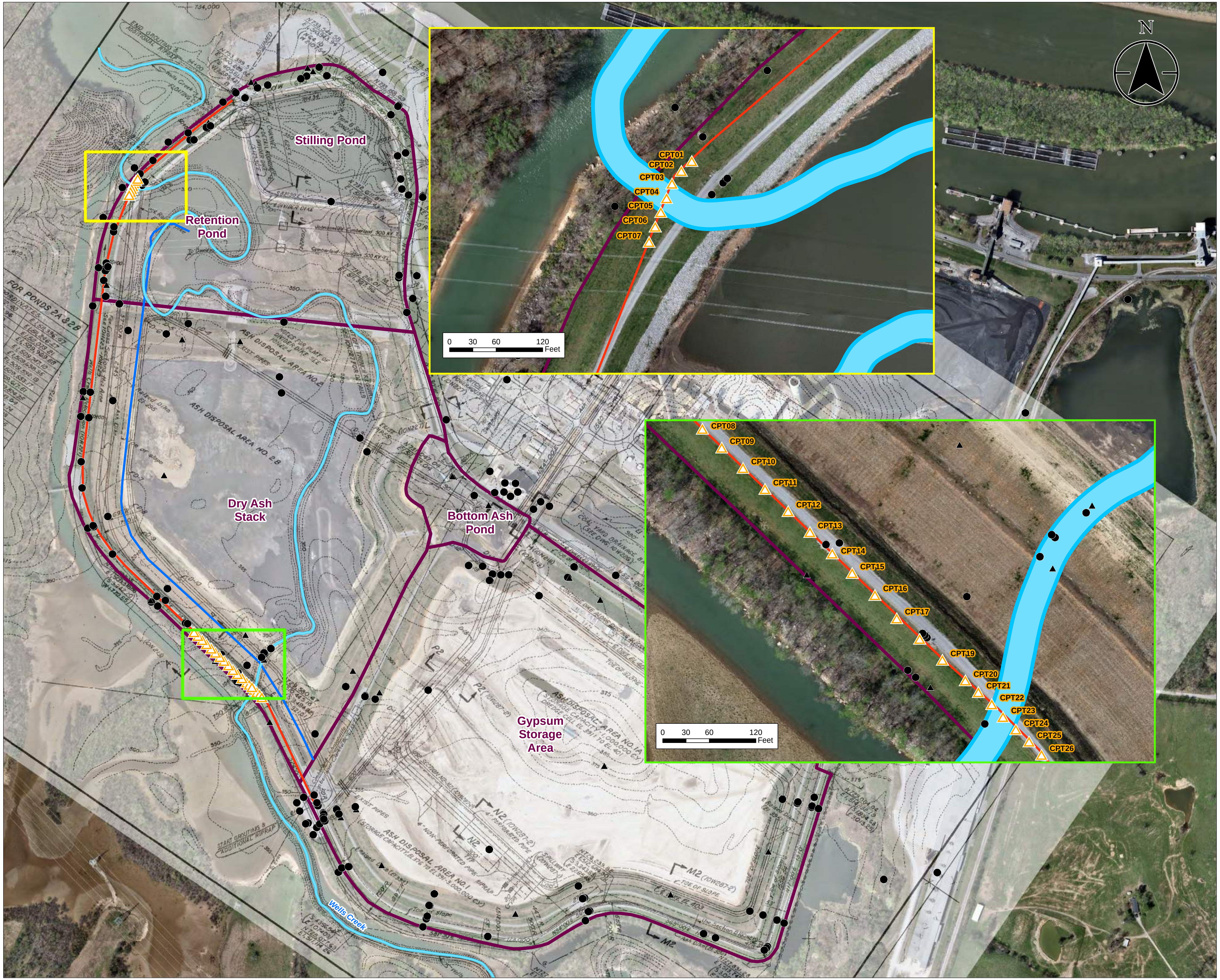


Exhibit No.
3

Title
Proposed Cone Penetration Testing

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

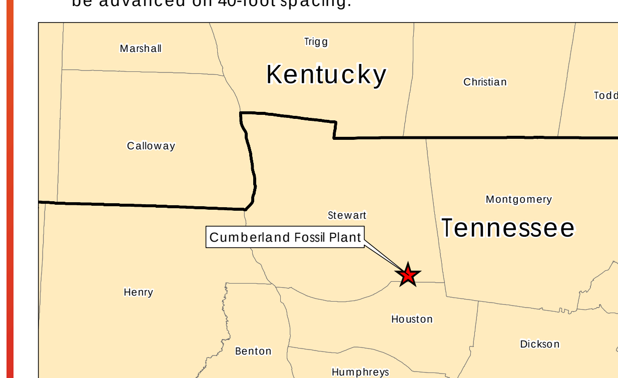
175566329
Prepared by TR on 2018-01-22
Technical Review by JD on 2018-01-22

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Existing Boring
- Existing CPT
- Historical Wells Creek Alignment (Approximate)
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Historical TVA Drawing 10N212R11 (1991) is shown
4. Based on historical mapping, Wells Creek is approximately 40 feet wide. Within 60 feet of the historical Wells Creek centerline, CPT borings will be advanced on 20-foot spacing. Outside of this window, CPT borings will be advanced on 40-foot spacing.



Stantec TVA

APPENDIX G
EXPLORATORY DRILLING SAP

Exploratory Drilling
Sampling and Analysis Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

EXPLORATORY DRILLING
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Exploratory Drilling
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ______________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

Melissa G. Nefecoth	6/25/18
TVA Investigation Project Manager	Date
Wm R. Dee	6/25/18
TVA Investigation Field Lead	Date
Dud Kilher	6/25/18
Health, Safety, and Environmental (HSE) Manager	Date
C.A. Haly	06/22/18
Investigation Consultant Project Manager	Date
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Stantec

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1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

Through the various information requests, as well as TDEC comments, a need for several exploratory borings at CUF (the Plant) has been identified. This Exploratory Drilling Sampling and Analysis Plan (SAP) has been prepared to outline the proposed borings and the methods to be employed during the Investigation.

2.0 OBJECTIVES

The objective of this Exploratory Drilling SAP is to outline the methods that will be used to execute the following activities:

- Where applicable, perform additional soil and rock borings, piezometer installation, and laboratory testing to refine subsurface characterization and material quantity estimates,
- Where applicable, install temporary wells to allow for pore water sampling and measuring piezometric (i.e., water) levels within CCR units.

Pore water sampling and water level readings are not within the scope of this SAP, but are addressed in other SAPs within the EIP.

Additional, future borings performed under other programs, such as EPA Final CCR Rule compliance and closure design, may be used to supplement the data necessary to respond to information requests in the EIP. However, performance of those borings is governed by other programs and is not covered herein.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 PLANT-SPECIFIC EXPLORATION PLAN

The proposed soil and rock boring locations were selected to aid in addressing data gaps and supplementing existing data, as necessary to address information requests of the TDEC Order for CUF. The rationale for individual cone penetration tests (CPT), borings, and/or well locations are discussed below. Refer to Figures 1 and 2 in Attachment A for a layout of proposed boring locations. Proposed boring locations are accessible using existing access routes without modification.

In order to address TDEC's information requests regarding CCR material quantity, water levels, CCR material characteristics, and subsurface materials, subsurface characterization will be supplemented by performing CPTs and installing multi-purpose borings and temporary wells at locations shown on Figures 1 and 2. These additional borings, some of which will be converted into temporary wells, will provide supplemental data relative to CCR thickness, water levels, foundation soil type and thickness, and top of bedrock elevations for the interior of the CCR units. A total of 26 CPTs and 19 borings are proposed. Table 1 provides a summary of CPTs, borings, and temporary wells proposed in each CCR unit. Table 2 lists individual CPTs and borings along with more detail about the purpose of each. If the boring for a temporary well demonstrates that the CCR is unsaturated and above the expected phreatic surface, the temporary well will not be installed and the boring will be backfilled.

Table 1. Summary of Exploratory Drilling Proposed in each CCR Unit

CCR Unit	Total No. of Proposed CPT	Total No. of Proposed Borings	No. of Borings with Temporary Wells	No. of Borings with Vibrating Wire Piezometers	No. of Borings with Rock Coring
Stilling Pond (including Retention Pond)	7	4	1	0	4
Dry Ash Stack	19	7	3	4	7
Gypsum Storage Area	0	8	6	0	5
Total	**26**	**19**	**10**	**4**	**16**

Table 2. Detailed Boring and CPT Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	Boring Purpose[1]
TW01	Gypsum Storage Area	Bedrock	Sluiced Ash	PZ, PW, Geo
TW02	Gypsum Storage Area	Gypsum	Gypsum	PZ, PW, Geo
TW03	Gypsum Storage Area	Bedrock	Sluiced Ash	PZ, PW, Geo
TW04	Gypsum Storage Area	Gypsum	Gypsum	PZ, PW, Geo
TW05	Gypsum Storage Area	Bedrock	Sluiced Ash	PZ, PW, Geo
TW06	Gypsum Storage Area	Gypsum	Gypsum	PZ, PW, Geo
TW07	Dry Ash Stack	Bedrock	Sluiced Ash	PZ, PW, Geo
TW08	Dry Ash Stack	Bedrock	Sluiced Ash	PZ, PW, Geo
TW09	Dry Ash Stack	Bedrock	Sluiced Ash	PZ, PW, Geo
TW10	Stilling Pond/Retention Pond	Bedrock	Sluiced Ash	PZ, PW, Geo
B-11	Stilling Pond/Retention Pond	Bedrock	--	Geo
B-12	Stilling Pond/Retention Pond	Bedrock	--	Geo
B-13	Stilling Pond/Retention Pond	Bedrock	--	Geo
B-14	Dry Ash Stack	Bedrock	--	PZ, Geo
B-15	Dry Ash Stack	Bedrock	--	PZ, Geo
B-16	Dry Ash Stack	Bedrock	--	PZ, Geo
B-17	Dry Ash Stack	Bedrock	--	PZ, Geo
B-18	Gypsum Storage Area	Bedrock	--	Geo
B-19	Gypsum Storage Area	Bedrock	--	Geo
CPT01	Stilling Pond/Retention Pond	Bedrock	--	Geo
CPT02	Stilling Pond/Retention Pond	Bedrock	--	Geo
CPT03	Stilling Pond/Retention Pond	Bedrock	--	Geo
CPT04	Stilling Pond/Retention Pond	Bedrock	--	Geo
CPT05	Stilling Pond/Retention Pond	Bedrock	--	Geo
CPT06	Stilling Pond/Retention Pond	Bedrock	--	Geo
CPT07	Stilling Pond/Retention Pond	Bedrock	--	Geo
CPT08	Dry Ash Stack	Bedrock	--	Geo
CPT09	Dry Ash Stack	Bedrock	--	Geo
CPT10	Dry Ash Stack	Bedrock	--	Geo
CPT11	Dry Ash Stack	Bedrock	--	Geo
CPT12	Dry Ash Stack	Bedrock	--	Geo
CPT13	Dry Ash Stack	Bedrock	--	Geo
CPT14	Dry Ash Stack	Bedrock	--	Geo
CPT15	Dry Ash Stack	Bedrock	--	Geo
CPT16	Dry Ash Stack	Bedrock	--	Geo
CPT17	Dry Ash Stack	Bedrock	--	Geo
CPT18	Dry Ash Stack	Bedrock	--	Geo
CPT19	Dry Ash Stack	Bedrock	--	Geo
CPT20	Dry Ash Stack	Bedrock	--	Geo
CPT21	Dry Ash Stack	Bedrock	--	Geo
CPT22	Dry Ash Stack	Bedrock	--	Geo

Table 2. Detailed Boring and CPT Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	Boring Purpose[1]
CPT23	Dry Ash Stack	Bedrock	--	Geo
CPT24	Dry Ash Stack	Bedrock	--	Geo
CPT25	Dry Ash Stack	Bedrock	--	Geo
CPT26	Dry Ash Stack	Bedrock	--	Geo

[1] PZ = Piezometric (Water) Levels in CCR; PW = Pore Water Sampling; Geo = Geotechnical Data

As shown in Figure 1, fifteen (15) of the proposed borings (TW01 through TW10, B-11, B-14 through B-17) are located on the CCR unit interiors, to improve spatial coverage for CCR thickness, water levels, foundation type and thickness, top of bedrock elevations, and shallow bedrock characterization. Two (2) borings (B-12, B-13) are located on the eastern perimeter of the Stilling Pond and two borings (B-18, B-19) are located on the southeastern perimeter of the Gypsum Storage Area, to improve subsurface characterization of the embankment, foundation soils (including foundation type and thickness), and bedrock in this vicinity.

Six borings (TW01 through TW06) are proposed in the interior of the Gypsum Storage Area. Borings are arranged in three pairs, to allow for installation of pairs of shallow and deep temporary wells. The deep temporary wells (TW01, TW03, TW05) will be screened near the bottom of the sluiced ash, after the portion of the borehole is sealed that penetrated the foundation soils and bedrock. These deeper temporary wells will allow water level readings and pore water sampling in the sluiced ash. The companion borings for the shallower temporary wells (TW02, TW04, TW06) will be screened at the bottom of the gypsum, just above the expected elevation of the drainage layer/trenches. These shallow temporary wells will allow water level readings and pore water sampling in the gypsum (if it is saturated). The paired water level readings will help understand potential vertical seepage gradients.

The temporary wells (TW07 through TW09) in the Dry Ash Stack will be screened near the bottom of the sluiced ash, after the portion of the borehole that penetrated the foundation soils and bedrock is sealed and grouted to the bottom of the ash. These temporary wells will allow water level readings and pore water sampling in the sluiced ash.

Two borings (TW10, B-11) are proposed in the interior of the Stilling Pond, on the divider dike that separates the Stilling Pond from the Retention Pond. The deeper temporary well (TW10) will be screened near the bottom of the sluiced ash, after the portion of the borehole is sealed that penetrated the foundation soils and bedrock. This deeper temporary well will allow water level readings and pore water sampling in the sluiced ash. The second boring (B-11) is for geotechnical data and will be backfilled upon completion. Two additional borings (B-12, B-13) are proposed on the east perimeter of the Stilling Pond. Both are for geotechnical data, and will be backfilled upon completion.

Four borings (B-14 through B-17) are proposed in the interior of the Dry Ash Stack along the historical Wells Creek alignment. The borings are primarily to evaluate the uppermost foundation soil type(s) along the historical Wells Creek alignment, but also improve spatial coverage for CCR thickness, water levels, foundation type and thickness, top of bedrock elevations, and shallow bedrock characterization. In these four borings, vibrating wire piezometers will be grouted in place in the major material zones encountered in the boring (e.g. CCR, foundation soil(s), bedrock). These vibrating wire piezometers will allow water level (i.e. pore water pressure) readings in the various materials and improve subsurface characterization in this vicinity.

Two borings (B-18, B-19) are proposed at the southeastern perimeter of the Gypsum Storage Area. The borings are located along the electrical resistivity imaging (ERI) alignment (ERI line CUF-07) at the location of a potential bedrock feature. The intent of these borings is to intercept (via rock coring) the interpreted location of the potential feature based on the ERI results. Boring B-18 will be advanced to an approximate elevation of 300 feet. Boring B-19 will be offset from boring B-18 and advanced to an approximate elevation of 275 feet. Boring termination elevations may be adjusted by the drilling inspector in the field based on observed conditions.

Borings will be advanced from the ground surface using a conventional rotary drill rig with standard penetration test (SPT) samples and/or undisturbed (Shelby) tube sampling until refusal, then rock coring will be performed in select borings for shallow bedrock characterization. SPT samples will be collected for general soil and CCR characterization. Undisturbed tube sampling (Shelby tubes) may be collected for possible laboratory testing. Rock coring in select borings will be performed to obtain approximately 20 feet of rock core to characterize the bedrock beneath the CCR units.

The objective of the rock cores is not to provide for a Plant-wide characterization of the deep bedrock. Instead, the objective is to confirm the top of rock elevation and the shallow bedrock stratigraphy and condition, to correlate with other existing data.

After rock coring has been completed, the following downhole testing will be performed prior to backfilling and/or temporary well installation. The downhole testing is proposed to further characterize subsurface lithology and hydrogeology of the bedrock:

- Acoustic televiewer logging to identify and characterize bedding, fractures, and structures;
- Geophysical methods; gamma logs, caliper logs, fluid resistivity (these methods will also record pH, conductivity, dissolved oxygen, and temperature);
- Downhole packer tests (or field hydraulic conductivity tests) to estimate the hydraulic conductivity of the bedrock.

As shown in Figure 2, 26 CPT soundings (CPT01 through CPT26) are proposed along the perimeters of the Dry Ash Stack and Stilling Pond (including Retention Pond). These CPTs are proposed to better characterize the uppermost foundation soils in the immediate vicinity of the mapped, pre-construction channels of Wells Creek and in an area of historical grouting. At both stream crossing locations along the perimeter dike system, a series of closely spaced Cone Penetration Test (CPT) soundings is proposed. The CPT data, correlated to existing nearby boring logs, can be used to differentiate relatively sandy (i.e., more pervious) foundation soils, if present. Pore pressure dissipation tests will be performed in select soundings and in select depth intervals. Additional CPT soundings may be added while in the field, if further delineation becomes necessary.

Supplemental laboratory testing is also proposed using surplus undisturbed (Shelby tube) samples from a recent exploration by Geocomp (2016). Borings were performed on the perimeter of Bottom Ash Pond and Stilling Pond (including Retention Pond). The actual testing program would be dependent upon review of tubes and extrusion of the samples to confirm the material type, available sample length, and sample condition.

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to advance borings, collect soil and rock samples, install instruments, backfill borings, document field activities, and assist in providing scientifically defensible results.

Exploratory Drilling activities will adhere to applicable ASTM standards and TVA Environmental Technical Instruction (TI) documents. The field geologist/engineer will maintain a project field book and field forms (hard copy or electronic) to record field measurements and observations. Field activities will be documented in accordance with Section 5.2.3.

5.1 PREPARATION FOR FIELD ACTIVITIES

Truck or track-mounted CPT rigs and/or drill rigs are proposed to advance borings for this exploration phase of the Investigation. The boring locations will be located and field utility cleared by TVA and/or Contractor personnel (using a field surveyor and the Excavation Permit process) prior to mobilizing the drill crews.

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer and a Tennessee licensed professional engineer or professional geologist.
- Complete required health and safety paperwork and confirm field team members have completed required training.
- Coordinate activities with the drill crew(s).
- Clear Access – Proposed boring locations will be marked using a wooden stake or survey flag with the position surveyed using the global positioning system (GPS). Suitability of each location will be evaluated for logistical issues including access, grubbing needs, overhead utility clearance, and proximity to Plant features. Access improvements, including clearing and grubbing or road building, will be completed prior to the investigation start date.
- Perform Environmental Review - As required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC has a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, plant staff will not issue an excavation permit ahead of the completed environmental review.

- Complete Utility Locate(s) / Excavation Permit(s) - Prior to initiating subsurface activities, subsurface utility clearance will be sought via the plant engineering department and/or the TN 811 service. At locations within the Plant, engineering will provide primary utility clearance assurance in addition to TN 811 being notified. At all other drilling locations, TVA or 3rd party underground locators will be engaged to clear boring locations. An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the drilling locations with pertinent TVA staff.

- Identify Water Source – During implementation of the EIP, a source of potable water will be required to complete several investigation tasks, including certain drilling methods and decontamination procedures.

- Obtain required functional and calibrated field instruments, including health and safety equipment.

5.2 SAMPLING METHODS AND PROTOCOLS

TVA proposes to perform disturbed soil sampling (i.e., split-spoon sampling) and rock coring for the Investigation. Undisturbed soil sampling (Shelby tube) may be performed in selected borings if observed subsurface conditions and testing needs warrant. The sampling will allow TVA to develop a better understanding of the subsurface profile within the CCR and foundation materials and provide samples for subsequent laboratory testing to characterize materials. For geotechnical investigation borings and piezometer installations, a Tennessee licensed professional geologist (PG) or professional engineer (PE) will be present and will log the borings. The PG or PE will have suitable experience in geotechnical or geological engineering projects to support the work. This approach has been used at current investigations at other TVA Plants in Tennessee.

5.2.1 Drilling, Logging, and Surveying

5.2.1.1 Exploratory Borings

CPTs will be advanced using truck- or track-mounted rigs and data collected per ASTM D5778. Borings will be advanced using truck- or track-mounted rotary drill rigs. The borings are proposed to be advanced utilizing hollow-stem augering techniques (ASTM D6151) until boring termination depth or auger refusal, whichever is shallower. In some situations, drilling with a casing advancer may be a suitable alternative to augering.

If needed due to high water levels or underlying soils in the field, drilling will be performed using mud rotary techniques. Temporary steel casing will be set for mud circulation purposes and an upward discharge drag bit connected to drill rods will advance the boring through the soil materials.

The upward discharge bits are designed to direct the drilling fluid and cuttings upward and out of the boring. The drilling fluids are conveyed to the surface and into a recirculation tub where the suspended drill cuttings can settle out.

The recirculation tub employs a series of baffles to promote settling of the suspended particles allowing recirculation (recycling) of the drilling mud. The drilling fluid density and viscosity will be monitored at approximate 15-foot depth intervals using a mud balance and Marsh funnel, respectively.

If borings are to be advanced into rock, upon completion of drilling in overburden, temporary steel casing will be installed and seated into competent rock. The purpose of the steel casing is to separate the bedrock from the overburden (including saturated zones of CCR) while rock coring is performed and drilling fluid (water) is circulated. Appropriate drilling methods will be selected to seat the casing and achieve the objective of separating saturated CCR from bedrock. Rock coring tools will be inserted through the casing and coring will be performed in bedrock to the bottom of the hole. The diameters of drill tooling will be as necessary to facilitate soil sampling, rock coring, and/or temporary well installation.

5.2.1.2 Borehole Logging

The field geologist/engineer will prepare a written or electronic field log for each boring. In addition to describing each recovered soil or rock sample, the log will document boring location, drilling personnel, tooling/equipment used, drilling performance, depth to water, sample number, sample recovery, SPT blow counts, Rock Quality Designation (RQD), and other relevant observations. Soil color will be logged per the appropriate Munsell soil color chart.

Similarly, the field geologist/engineer will prepare a written or electronic installation log for each vibrating wire piezometer or temporary well. The log will document location, materials, depth, depth interval for each backfill material, and surface completion details (protective casing, concrete pad, bollards, etc.).

Field documentation will also be prepared for development and slug testing of each temporary well.

5.2.1.3 Surveying

Once completed, borings will be surveyed for horizontal and vertical control by survey grade GPS. The final survey of each location will be conducted following completion and abandonment of each individual sampling location. The survey data will be added to the final boring logs once available.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. Boring log forms (hard copy or electronic) will be used to document lithologic conditions and field observations at each boring location.

5.2.3.3 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

5.2.4.1 Standard Penetration Test Sampling

The Standard Penetration Test (SPT) samples will provide information for developing the field boring logs/soil profiles, and soil specimens for laboratory natural moisture content and index testing. The SPT sampling will be conducted in accordance with ASTM D 1586 *Standard Method for Penetration Testing and Sampling for Soils*, and consists of dropping a 140-pound hammer from a height of 30 inches, to drive a standard size 2-inch diameter split-spoon sampler to a depth of 18-inches.

In certain cases, larger diameter sampling devices (e.g., 3-inch diameter split-spoon samplers) may be utilized to obtain disturbed samples. Applications of larger samplers may include obtaining larger quantity of material per depth interval or collecting material with larger particles (e.g., gravel too large for SPT sampling). Although similar to an SPT sample, the in-situ penetration resistance is not equivalent to a SPT blowcount (i.e., SPT N-value).

5.2.4.2 Shelby Tube (ST) Sampling

The guidelines for performing ST sampling for geotechnical investigations are found in ASTM D 1587 and United States Army Corps of Engineers (USACE) Engineer Manual EM 1110-1-1804 *Geotechnical Investigations,* Appendix F. The USACE manual is intended as a guide of commonly accepted soil sampling practices and procedures used by geotechnical personnel performing field sampling operations for earthen dams.

5.2.4.3 Rock Core Sampling

Rock coring will be performed in select borings to provide samples that can be visually examined to characterize the rock strata type and structure. Rock coring will be performed in accordance with ASTM D 2113.

5.2.5 Preservation and Handling

5.2.5.1 SPT Samples

SPT samples will be logged and placed in glass jars. Once each jar is filled, the rim and threads will be cleaned, the jar capped, and a label (Section 5.2.5.4) will be applied to the jar. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean before placing the sample container in a box for transport.

5.2.5.2 Shelby Tube Samples

Upon extraction of a ST sample from the boring, the tube will be carefully handled to prevent disturbance. After logging the sample recovery and describing the soil that is visible at the end of the tube, the ends will be labeled (top and bottom), sealed and capped. The top and bottom of each tube will be sealed with molten microcrystalline petroleum wax. Expandable O-ring packers may be used in lieu of wax seals. Plastic caps will be placed at each end of the tube and will be sealed with electrician tape. Each tube will be labeled (Section 5.2.5.4) and stored upright in a rack (Section 5.2.5.5).

5.2.5.3 Rock Core Samples

The recovered rock core specimens will be placed in labeled, wooden core boxes. The core boxes will be protected from the weather and transported to an appropriate on-site or off-site storage facility.

5.2.5.4 Sample Labels and Identification System

Each SPT jar and ST will have a sample label affixed. Sample labels will contain the following information recorded in waterproof, non-erasable ink. Rock core boxes will have similar information written directly on the wooden core box in waterproof, non-erasable ink:

- Project number
- Sample location
- Boring ID number
- Depth of sampling interval
- Date of sample collection
- Sampler's initials

5.2.5.5 Packaging and Shipping

At appropriate intervals, assigned personnel will transport the samples to the testing laboratory or designated storage facility. SPT and other disturbed bulk samples (if any) will be treated as Group B samples as discussed in ASTM D4220.

The Shelby tubes will be stored vertically in padded racks constructed in accordance with ASTM D4220. Based on anticipated weather conditions during sampling operations, care will be taken in the storage of the samples to guard against the samples being exposed to extreme heat or cold. Prior to transport, the tubes will be transferred to a custom box built in accordance with ASTM D4220 guidelines for transporting Group D type soil samples.

Core boxes will be stacked for stable, secure transport to the laboratory, on-site, or off-site storage facility.

5.2.6 Sample Analyses

Select soil samples obtained during the geotechnical investigation will be subjected to geotechnical laboratory testing. Testing will be assigned to characterize the predominant CCR and soil materials recovered in each boring. The laboratory tests will be performed in accordance with applicable ASTM standard testing procedures.

The laboratory analyses are expected to include natural moisture content determinations (D2216), sieve and hydrometer analyses (D422), specific gravity (D854), and Atterberg Limits (D4318). The results of the testing will be used to assist in subsurface characterization and correlation with existing data. If other tests are found to be necessary, they will also be performed in accordance with applicable ASTM standard testing procedures. The Plant-specific laboratory testing program will be developed based on the recovery and spatial distribution of samples from the drilling and sampling program.

5.2.7 Equipment Decontamination Procedures

Documented decontamination will be performed for drilling equipment, tooling, and instruments in contact with subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Decontamination pads will be constructed for decontamination of large downhole tooling (augers, drill rods, etc.) using a high-pressure washer/steam cleaner.

Decontamination pads will be constructed at locations designated by TVA personnel using poly sheeting with sufficient berms to contain decontamination fluids and prevent potential runoff to uncontrolled areas. Following decontamination, fluids will be disposed of in accordance with Section 5.2.8. Decontamination activities will be performed away from surface water bodies and areas of potential impacts.

Decontamination of non-disposable sampling equipment or instruments can be performed using potable water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instrument (e.g., split spoons, water level meters, pumps for well development, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Soil cuttings
- Rock cuttings
- Drilling mud
- Well development water
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

5.3 DOWNHOLE TESTING IN ROCK

5.3.1 Downhole Geophysics

In proposed borings with rock coring, the following suite of geophysical analyses will be performed (only where specified) to investigate groundwater conditions deeper in the bedrock.

Acoustic Televiewer: This tool generates an image of the borehole wall by transmitting acoustic pulses from a rotating sensor and records the subsequent amplitudes and travel times reflected at the borehole wall giving an unwrapped and continuous image of the borehole and allows for the mapping and evaluation of fractures.

The acoustic televiewer requires a fluid filled borehole as the fluid transmits the acoustic signal and data can only be collected in open borehole sections.

Heat Pulse Flow Meter: This instrument will measure the vertical direction and flow rate of fluids in a borehole. The instrument is lowered to a desired depth, typically above and below a known fracture, at which point a heat grid is released from the instrument into the water.

The travel time of the heat grid to either the sensor above or below is measured and used to calculate a flow rate.

Gamma: Natural gamma (or gamma) logging uses the scintillation properties of certain crystals to detect the presence of gamma radiation from unstable isotopes in the formations adjacent to the well or borehole. In aquifers that are not contaminated by artificial radioisotopes, the most significant naturally-derived radioisotopes that emit gamma radiation are potassium-40 (K40) and daughter products of the uranium and thorium series. It can be used in fluid filled or dry boreholes and is used for lithologic and stratigraphic correlation.

Fluid Resistivity log: Records the electric resistivity of water in the borehole. Changes in fluid resistivity reflect differences in dissolved-solids concentration of water. Fluid-resistivity logs are useful for delineating water-bearing zones and identifying vertical flow in the borehole.

Caliper Log: The caliper arms expand or contract to measure the diameter of the borehole as the probe is pulled up through the borehole. Surface equipment records the measurements transmitted up to the ground surface through the cable attached to the probe. Changes in diameter of the borehole indicate the size and location of fractures or irregularities caused by drilling or lithology. Often the caliper tools are not sensitive enough to detect small but hydraulically important fractures and it may not detect vertical fractures intersected by the borehole, unless one of the caliper arms happens to align with the vertical fracture.

In addition, pH, dissolved oxygen, temperature, and groundwater conductivity will be measured in the pilot holes. The purpose of these measurements is to provide a qualitative profile of changes in these parameters that might indicate the presents of different waters. Logs of these parameters are useful for delineating water-bearing zones and identifying vertical flow in the borehole between zones of differing hydraulic head penetrated by wells. Borehole flow between zones is indicated by changes in values of the parameters as instruments are lowered into and raised from the pilot holes.

5.3.2 Pressure Testing

Upon completion of rock coring and downhole geophysical testing (where specified), targeted pressure testing (packer tests) will be conducted to provide a measure of hydraulic conductivity of bedrock. The intervals to be tested will be selected based on results of the geophysical tests.

TVA proposes that downhole water pressure tests (or field hydraulic conductivity tests) be performed in each rock core boring. These tests work by isolating an identified interval (generally a ten-foot interval) of the borehole with inflatable rubber packers.

Potable water is then pumped into the interval at constant pressure for typically five minutes with volume of water lost being measured using a flow meter. The hydraulic conductivity values are then calculated from the field data using an appropriate formula that may be based on the rate of flow into the formation at each location.

5.4 WELL INSTALLATION AND BACKFILLING

After a boring is advanced to its intended bottom depth, one of the following actions may be taken:

- Backfill the borehole without installing a well or a vibrating wire piezometer.
- Install a vibrating wire piezometer and backfill the borehole around the instrument.
- Install a temporary well and backfill the annular space around the well materials,

In some cases, the lower portion of a borehole may be backfilled, followed by installing a vibrating wire piezometer or temporary well in the upper portion.

If a boring penetrates an engineered component (e.g., low hydraulic conductivity soil layer or vegetative soil layer), these interval(s) will be backfilled such that equivalent or better performance is maintained.

5.4.1 Backfilling Boring without Instrumentation

Borings that do not include instrumentation (i.e., temporary well or vibrating wire piezometer) will generally be backfilled with a bentonite-cement grout. A tremie pipe will be lowered to the bottom of borehole and grout will be injected as the drilling tools are removed, to displace water and cuttings to appropriately seal the boring. Stage grouting is not anticipated due to the modest depths. Backfill grout will use the following mix:

- 30 gallons of water
- 94 lbs. of Portland Cement
- 25 lbs. of Bentonite
- This will produce a mix with a Water: Cement: Bentonite (W: C: B) ratio (by weight) of 2.5: 1.0: 0.3

If highly permeable zones are encountered (e.g., fractured rock), the grout mixture may be thickened. Bentonite pellets may be used to seal a permeable zone before resuming grouting above such a zone.

5.4.2 Temporary Wells

Within the context of the EIP, a temporary well may be used for measuring water levels, as well as obtaining pore water samples for analytical testing. Although constructed in the same way as a monitoring well, a temporary well serves a unique purpose for a limited duration and is thus differentiated in name.

Temporary wells will be installed by qualified drill crews using rotary or sonic drill units working under the direction of a licensed Tennessee driller. Additionally, field supervision will be provided by a Tennessee licensed PG or PE. The PG or PE will have suitable experience in geotechnical or geological engineering projects to support the work. This approach has been used at current investigations at other TVA Plants in Tennessee.

Temporary wells will be installed in accordance with TVA TI ENV-TI-05.80.25, *Monitoring Well and Piezometer Installation and Development*. Exact depth/location of each screen will be determined based on as-drilled conditions. A temporary well installation record will be drafted for each well and will include notes and details of the installation procedures.

5.4.2.1 Materials and Installation

The temporary wells will be installed using current industry and regulatory protocols to reduce potential for introducing contaminants during the drilling and installation process. Decontamination processes will be in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*. These procedures include, in part, decontamination of the drilling equipment and tools before and after each well by washing with hot, potable water delivered under high pressure, using new well screen and riser that have been cleaned and sealed in plastic at the factory, and placing washed filter pack sand that is certified by NSF International. Other steps employed during the installations include the workers donning clean, nitrile gloves during the handling of downhole equipment and well materials, and using potable water for grouting purposes.

A temporary well will consist of a four-inch diameter Schedule 40 PVC well screen (0.010-inch slots) and riser. The screen and riser will consist of flush-joint, threaded PVC pipe. The screen length will be selected based on the results of the boring and the target stratum, but will not be longer than 10 feet. A pre-packed well screen may be used. A four-inch diameter Schedule 40 PVC bottom well plug measuring approximately six inches in length will be threaded onto the bottom of the screen. The PVC riser will extend above (2.5 feet minimum) the ground surface and will be capped with a temporary plug or slip cap.

The annular space will be backfilled with a sand filter pack (20/40 mesh) extending a minimum of two feet above and six inches below the screen. A minimum two-foot thick bentonite pellet seal will be placed on top of the sand filter pack. After the bentonite pellet seal has sufficiently hydrated, (minimum of 8 hours of hydration time when using cement grouts above the seal), the remaining annular space will be backfilled with a non-shrink, bentonite-cement grout.

It should be noted that the bentonite-cement grout, sand filter zones, and bentonite pellets will be placed by tremie method through one-inch diameter PVC pipe. The bentonite-cement grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process.

If vibrating wire piezometers became necessary, one or more transducers (at multiple depths, if needed) can be installed in a boring and grouted in-place. These grouted in-place piezometers (GIPPs) will be attached to a sacrificial one-diameter PVC pipe. The boring will be backfilled using the bentonite-cement grout described previously, placed by the tremie method.

If the well is not to be installed at the bottom of the borehole, the lower portion of the hole will be backfilled with bentonite-cement grout or bentonite pellets. After the grout cures enough to support the weight of the overlying well materials and backfill, the well can be installed above the grouted zone.

Subsequent wellhead construction will consist of an above-grade, steel locking protective cover anchored to a concrete surface pad. The protective cover will extend above the concrete pad and the annular space will be filled with sand or pea gravel to about six-inches below the top of PVC casing. Steel protective bollards filled with concrete will be installed near each corner of the concrete pad. If the installation is only expected to be used for a relatively short duration and it is located in an area of little vehicular activity (i.e., low risk of damage), the surface protection may be modified to allow for easier removal when the instrument is no longer needed. The top of each well casing will be surveyed and correlated to the vertical datum used by the Plant.

An example installation log is shown in Figure 3. A drawing of the wellhead construction is shown in Figure 4.

5.4.2.2 Well Development

Each new well will be developed by a combination of bailing, surging, and pumping after a minimum of 24 hours following completion. Equipment will be decontaminated per TVA TI ENV-TI-05.80.05. First, a bailer will be lowered and raised within the screened intervals to create a slight surging action to dislodge particles within the wells and sand filter packs. A baseline reading of turbidity, pH, temperature, and specific conductance will be measured using a properly calibrated Oakton® turbidity and PCSTestr 35 water testing meters (or equivalents). If the well contains heavy sediment, further bailing will be performed before continuation of development with surge blocks and submersible pumps.

A surge block will be used within the screened interval to move water and particles through the screen and sand filter packs. This process may be repeated several times to decrease the water turbidity within the wells.

Lastly, a submersible pump will be employed to further develop the wells until an acceptable level of turbidity is achieved. Target turbidity value of less than or equal to ten (10) Nephelometric turbidity units (NTUs) will be utilized for temporary wells per TVA TI ENV-TI-05.80.42. If the target turbidity value cannot practically be achieved, well development will be conducted according to the requirements listed in TVA TI ENV-TI-05.80.25, *Monitoring Well and Piezometer Installation and Development*.

5.4.2.3 Slug Testing

After development, TVA will perform a slug test in each temporary well to measure hydraulic conductivity. Equipment will be decontaminated per TVA TI ENV-TI-05.80.05. The slug tests will be performed in accordance with ASTM D 4044, *Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*. A pressure transducer with a data recorder will be used to collect water level information from the wells.

As part of the slug testing, each well will be tested by taking an initial measurement of the static water level followed by the insertion of the pressure transducer into the well. After the transducer has been installed and the water level stabilizes, a solid slug (e.g., PVC pipe filled with sand) will be introduced into the well to cause a nearly instantaneous change in the water level. The water levels will then be recorded at regular intervals until reaching near static levels. After reaching static levels, the test will be terminated and a second slug test will be conducted by instantaneously removing the slug and monitoring water levels until static levels are reached again. The results will be recorded electronically and downloaded into a data collector. Raw data will be checked in the field for discrepancies prior to demobilizing from the Plant.

The field data, once collected and returned to the office, will be reduced using a software program to estimate the hydraulic conductivity of the in-situ soils.

5.4.3 Monitoring and Sampling

Monitoring and/or sampling of temporary wells is not addressed in this SAP. Refer to the CCR Material Characteristics SAP.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to Exploratory Drilling.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

The accuracy of the drilling, temporary well installation and slug testing processes must be maintained throughout the investigation. In addition, planned drilling and installation methods must be confirmed during field activities to provide confidence that porewater samples and water level measurements collected as part of other SAPs provide representative analytical results and data.

Field personnel will be responsible for performing checks to confirm that the SAP has been followed. This consists of the completion of applicable field forms and documentation of field activities.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 3. Preliminary Schedule for Exploratory Drilling SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Exploratory Drilling SAP Submittal		Completed
Prepare for Field Activities	20 Days	Following EIP Approval
Conduct Field Activities	80 Days	Following Field Preparation
Laboratory Analysis	40 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Assessment of suitability of areas and access to borings, including clearing and grubbing, will be completed prior to the exploration start date.
- Sampling methods and field locations may be adjusted based on actual field conditions. Changes made in the field will be reported in the Environmental Assessment Report (EAR) as appropriate.
- Well screen and riser pipe dimensions may be adjusted based on actual field conditions and sampling needs. Changes made in the field will be reported in the EAR as appropriate.
- Laboratory testing of surplus undisturbed samples assumes that samples are still suitable for testing. Suitability cannot be confirmed until samples are extruded from the tubes and visually evaluated.

9.0 REFERENCES

Geocomp Consulting, Inc. (Geocomp). 2016. "Tennessee Valley Authority, EPA Seismic Assessment, Supplemental Site Exploration, Cumberland Fossil Plant, Stilling Pond (including Retention Pond) and Bottom Ash Pond, Final Report." Prepared for Tennessee Valley Authority. October.

Tennessee Valley Authority (TVA). 2017a. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Monitoring Well and Piezometer Installation and Development." Technical Instruction ENV-TI-05.80.25, Revision 0000. May 8.

Tennessee Valley Authority (TVA). 2017d. "Groundwater Sampling." Technical Instruction ENV-TI-05.80.42, Revision 0001. March 31.

United States Army Corps of Engineers (USACE). 2001. "Geotechnical Investigations." EM 1110-1-1804. January.

ATTACHMENT A
FIGURES

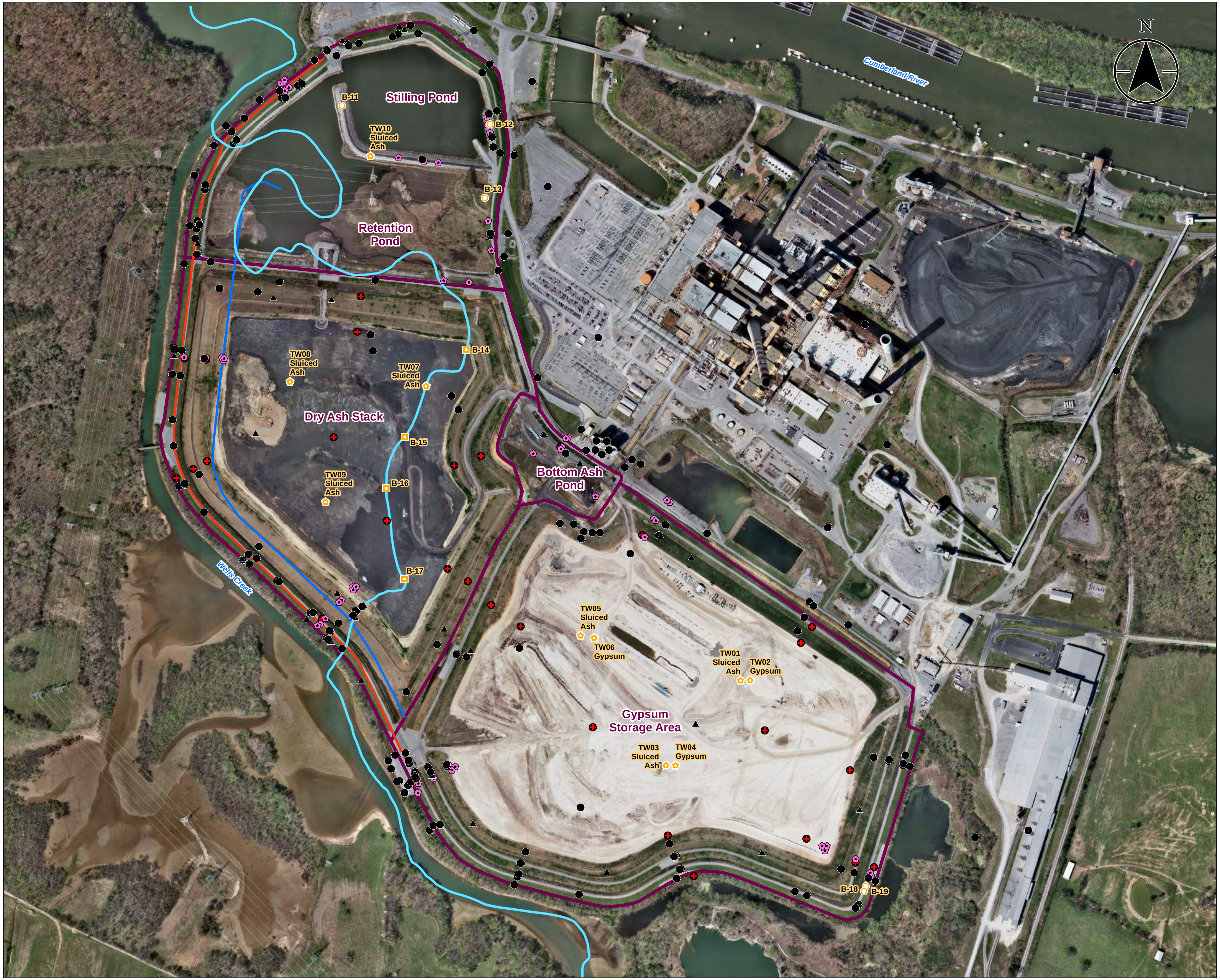


Figure No.
1

Title
Proposed Geotechnical Borings

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
175566329
Stewart County, Tennessee
Prepared by TR on 2018-01-23
Technical Review by JD on 2018-01-23

0 300 600 900 1,200
Feet
1:3,600 (At original document size of 22x34)

Legend

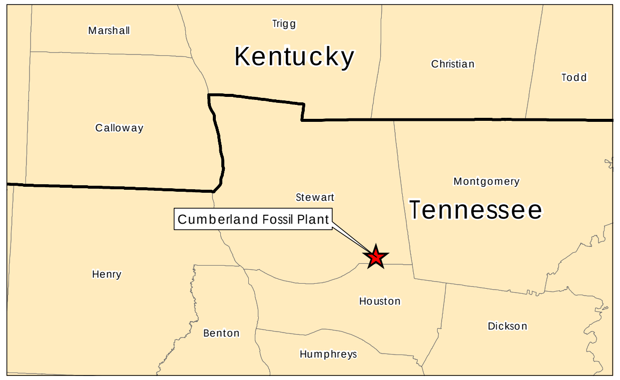
- Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, Geotechnical Data)(Screened Interval)
- Boring (Geotechnical Data)
- Boring with Piezometer Vibrating Wire
- Existing Boring
- Existing CPT

Proposed Boring Locations for Other Ongoing TVA Projects

- Seismic Stability Evaluation Boring or CCR Rule Boring
- Proposed Closure Instrumentation Boring
- Historical Wells Creek Alignment (Approximate)
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Geotechnical data includes CCR thickness, clay foundation soil thickness, top of rock elevation, and rock coring (RQD).



Stantec

TVA

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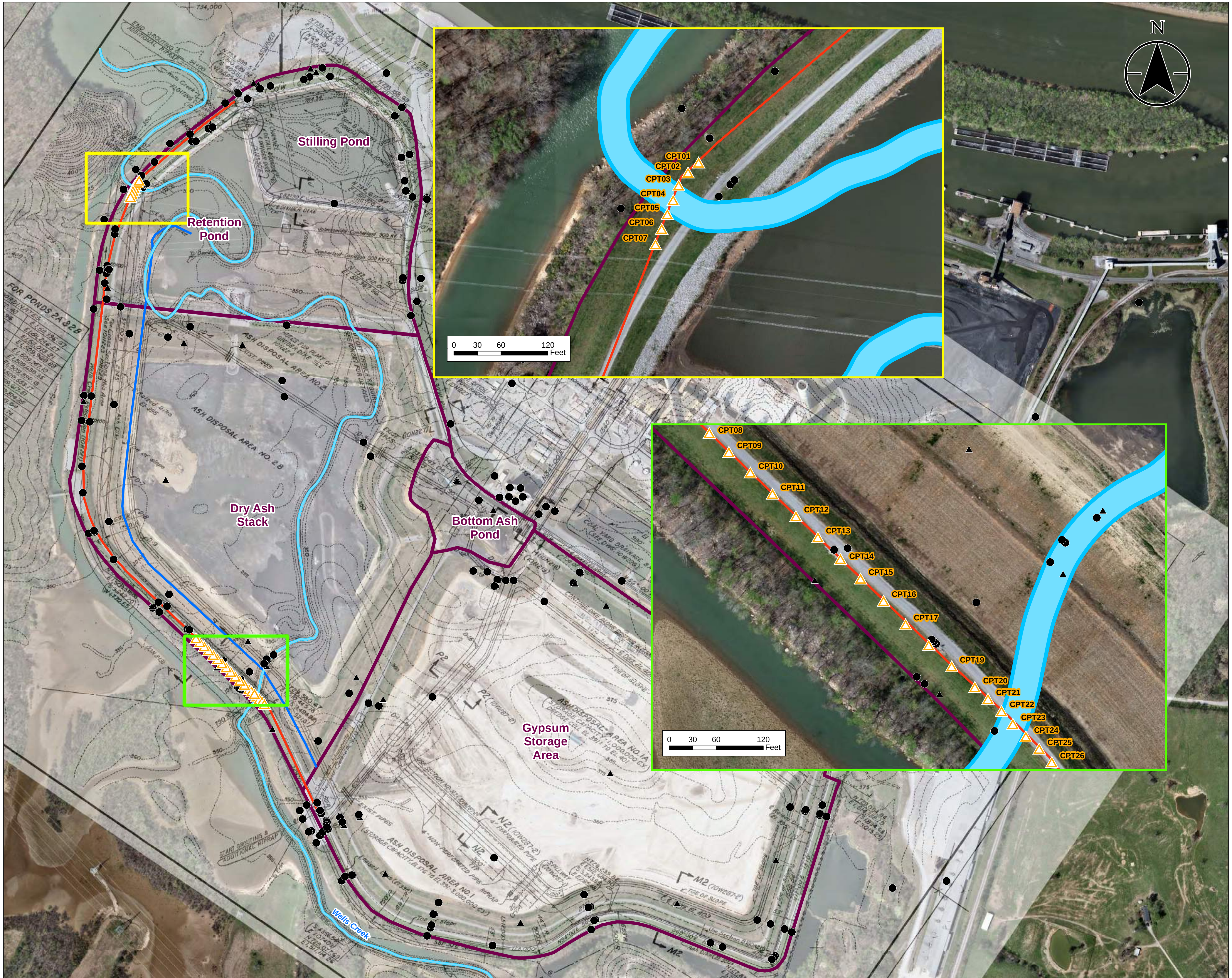


Figure No.
2

Title
Proposed Cone Penetration Testing

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

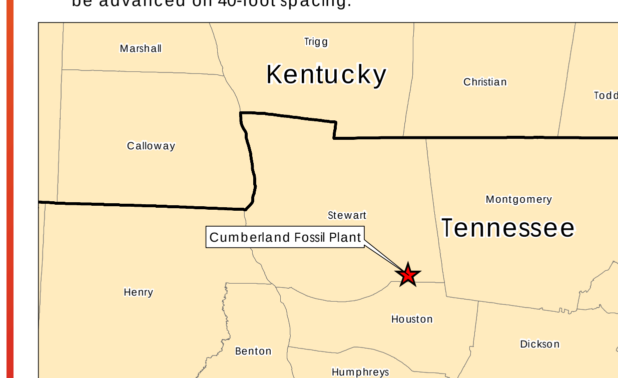
175566329
Prepared by TR on 2018-01-22
Technical Review by JD on 2018-01-22

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Existing Boring
- Existing CPT
- Historical Wells Creek Alignment (Approximate)
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Historical TVA Drawing 10N212R11 (1991) is shown
4. Based on historical mapping, Wells Creek is approximately 40 feet wide. Within 60 feet of the historical Wells Creek centerline, CPT borings will be advanced on 20-foot spacing. Outside of this window, CPT borings will be advanced on 40-foot spacing.



Stantec TVA

U:\TVA-EP\175566329\gis\mxds\REV31000_CUF_Proposed_ConePenetration_Testing.mxd Revised: 2018-01-22 By: mbough

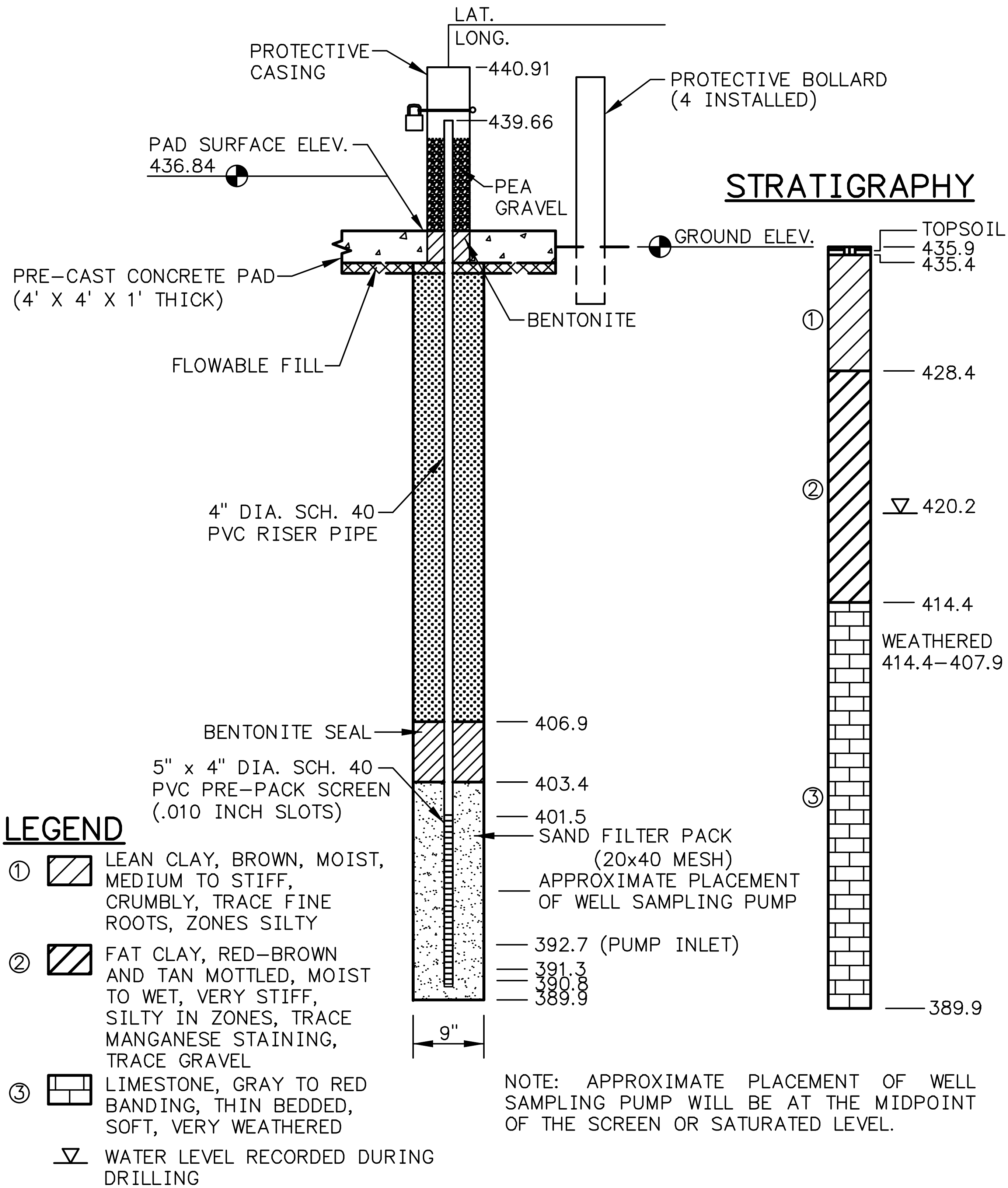
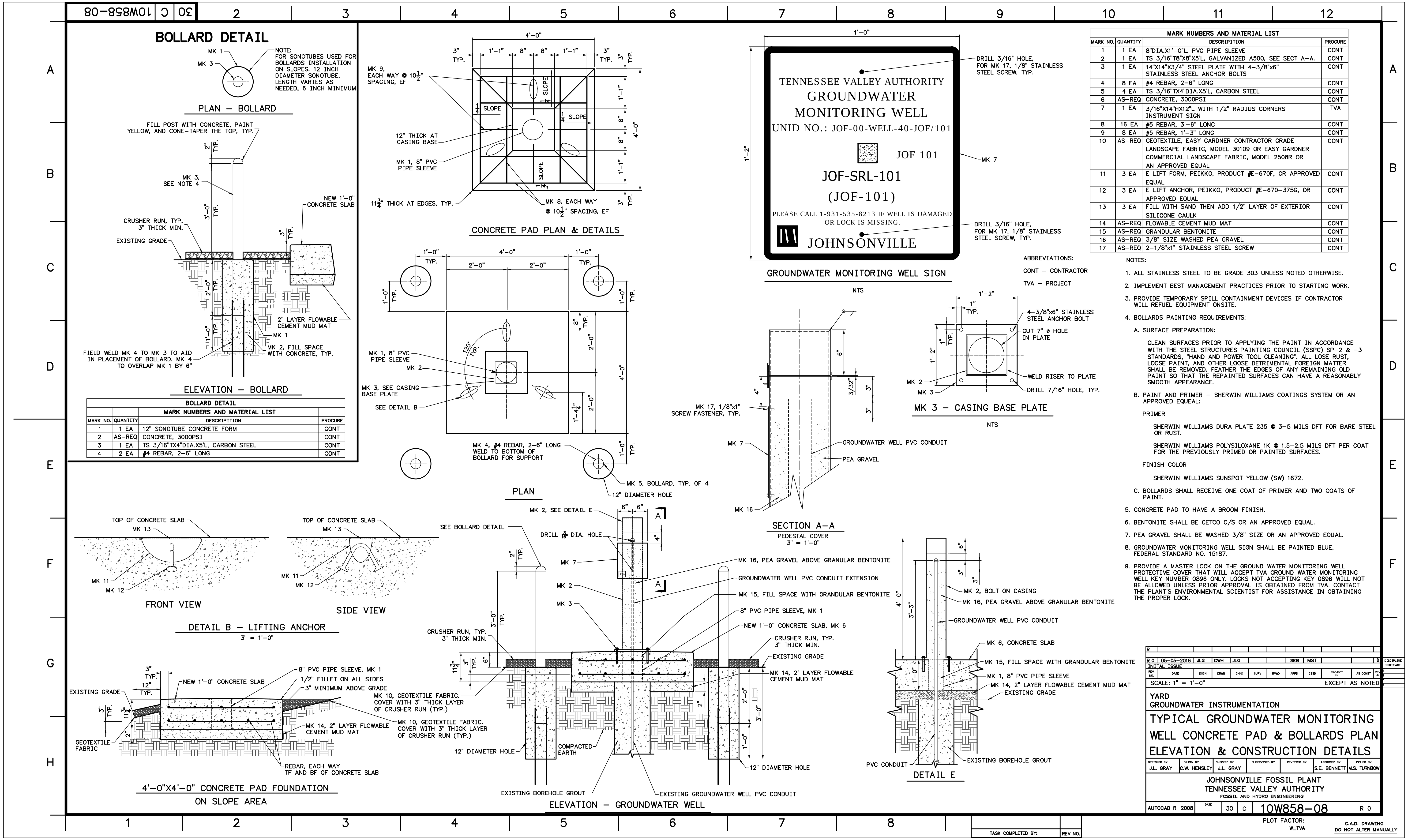


Figure 3. Temporary Well Installation Schematic



BOLLARD DETAIL			
		MARK NUMBERS AND MATERIAL LIST	
MARK NO.	QUANTITY	DESCRIPITION	PROCURE
1	1 EA	12" SONOTUBE CONCRETE FORM	CONT
2	AS-REQ	CONCRETE, 3000PSI	CONT
3	1 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
4	2 EA	#4 REBAR, 2-6" LONG	CONT

MARK NUMBERS AND MATERIAL LIST			
MARK NO.	QUANTITY	DESCRIPITION	PROCURE
1	1 EA	8"DIA.X1'-0"L. PVC PIPE SLEEVE	CONT
2	1 EA	TS 3/16"T8"X8"X5'L, GALVANIZED A500, SEE SECT A-A.	CONT
3	1 EA	14"X14"X3/4" STEEL PLATE WITH 4-3/8"x6" STAINLESS STEEL ANCHOR BOLTS	CONT
4	8 EA	#4 REBAR, 2-6" LONG	CONT
5	4 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
6	AS-REQ	CONCRETE, 3000PSI	CONT
7	1 EA	3/16"X14"HX12"L WITH 1/2" RADIUS CORNERS INSTRUMENT SIGN	TVA
8	16 EA	#5 REBAR, 3'-6" LONG	CONT
9	8 EA	#5 REBAR, 1'-3" LONG	CONT
10	AS-REQ	GEOTEXTILE, EASY GARDNER CONTRACTOR GRADE LANDSCAPE FABRIC, MODEL 30109 OR EASY GARDNER COMMERCIAL LANDSCAPE FABRIC, MODEL 2508R OR AN APPROVED EQUAL	CONT
11	3 EA	E LIFT FORM, PEIKKO, PRODUCT #E-670F, OR APPROVED EQUAL	CONT
12	3 EA	E LIFT ANCHOR, PEIKKO, PRODUCT #E-670-375G, OR APPROVED EQUAL	CONT
13	3 EA	FILL WITH SAND THEN ADD 1/2" LAYER OF EXTERIOR SILICONE CAULK	CONT
14	AS-REQ	FLOWABLE CEMENT MUD MAT	CONT
15	AS-REQ	GRANDULAR BENTONITE	CONT
16	AS-REQ	3/8" SIZE WASHED PEA GRAVEL	CONT
17	AS-REQ	2-1/8"x1" STAINLESS STEEL SCREW	CONT

NOTES:

1. ALL STAINLESS STEEL TO BE GRADE 303 UNLESS NOTED OTHERWISE.
2. IMPLEMENT BEST MANAGEMENT PRACTICES PRIOR TO STARTING WORK.
3. PROVIDE TEMPORARY SPILL CONTAINMENT DEVICES IF CONTRACTOR WILL REFUEL EQUIPMENT ONSITE.
4. BOLLARDS PAINTING REQUIREMENTS:
   A. SURFACE PREPARATION:
      CLEAN SURFACES PRIOR TO APPLYING THE PAINT IN ACCORDANCE WITH THE STEEL STRUCTURES PAINTING COUNCIL (SSPC) SP-2 & -3 STANDARDS, "HAND AND POWER TOOL CLEANING". ALL LOSE RUST, LOOSE PAINT, AND OTHER LOOSE DETRIMENTAL FOREIGN MATTER SHALL BE REMOVED. FEATHER THE EDGES OF ANY REMAINING OLD PAINT SO THAT THE REPAINTED SURFACES CAN HAVE A REASONABLY SMOOTH APPEARANCE.
   B. PAINT AND PRIMER – SHERWIN WILLIAMS COATINGS SYSTEM OR AN APPROVED EQUEAL:
      PRIMER
      SHERWIN WILLIAMS DURA PLATE 235 @ 3-5 MILS DFT FOR BARE STEEL OR RUST.
      SHERWIN WILLIAMS POLYSILOXANE 1K @ 1.5-2.5 MILS DFT PER COAT FOR THE PREVIOUSLY PRIMED OR PAINTED SURFACES.
      FINISH COLOR
      SHERWIN WILLIAMS SUNSPOT YELLOW (SW) 1672.
   C. BOLLARDS SHALL RECEIVE ONE COAT OF PRIMER AND TWO COATS OF PAINT.
5. CONCRETE PAD TO HAVE A BROOM FINISH.
6. BENTONITE SHALL BE CETCO C/S OR AN APPROVED EQUAL.
7. PEA GRAVEL SHALL BE WASHED 3/8" SIZE OR AN APPROVED EQUAL.
8. GROUNDWATER MONITORING WELL SIGN SHALL BE PAINTED BLUE, FEDERAL STANDARD NO. 15187.
9. PROVIDE A MASTER LOCK ON THE GROUND WATER MONITORING WELL PROTECTIVE COVER THAT WILL ACCEPT TVA GROUND WATER MONITORING WELL KEY NUMBER 0896 ONLY. LOCKS NOT ACCEPTING KEY 0896 WILL NOT BE ALLOWED UNLESS PRIOR APPROVAL IS OBTAINED FROM TVA. CONTACT THE PLANT'S ENVIRONMENTAL SCIENTIST FOR ASSISTANCE IN OBTAINING THE PROPER LOCK.

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R 0	05-05-2016	JLG	CWH	JLG			SEB	MST			D
INITAL ISSUE											

SCALE: 1" = 1'-0" EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

TYPICAL GROUNDWATER MONITORING WELL CONCRETE PAD & BOLLARDS PLAN ELEVATION & CONSTRUCTION DETAILS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	C.W. HENSLEY	J.L. GRAY			S.E. BENNETT	M.S. TURNBOW

JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2008 | DATE | 30 | C | 10W858-08 | R 0

PLOT FACTOR: W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.

Figure 4. Typical Temporary Well Construction Details

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Exploratory Drilling

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Cone penetrometer testing assembly
Hollow stem augers
Split-spoon sampler and associated rods
Shelby tube sampler
[1]Drilling Rig and associated equipment
Water pump and water tank
Core barrel
Tremie pipe
Cement
Bentonite
Piezometer screen
Sand
Piezometer standpipe
Water level indicator meter
Well pump (purging well) and tubing
Hand tools (e.g. wrench, hammer, etc.)
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Drilling rig equipment will be selected based on site conditions, selected by the Drilling Contractor, and approved by TVA.

APPENDIX H
MATERIAL QUANTITY SAP

Material Quantity
Sampling and Analysis Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

Material Quantity
Sampling and Analysis Plan
Cumberland Fossil Plant

TITLE AND REVIEW PAGE

Title of Plan: Material Quantity
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ____________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

Melissa G. Hedgecoad
TVA Investigation Project Manager — 6/25/18 Date

TVA Investigation Field Lead — 6/25/18 Date

Health, Safety, and Environmental (HSE) Manager — 6/25/18 Date

Investigation Consultant Project Manager — 06/22/18 Date

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.06.21 16:00:49 -04'00'
QA Oversight Manager — Date

Ryan Jones
Laboratory Project Manager — 06/22/18 Date

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, TVA has developed this Material Quantity Sampling and Analysis Plan (SAP) to answer TDEC's information requests regarding three-dimensional models, CCR material quantity, groundwater elevations, saturation levels, and subsurface conditions with respect to the Stilling Pond (including Retention Pond), Dry Ash Stack, Bottom Ash Pond, and Gypsum Storage Area (Study Area Units) at the CUF Plant (Plant).

2.0 OBJECTIVES

The objectives of this Material Quantity SAP are to describe the methods TVA will use to answer TDEC's information requests regarding CCR unit geometry, CCR material quantity, groundwater elevations, saturation levels, and subsurface conditions with respect to the Study Area. Activities described in this SAP will be completed to:

- Estimate the volume of CCR below and above groundwater
- Estimate the volume of CCR below and above the piezometric level of saturation
- Develop three-dimensional models of the subsurface from ground surface to bedrock and CCR volume estimates for each CCR unit
- Produce drawings specified in TDEC's information requests from the three-dimensional model

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 APPROACH

4.1 EXPLORATORY BORINGS AND TEMPORARY WELLS

4.1.1 Proposed TDEC Order Borings and Temporary Wells

TVA proposes performing cone penetration tests (CPTs) and installing multi-purpose borings and temporary wells at locations shown on Figures 1 and 2 (Attachment A) to supplement existing data related to CCR thickness, piezometric saturation levels, clay foundation (and/or other materials) thickness, and top of bedrock elevations within the interior of the CCR units. A total of 26 CPTs and 19 borings are proposed. To evaluate water levels in saturated material, 10 of the borings will be completed as temporary wells screened in saturated material within the CCR units. Details regarding proposed drilling, sampling, and well installation activities are provided in the Exploratory Drilling SAP. Table 1 summarizes the number of CPTs, borings, and temporary wells proposed in each CCR unit.

Table 1. Summary of Exploratory Drilling Proposed in each CCR Unit

CCR Unit	Total No. of Proposed CPT	Total No. of Proposed Borings	No. of Borings with Temporary Wells	No. of Borings with Vibrating Wire Piezometers	No. of Borings with Rock Coring
Stilling Pond (including Retention Pond)	7	4	1	0	4
Dry Ash Stack	19	7	3	4	7
Gypsum Storage Area	0	8	6	0	5
Total	**26**	**19**	**10**	**4**	**16**

4.1.2 Proposed Borings for Other Ongoing TVA Projects

As shown on Figure 2, TVA plans to perform approximately 73 additional borings and install up to 175 additional piezometers for other on-going project needs. These borings are planned to:

- Support ongoing seismic stability analyses
- Support the closure design for the Chemical Pond

- Supplement existing instrumentation to continue to monitor phreatic conditions in the CCR units for ongoing routine operations

Many of the proposed borings will receive several nested piezometers within the same boring, at multiple elevations; actual quantities will depend on observed subsurface conditions. The schedule to complete these borings and associated data analysis is not tied to or driven by the TDEC Order objectives or the Environmental Assessment Report (EAR); however, TVA will incorporate data from these borings into the three-dimensional model of the CCR units based on the following conditions:

1. The data meets one or more of the Material Quantity SAP objectives.

2. The data meets criteria in the Evaluation of Existing Geotechnical Data.

3. The schedules for these other ongoing TVA projects align with the TDEC Order schedule.

4.1.3 Data Analysis

Data from the proposed multi-purpose borings will be compared to the existing boring data and pre-construction topographic information available for each CCR unit. If this evaluation indicates different results between information sources for the lower CCR surface elevations, additional borings may be warranted. TVA will communicate with TDEC and discuss / determine if additional data collection is needed to meet the objectives listed in Section 2.0.

4.1.4 Water Level Monitoring

Monthly water level monitoring will be conducted for six months to establish and monitor levels in each CCR unit. TVA proposes using manual readings from temporary wells and open standpipe piezometers and automated readings from existing automated vibrating wire transducer piezometers shown on Figures 2 and 3 to estimate saturation levels in CCR. Details regarding water level monitoring field activities are provided in the CCR Material Characteristics SAP. Following characterization of the Plant and in communication with TDEC, TVA may elect to remove the temporary wells.

4.2 THREE-DIMENSIONAL MODELS

Three-dimensional models of the Study Area Units will be developed to depict subsurface conditions from the ground surface to bedrock using the data summarized below which includes data from the proposed exploratory borings, CPTs, and temporary wells discussed in Section 4.1.

1. The most recent permit drawings will be used to model the anticipated final elevations of the Dry Ash Stack and Gypsum Storage Area.

2. Ground and aerial survey data will be used with record drawings to model features such as a soil cap and riprap layers.

3. TVA surveyed slopes, embankments, and benches to develop stability cross-sections. TVA will use this topographic data with the most recent aerial survey data to model the geometry of the dikes and benches.

4. Contour data from the most recent aerial and hydrographic surveys will be used to model the upper CCR surface.

5. Pre-construction topographic information from TVA Drawing 10N212 (see Figure 4) and data from CPTs and borings that penetrated the lower boundary of the CCR surface shown on Figures 1, 2, and 5 will be used to model the lower CCR surface.

6. Data from CPTs and borings that encountered foundation soils shown on Figures 1, 2, and 6, will be used to model the foundation soils underlying the CCR units.

7. Data from borings that encountered top of bedrock shown on Figures 2 and 7 and Electrical Resistivity Imaging (ERI) transects shown on Figure 6 will be used to model the top of bedrock surface.

8. Estimated piezometric levels of saturation discussed in Section 4.1.4 will be incorporated into the models.

9. Groundwater levels estimated as part of the hydrogeological investigation described in the Hydrogeological Investigation SAP will be incorporated into the models.

The three-dimensional model will be generated using software capable of rendering three-dimensional surfaces and calculating volumes such as Autodesk's AutoCAD Civil 3D or ArcGIS. Environmental Visualization Software (EVS) may also be used to visualize the three-dimensional model of the CCR units.

Regarding the information request for the top of bedrock surface, the geologic setting at the Plant is unique due to its location in the Wells Creek Structure, a meteor impact zone. The structural geology of this vicinity is well documented and high quality geologic mapping is available, including Wilson and Stearns (1968) and Ford, Orchiston and Clendening (2012), among others. Figure 7 shows the existing borings with top of bedrock elevations, superimposed on the geologic map from Wilson and Stearns (1968). As expected, the bedrock beneath the Plant is highly irregular, with many mapped faults/fractures and sharp changes in the bedrock elevation over short horizontal distances. Generating a detailed top of bedrock surface contour map based on borings and/or geophysics will have limitations. However, the available data can be compared with the existing geologic maps to look for unexpected trends. Therefore, the overall intent of characterizing the bedrock surface beneath the Plant will be satisfied.

4.3 DRAWINGS

After the three-dimensional models are finalized, they will be used to produce drawings of the Study Area Units showing the following:

- Estimated final elevation of the Dry Ash Stack and Gypsum Storage Area
- Subsurface material types, properties, elevations, and thickness from the ground surface to top of bedrock
- Correlation of top of bedrock elevations (from borings, etc.) with Plant geologic mapping information
- Top of bedrock contours
- Estimated piezometric saturation levels, contours, and river stage
- Estimated groundwater elevations, contours, and river stage
- Plan view showing areas where CCR is saturated
- Normal/minimum pool elevation (lowest spillway rim elevation) and minimum embankment crest elevation (maximum pool elevation) in Stilling Pond (including Retention Pond)
- Estimated extent of clay foundation between CCR and bedrock and estimated groundwater elevation

4.4 VOLUMETRIC ESTIMATES

The following volumetric estimates will be calculated for each Study Area Unit using three-dimensional modeling software such as Autodesk's AutoCAD Civil 3D or ArcGIS:

- Total volume of CCR in each CCR unit
- Volume of CCR below estimated piezometric saturation levels
- Volume of CCR below estimated groundwater elevations
- Volume of CCR above estimated piezometric saturation levels
- Volume of CCR above estimated groundwater elevations

The total volume of CCR at the Plant will also be estimated. These volumetric estimates will be calculated using two methods to validate the model and results.

5.0 REPORTING AND DELIVERABLES

The EAR will document the field activities from the Investigation. This will include deviations from those procedures, results, and geological and hydrogeological interpretations. The results of the CCR material quantity assessment, including three-dimensional models of the facilities, drawings, and volumetric estimates, will also be incorporated into the EAR.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to this Material Quantity SAP.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

The accuracy of the material quantity analysis procedures must be maintained throughout the investigation. Field and office personnel will be responsible for performing checks to confirm that the SAP has been followed. This consists of the completion of applicable field forms and documentation of field and office activities.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 2. Preliminary Schedule for Material Quantity SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Material Quantity SAP Submittal	-	Completed
Develop models	60 Days	Following EIP Approval
Supplement models with data from proposed TDEC Order multi-purpose borings and temporary wells	30 Days	Following Field Activities
Supplement models with data from proposed borings for other ongoing TVA projects	30 Days	Following Field Activities
Data Analysis and Model Update	30 Days	Following Field Activities
Use model to develop drawings and complete volumetric estimates	90 Days	Following Modeling Activities
Reporting and deliverables	60 Days	Following Analysis Activities

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Inaccuracies in historical data may cause uncertainty in the material quantity analysis. Uncertainty in the material quantity analysis will be evaluated and taken into consideration when determining if sufficient data has been gathered to complete the analysis.

9.0 REFERENCES

Ford, JRH, Orchiston, Wayne, and Clendening, Ron. 2012. The Wells Creek Meteorite Impact and Changing Views on Impact Cratering," Journal of Astronomical History and Heritage, 15 (3), 159-178.

Tennessee Valley Authority (TVA). 1991. Ash Disposal Areas Sheet No. 1. TVA Record Drawing No. 10N212 Rev. 11.

Wilson, C. W. Jr. and Stearns, R. G. 1968. Geology of the Wells Creek Structure, Tennessee. Bulletin 68, Tennessee Division of Geology.

ATTACHMENT A
FIGURES

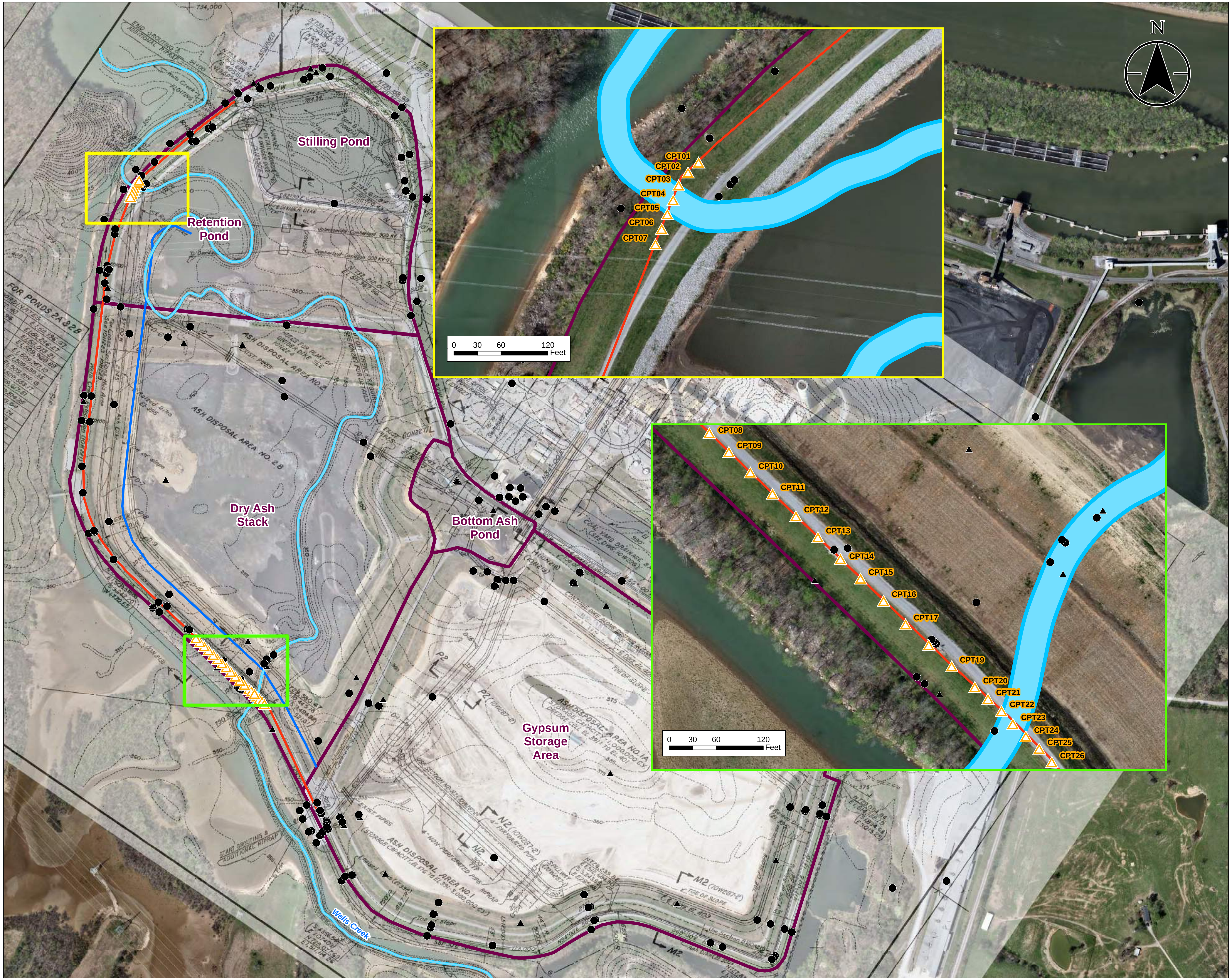


Figure No.
1

Title
Proposed Cone Penetration Testing

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

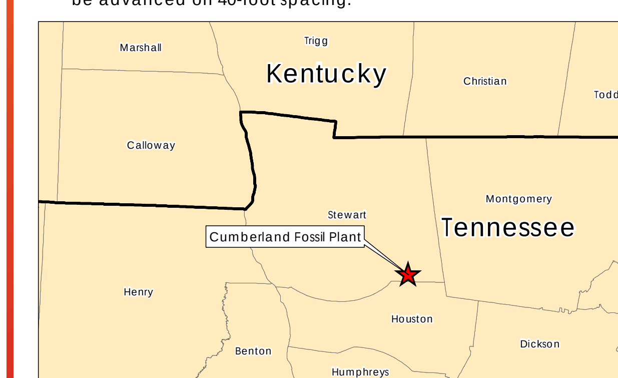
175566329
Prepared by TR on 2018-01-22
Technical Review by JD on 2018-01-22

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Existing Boring
- Existing CPT
- Historical Wells Creek Alignment (Approximate)
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Historical TVA Drawing 10N212R11 (1991) is shown
4. Based on historical mapping, Wells Creek is approximately 40 feet wide. Within 60 feet of the historical Wells Creek centerline, CPT borings will be advanced on 20-foot spacing. Outside of this window, CPT borings will be advanced on 40-foot spacing.



Stantec
TVA

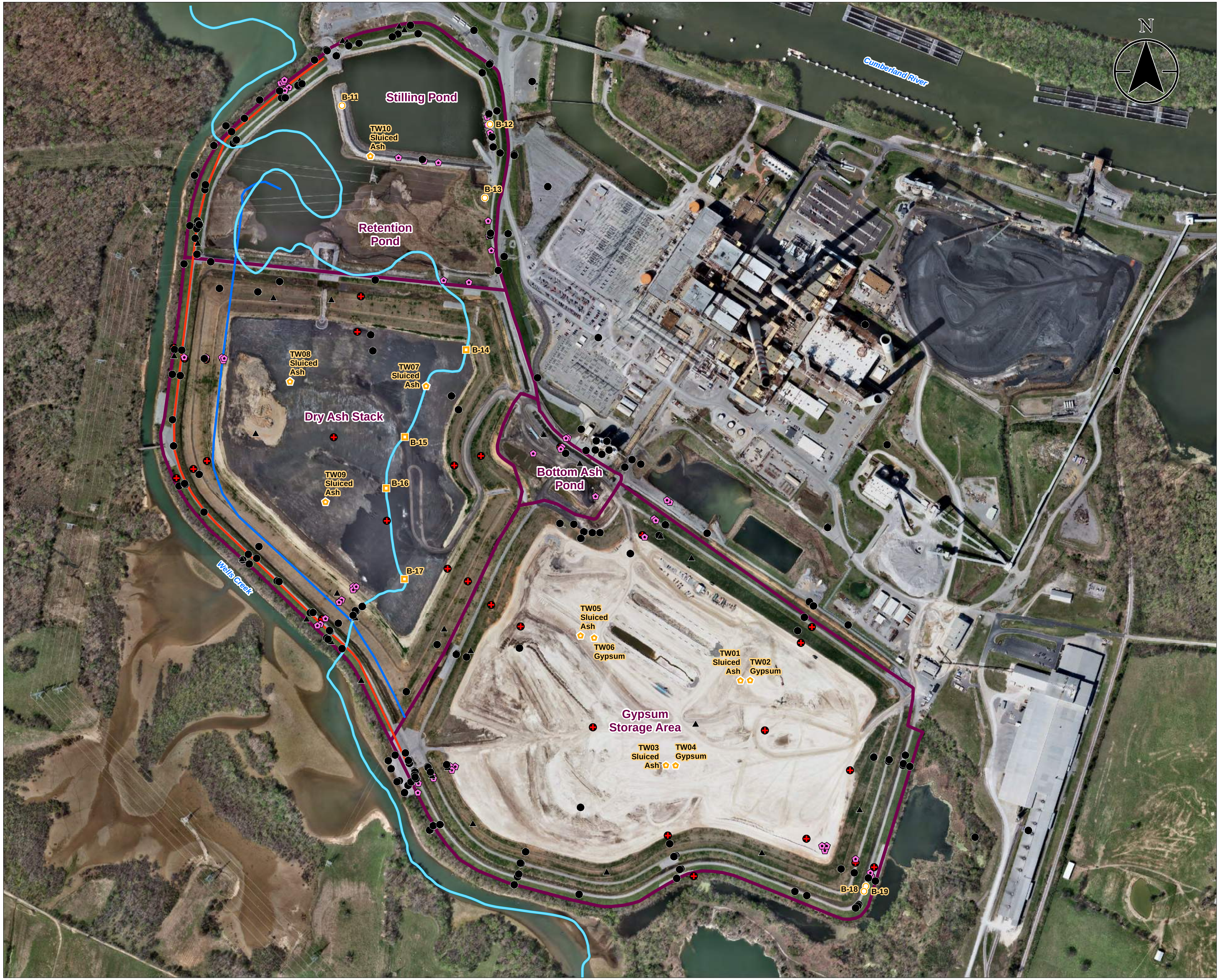


Figure No.
2

Title

Proposed Geotechnical Borings

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

175566329

Stewart County, Tennessee

Prepared by TR on 2018-01-23
Technical Review by JD on 2018-01-23

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

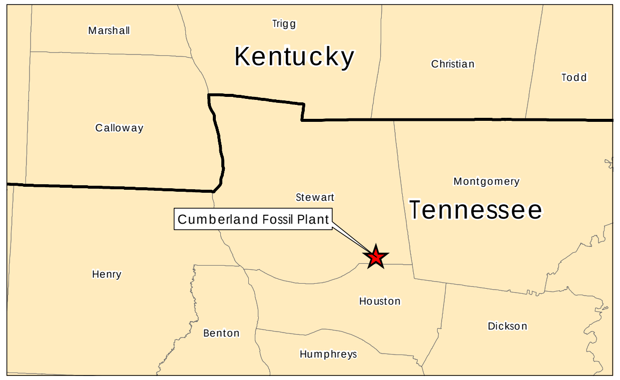
- Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, Geotechnical Data)(Screened Interval)
- Boring (Geotechnical Data)
- Boring with Piezometer Vibrating Wire
- Existing Boring
- Existing CPT

Proposed Boring Locations for Other Ongoing TVA Projects

- Seismic Stability Evaluation Boring or CCR Rule Boring
- Proposed Closure Instrumentation Boring
- Historical Wells Creek Alignment (Approximate)
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Geotechnical data includes CCR thickness, clay foundation soil thickness, top of rock elevation, and rock coring (RQD).



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TVA

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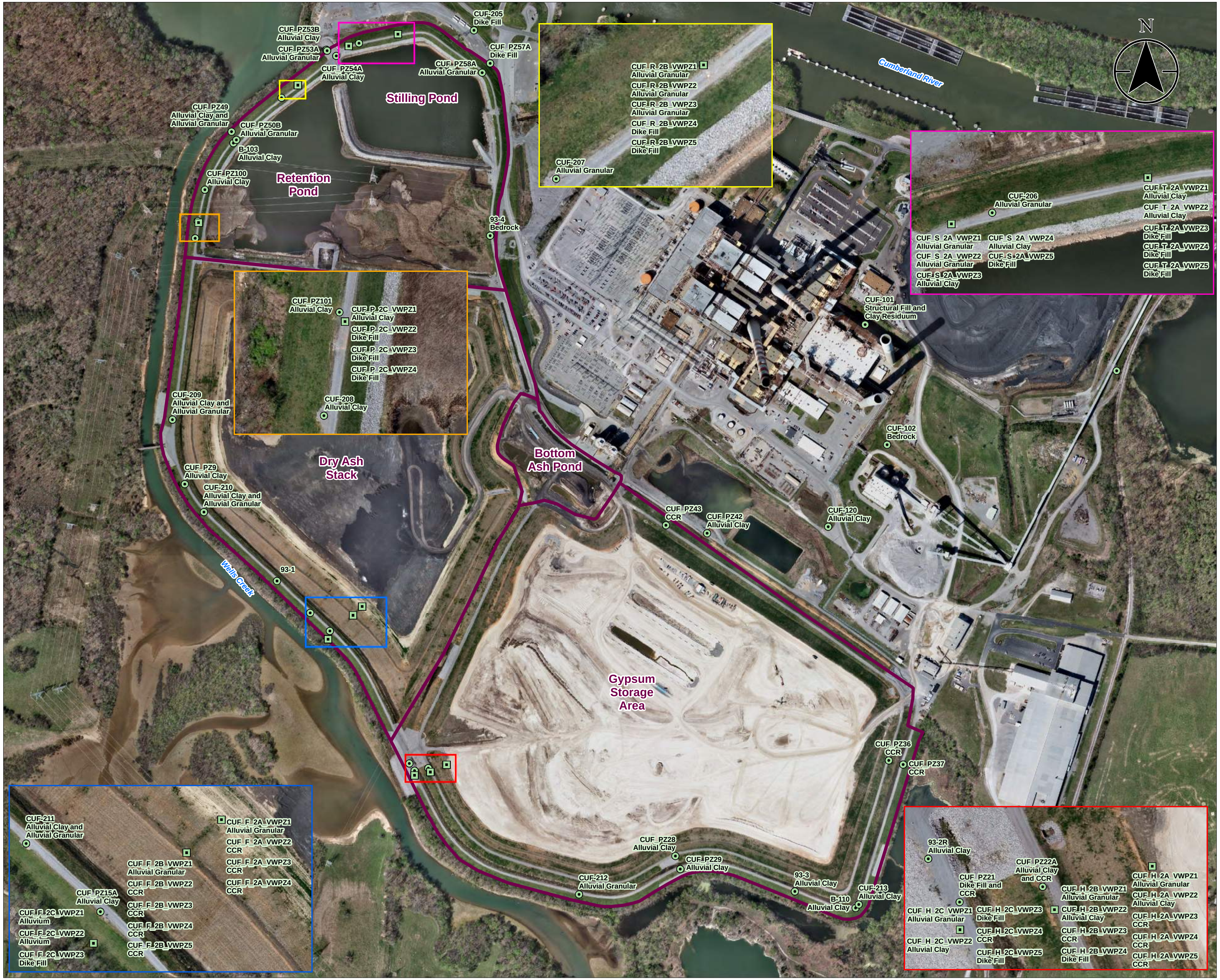


Figure No.
3

Title
Existing Instrumentation

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

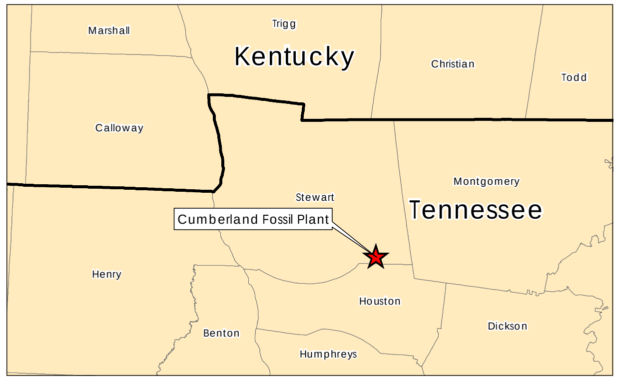
Project Location
175566329
Stewart County, Tennessee
Prepared by TR on 2018-01-22
Technical Review by EM on 2018-01-22

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Active Piezometer Open Standpipe (Screened Interval)
- Active Piezometer Vibrating Wire (Screened Interval)
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

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Figure No.
4

Title

Existing Groundwater Wells

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-13
Technical Review by JD on 2017-10-13

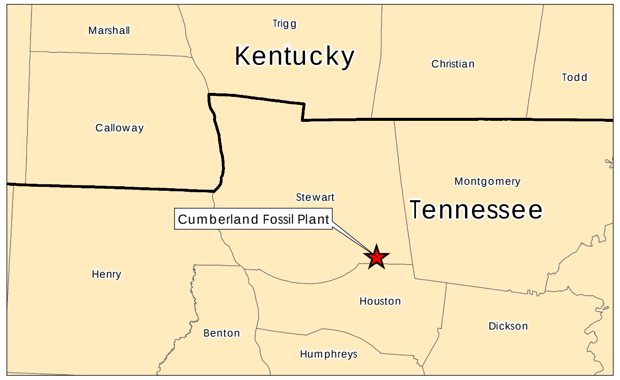
0 400 800 1,200 1,600 Feet

1:4,800 (At original document size of 22x34)

Legend

- Existing Observation Well
- Existing Groundwater Monitoring Well
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Historical TVA Drawing 10N212R11 (1991) is shown



Stantec TVA

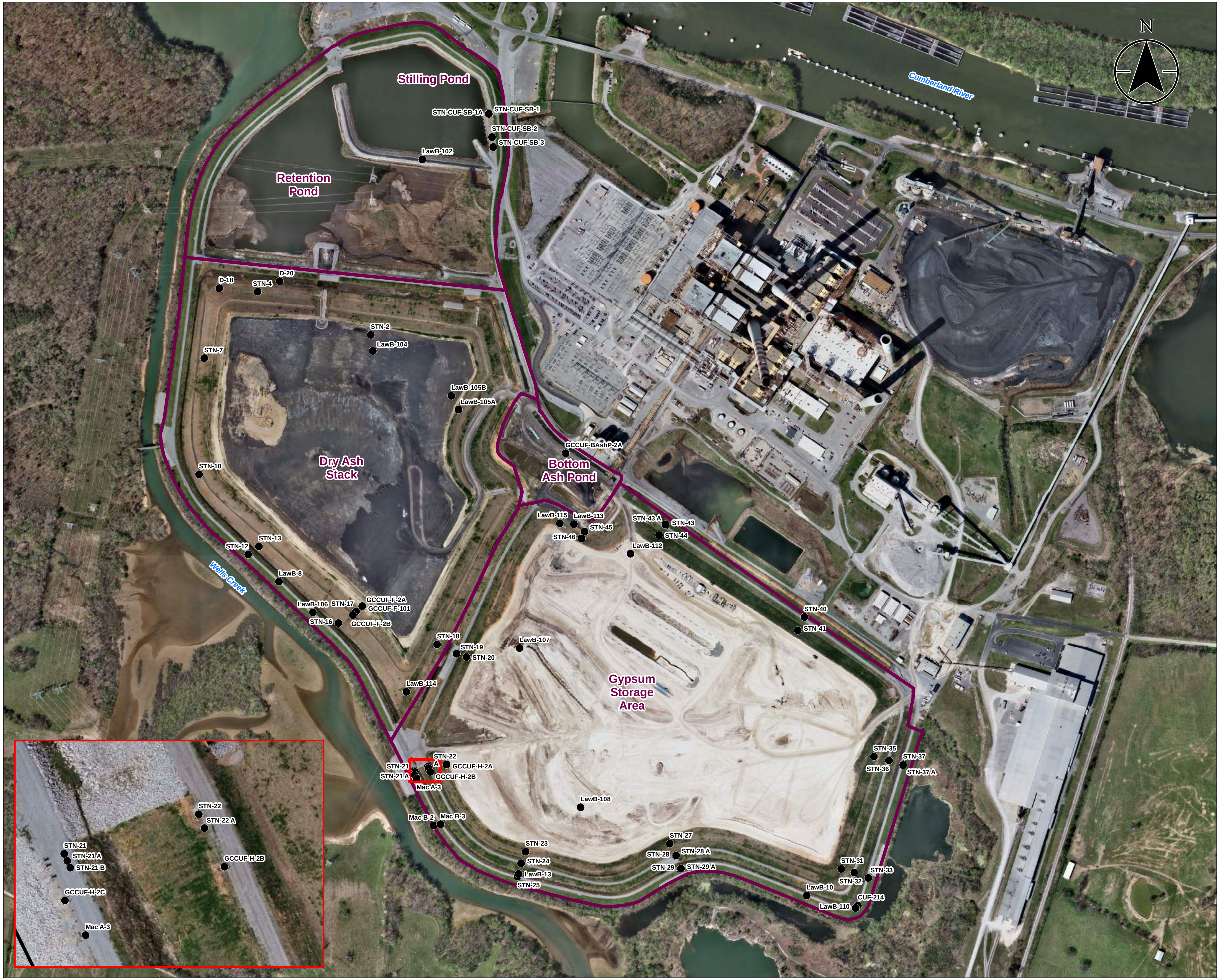


Figure No.
5

Title
Existing CCR Thickness Boring Data

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-13
Technical Review by JD on 2017-10-13

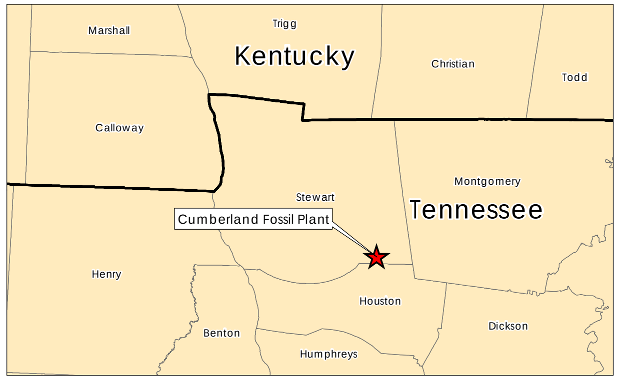
0 300 600 900 1,200
Feet
1:3,600 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



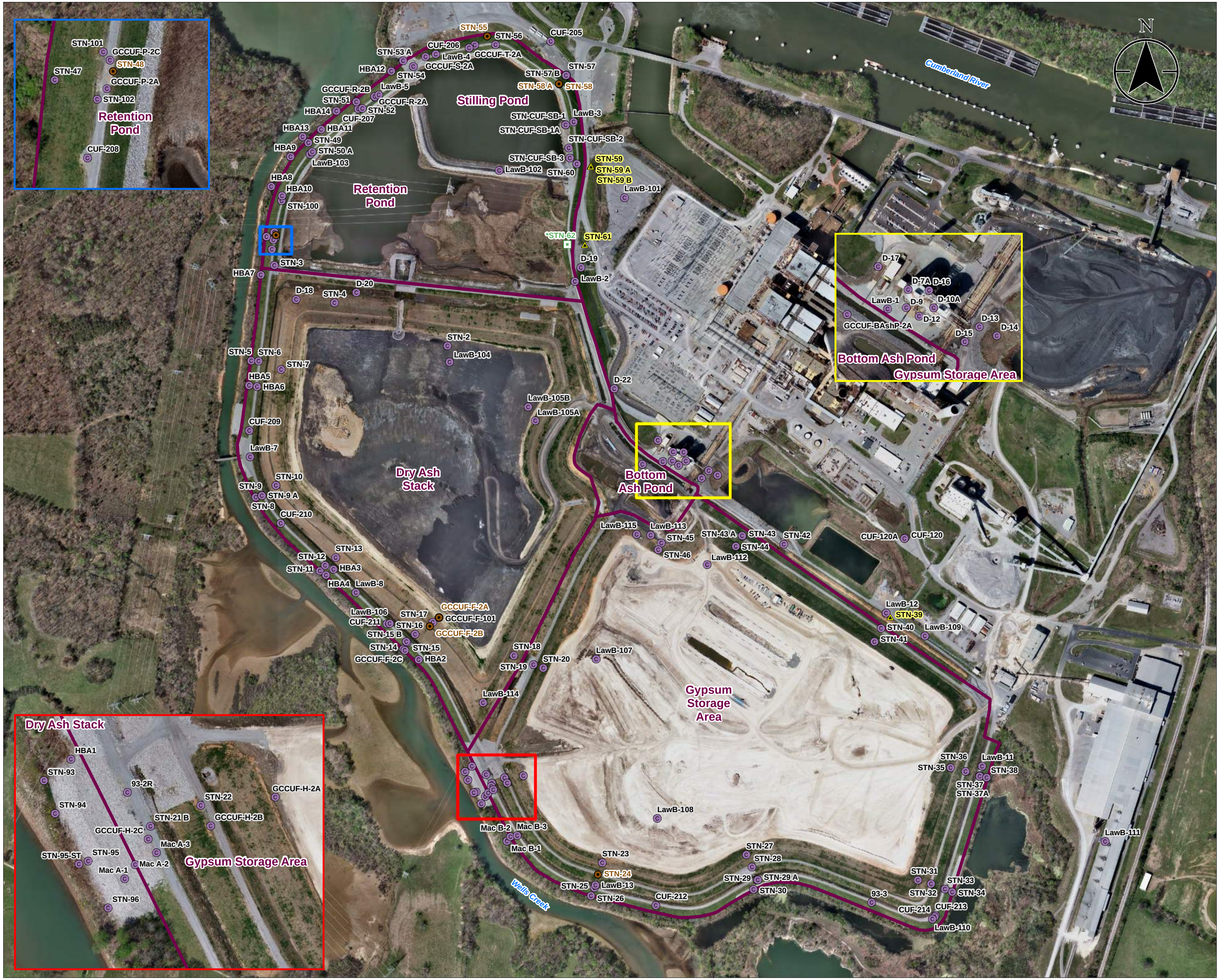


Figure No.

6

Title

Uppermost Foundation Soil Data

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

Stewart County, Tennessee

175566329

Prepared by TR on 2017-11-07
Technical Review by JD on 2017-11-07

0 300 600 900 1,200 Feet

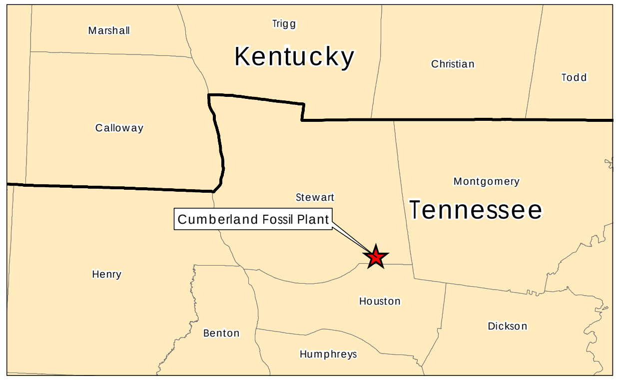
1:3,600 (At original document size of 22x34)

Legend

- Alluvial (Clay)
- Alluvial (Granular)
- Clayey Fill
- Bedrock*
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. * Indicates Constructed Cut-off Trench Extends to Bedrock



Stantec

TVA

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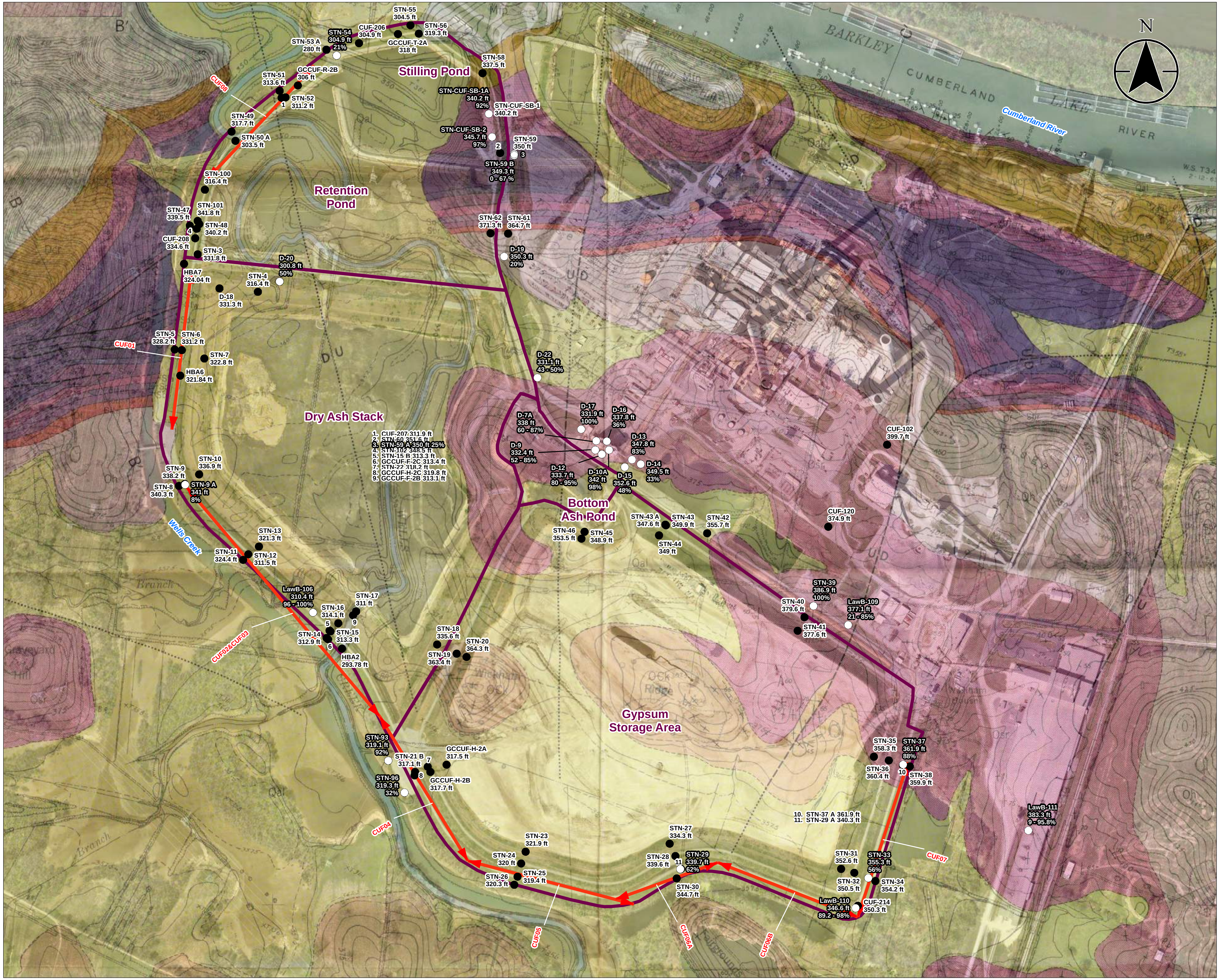


Figure No.
7

Title
Existing Top of Rock Elevation Boring Data

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2017-11-07
Technical Review by JD on 2017-11-07

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

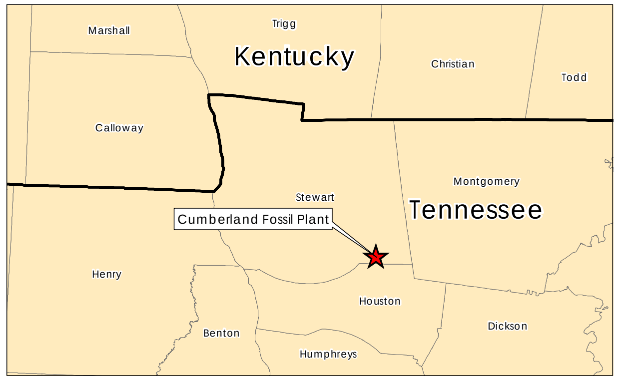
Borings without Rock Core Data [ID & TOR Elevation]

Borings with Rock Core Data [ID, TOR Elevation, RQD]

ERI Transect

CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. RQD value corresponds to upper 20 feet of rock core
4. Geologic map corresponds to Tiedemann, C.W. et al (1968). "Geologic Map of Wells Creek Basin"



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TVA

APPENDIX I
CCR MATERIAL CHARACTERISTICS SAP

CCR Material Characteristics Sampling and Analysis Plan Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

CCR MATERIAL CHARACTERISTICS
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: CCR Material Characteristics
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ______________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	6/25/18 Date
TVA Investigation Field Lead	6/25/18 Date
Health, Safety, and Environmental (HSE) Manager	6/25/18 Date
Investigation Consultant Project Manager	06/25/18 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.06.21 16:01:50 -04'00' QA Oversight Manager	Date
Laboratory Project Manager	06/22/18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

TDEC's comments included a request for a sampling plan to determine the leachability of CCR constituents (listed in 40 CFR Part 257, Appendix III and IV of the CCR Rule) from material in surface impoundments, landfills, and non-registered CCR units at the CUF Plant (Plant). TDEC's comments also included a request for a Pore Water Sampling and Analysis Plan (SAP) for the Plant. The submittal of this CCR Material Characteristics SAP addresses both requests.

2.0 OBJECTIVES

The objective of this CCR Material Characteristics SAP is to characterize the leachability of CCR constituents from material in a CCR unit, in response to the TDEC Order. The approach is to collect and analyze pore water and CCR material from the locations identified in Section 4.0.

This CCR Material Characteristics SAP will provide procedures necessary to conduct the sampling and analysis of pore water and CCR material in the CCR units, and to characterize them for the CCR Parameters list. Proposed activities will include the following major tasks:

- Verify proposed sampling locations using the global positioning system (GPS)
- Develop temporary wells in the ash disposal area (drilling and installation procedures of the temporary wells are outlined in the Exploratory Drilling SAP)
- Collect pore water and CCR material samples from the temporary well locations
- Conduct laboratory testing and analyses

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

The Study Area for this CCR Materials Characteristics SAP consists of the Gypsum Storage Area, the Dry Ash Stack, and the Stilling Pond. Each proposed sampling location in the Study Area will accommodate sampling for pore water and CCR material. Pore water will be collected as filtered and unfiltered samples, while CCR material will be collected as unsaturated and saturated samples (as conditions allow). Ten sample locations were selected based on TDEC's request to characterize the leachability of constituents from the material in each CCR Unit. All samples will be taken from temporary wells placed in the CCR units, which will also be used to determine the water level in those units.

In temporary wells TW02, TW04, and TW06, pore water samples will be taken above the drainage layer in the Gypsum Storage Area, but within the phreatic zone, to characterize the pore water constituents in the stacked gypsum. In temporary wells TW01, TW03 and TW05, pore water samples will be taken below the drainage layer at the base of the unit, in the original sluiced ash, placed there when the Ash Disposal Area was one single unit. In temporary wells TW07, TW08, TW09, and TW10, pore water samples will be taken at the base of the unit in the original sluiced ash.

During construction and installation of the temporary wells (i.e., sampling locations), a CCR material grab sample will be taken from each 5-foot core boring, from the top of the unit to its base. This will result in the collection of CCR material samples from both the phreatic zone (for saturated samples) and non-phreatic zone (for unsaturated samples). Samples shall not be taken from active ponds; they shall only be taken from ponds have been dewatered and stabilized.

A map showing all pore water/CCR material sampling locations is provided as Figure 1 in Attachment A. Installation and construction specifications for the temporary wells are provided in the CUF Exploratory Drilling SAP.

Table 1. Proposed Sample Locations

Sample Location ID	Description
TW01	Gypsum Storage Area – northeastern TW*
TW02	Gypsum Storage Area – northeastern TW
TW03	Gypsum Storage Area - southern TW
TW04	Gypsum Storage Area - southern TW
TW05	Gypsum Storage Area - northwestern TW
TW06	Gypsum Storage Area - northwestern TW
TW07	Dry Ash Stack - northeastern TW
TW08	Dry Ash Stack - northwestern TW
TW09	Dry Ash Stack - southern TW
TW10	Stilling Pond [tentative sample based on status of pond (i.e., dry or wet)]

*Temporary well

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to collect samples, document field activities, and assist in providing scientifically defensible results.

Pore water and CCR material sampling will adhere to applicable EPA and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will conduct the following:

- Designate a Safety Officer
- Complete required health and safety paperwork and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator to ensure that sample bottles and preservatives are ordered, coolers and analyte-free deionized (DI) water are obtained, and sampling and sample arrival dates are communicated to the laboratories
- Obtain required calibrated field instruments, including health and safety equipment, water level meters, and equipment needed for measuring parameters that define stability during well purging
- Discuss project objectives and potential hazards with project personnel
- Complete sample paperwork to the extent possible prior to deploying to the field, including chain-of-custody (COC) forms and sample labels
- Obtain ice prior to sample collection for sample preservation

5.2 SAMPLING METHODS AND PROTOCOL

Sampling and collection methods will be conducted in accordance with applicable TVA Technical Instructions (TIs), including:

- ENV-TI-05.80.02 *Sample Labeling and Custody*
- ENV-TI-05.80.03 *Field Record Keeping*
- ENV-TI-05.80.04 *Field Sampling Quality Control*

- ENV-TI-05.80.05 *Field Sampling Equipment Cleaning and Decontamination*
- ENV-TI-05.80.06 *Handling and Shipping of Samples*
- ENV-TI-05.80.42 *Groundwater Sampling*
- ENV-TI-05.80.44 *Groundwater Level and Well Depth Measurement*
- ENV-TI-05.80.46 *Field Measurement Using A Multiparameter Sonde*

5.2.1 Pore Water and CCR Material Collection and Analysis

Pore water samples will be collected from the phreatic zone at the base of a unit, and above any applicable drainage layer, in order to obtain in-situ leaching information for the material. The analyses of actual pore water samples will provide real-time measurements of any constituents that may be leaching from the material.

Samples of CCR material will be collected from the borings advanced for the temporary wells, constructed specifically to obtain pore water samples, from both saturated and unsaturated zones in the CCR unit. These samples will be analyzed for the parameters described below, after being subjected to the most applicable leaching method based on emerging science in the industry, which could include the Synthetic Precipitation Leaching Procedure (SPLP).

The pore water and CCR material samples will be analyzed for the constituents listed in 40 CFR Part 257, Appendices III and IV, and the five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations) which include copper, nickel, silver, vanadium, and zinc. The combined Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as the "CCR Parameters." Total organic carbon (TOC), iron, and manganese have been added to the CCR Parameters list as specific parameters of interest under this SAP. Sample analyses are described in greater detail in Section 5.2.6.

5.2.1.1 Water Level Measurements

Prior to sampling, each temporary well and staff gauge will be inspected for damage or indications that the well integrity has been compromised. If field observations indicate the need for well or staff gauge maintenance or repairs, the Field Team Leader will notify TVA.

After the temporary well and staff gauge integrity inspection is completed, the water level in each well and at each staff gauge will be measured in relation to a surveyed reference point (e.g., top of well casing) using an electronic water level indicator.

Groundwater elevation data will be measured and recorded in accordance with TVA TI ENV-TI-05.80.44, *Groundwater Level and Well Depth Measurement*. The elevation will be recorded to the nearest 0.01 foot. To the extent possible, the field team will minimize the length of time between collection of the first and last water level measurement for the monitoring well network and staff gauges. At a minimum, measurements will be made within the same day. In addition, barometric pressure readings will be recorded daily. TVA plans to use a multi-parameter sensor equipped with a National Institute of Science & Technology (NIST) certified temperature sensor.

The water level indicator will be decontaminated between each well by following the decontamination procedures provided below in Section 5.2.7.

5.2.1.2 Well Purging

Following the measurement of water levels, monitoring wells will be purged using a dedicated pump for pore water sampling. Purging will continue until field measurements of water quality parameters stabilize during three consecutive readings at 3 to 5 minute intervals per the criteria listed in TVA TI ENV-TI-05.80.42, *Groundwater Sampling*. The stabilization criteria follow:

- pH - ±0.1;
- Specific conductivity - ±5%;
- Dissolved oxygen (DO) - ±10% for > 0.5 mg/L or <0.5 mg/L; and
- Turbidity - below 10 NTUs or ±10% for values above 10 NTUs.

Field measurements, including pH, specific conductivity, turbidity, oxidation/reduction potential, and temperature, will be collected during purging using a flow-through cell. Once the field parameters have stabilized, samples will be collected. For low yield wells, field parameters will be measured at the time of sample collection in an open sample container using a multi-parameter probe. A final turbidity measurement will be made after each sample is collected.

If after 2 hours of purging field parameters have not stabilized, then groundwater samples will be collected and the efforts to stabilize parameters will be recorded in the field log book and field data sheet. A final turbidity measurement will be made after each sample is collected.

Purging beginning and end times, pumping rates, water quality parameter readings, and groundwater levels will be recorded throughout the purging operation on field sampling forms. The total volume purged at each well may vary based on recharge rates and stabilization of water quality parameters.

Low-flow purging techniques will be used to collect a representative sample from the water bearing unit unless the wells do not yield sufficient water. If pump settings are unknown, purging will begin at a minimum pumping rate of 0.1 liter per minute (L/min) and will be slowly increased to a setting that induces little or no drawdown, if possible. Pumping rates will not exceed 0.5 L/min. If drawdown exceeds 0.3 feet, but reaches stability, purging of the well will continue and the current flow rate, drawdown, and time will be recorded on the field data sheet by the sampler.

Low yield wells will be purged until standing water is removed. Groundwater samples will be collected with a low-flow pump, as soon as water levels return to 80% within the well bore, but no later than 24 hours after the well purge.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the Quality Assurance Project Plan (QAPP).

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. Field logbooks will be used to record daily activities, including sample collection and tracking information.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Consultant will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

5.2.4.1 Pore Water Sampling

Pore water sample collection will adhere to TVA TI ENV-TI-05.80.42, *Groundwater Sampling*. The sampling team leader will maintain a project field book and field forms to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

Filtered and unfiltered pore water samples will be collected once from each of the temporary well locations, in appropriate, laboratory provided, pre-preserved sample containers. Samples will be collected directly from the pump discharge line.

A final reading of water quality parameters will be conducted and documented on field sampling forms at the time of sample collection, but these measurements will not be from the sample itself. Unfiltered pore water samples will be collected in appropriate, laboratory provided, pre-preserved sample containers.

The sampler will wear clean latex (or equivalent) gloves when handling sample containers and will not touch the interior of containers or container caps. New gloves will be used when handling each sample. When filling sample bottles, care will be taken to minimize sample aeration (i.e., water will be directed down the inner walls of the sample bottle) and avoid overfilling and diluting preservatives. Each sample bottle will be capped before filling the next bottle.

It will be necessary to collect filtered (dissolved) inorganic constituent samples, in addition to unfiltered (total) inorganic constituent samples. Dissolved sample collection will be accomplished in accordance with TVA TI ENV-TI- 05.80.42.

Issues that could affect the quality of samples will be recorded on the field data sheet or in the log book along with the action(s) taken to resolve the issue. These could include observations such as clogged sampling tubes, highly turbid samples or defective materials or equipment.

5.2.4.2 CCR Material Sampling

Boring advancement through the CCR material to the base of the unit will be in concurrence with the Plant Exploratory Drilling SAP, with CCR material collected using 3-inch diameter split-spoon samplers. Continuous sampling will be conducted until the base of the CCR unit has been reached. Split-spoons will be decontaminated between sampling locations in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*.

Grab samples will be collected at the mid-point of the first unsaturated and saturated sample collected. No composite samples are proposed. Each sample will be collected with a gloved hand, properly decontaminated sample scoop, or certified clean disposable sample scoop. Field samplers will wear a new pair of disposable nitrile gloves while handling each sample. The samples will be placed in a new, re-sealable bag and will be homogenized using a gloved hand or decontaminated sample scoop, certified clean disposable sample scoop and/or by kneading the material through the outside of the bag until the physical appearance is consistent over the entire sample. After homogenization, the sample will be collected from the bag and placed in the appropriate laboratory-supplied sample containers. Each sample will be submitted to the laboratory for analytical testing (refer to Section 5.2.6).

5.2.5 Preservation and Handling

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody*. Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA ENV-TI-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Consultant Project Manager.

5.2.6 Sample Analyses

Pore water and CCR material samples will be submitted to the TVA-approved laboratory for analysis. Pore water samples will consist of filtered and unfiltered samples, and analyzed for the CCR Parameters and additional parameters of interest. CCR material samples (both saturated and unsaturated) will be subjected to the most applicable leaching method based on emerging science in the industry, which could include the Synthetic Precipitation Leaching Procedure (SPLP), prior to an analysis for the CCR Parameters and additional parameters of interest.

All samples will be analyzed for the CCR related constituents listed in Title 40 of the Code of Federal Regulations Part 257 (40 CFR 257), Appendices III and IV. As an Appendix IV constituent, arsenic will be speciated into arsenate and arsenite. In addition, five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the 40 CFR 257 Appendices III and IV, will be analyzed to maintain continuity with TDEC environmental programs. The additional constituents listed in TDEC Appendix 1 include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, are referred to collectively as "CCR Parameters." Total organic carbon (TOC), manganese, and iron will be analyzed as additional parameters of interest.

Tables 2 through 5 summarize the constituents requiring analysis. Analytical methods, preservation requirements, container size, and holding times for each chemical analysis are presented in Table 6. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 2. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids

Table 3. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride

Appendix IV Constituents
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 4. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 5. Additional Parameters of Interest

Parameters of Interest*
Total Organic Carbon (TOC)
Iron
Manganese

* Constituents not included in the CCR Parameters

Table 6. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Radium 226	SW-846 903.0	HNO3 to pH < 2 Cool to <6°C	1 L glass or Plastic	180 days
Radium 228	SW-846 904.0	HNO3 to pH < 2 Cool to <6°C	2 L glass or plastic	180 days
Chloride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Fluoride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Sulfate	SW-846 9056A	Cool to <6°C	125-mL HDPE	28 days
pH	SW-846 9040C (field measurement)	NA	NA	15 minutes
Total Organic Carbon (TOC)	Liquid - SW-846 9060A Solid - SW-846 9060A	H_2SO_4 to pH<2; Cool to <6°C Cool to <6°C	500-mL glass or plastic 50-mL HDPE	28 days 28 days

The pH of groundwater samples will be measured in the field.

5.2.7 Equipment Decontamination Procedures

Documented decontamination will be performed for non-dedicated sampling equipment in contact with groundwater or surface water, and drilling equipment, tooling, and instruments in contact with subsurface materials, in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Pumps dedicated to a specific well do not need to be decontaminated.

Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox ® and/or other appropriate non-phosphatic detergent in 5-gallon buckets. Following decontamination, fluids will be disposed of in accordance with the Section 5.2.8.

Decontamination of sampling equipment and instruments (i.e., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Soil Cuttings
- Purge Water
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to pore water and CCR material sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, Field Sampling Quality Control. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. MS/MSD samples will be collected by filling bottles alternately by thirds in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control* into three sets of identical, laboratory-prepared sample bottles.

Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD. For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of blank per lot.

Field Blanks - One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals, (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to ensure the label is not removed. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 7. Preliminary Schedule for CCR Material Characteristics SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
CCR Material Characteristics SAP Submittal		Completed
Preparations and Coordination for Field Activities	25 Days	Following notice to proceed and installation of temporary wells (outlined in Exploratory Drilling SAP)
Conduct Field Activities	20 Days	Following Field Preparation
Laboratory Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Approved sampling methods and protocols may have to be substituted in the EIP based on changing field conditions.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017a. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017f. "Groundwater Sampling." Technical Instruction ENV-TI-05.80.42, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017g. "Groundwater Level and Well Depth Measurement." Technical Instruction ENV-TI-05.80.44, Revision 0000. March 31

Tennessee Valley Authority (TVA). 2017h. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

ATTACHMENT A
FIGURE

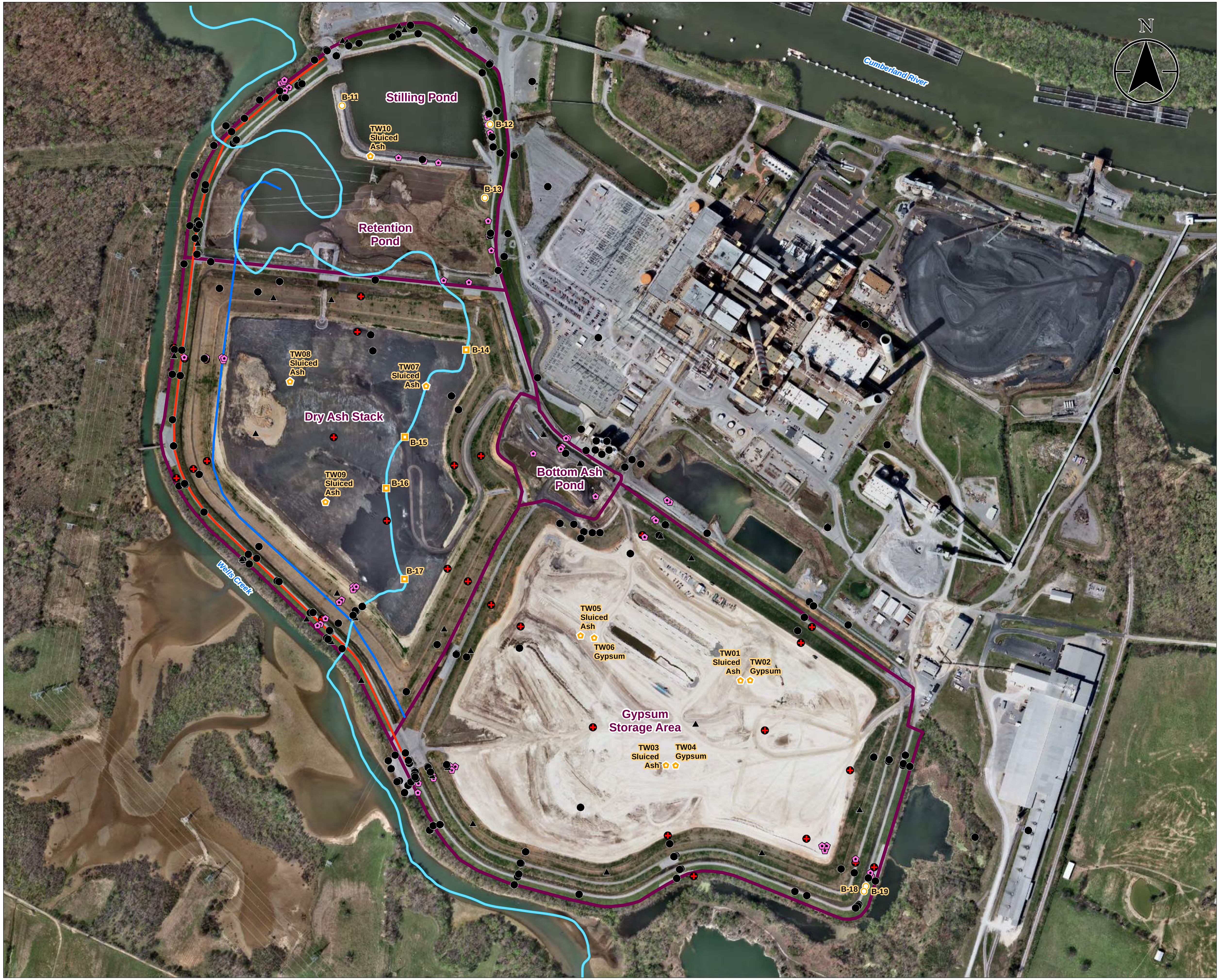


Figure No.

1

Title

Proposed Geotechnical Borings

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

175566329

Stewart County, Tennessee

Prepared by TR on 2018-01-23
Technical Review by JD on 2018-01-23

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

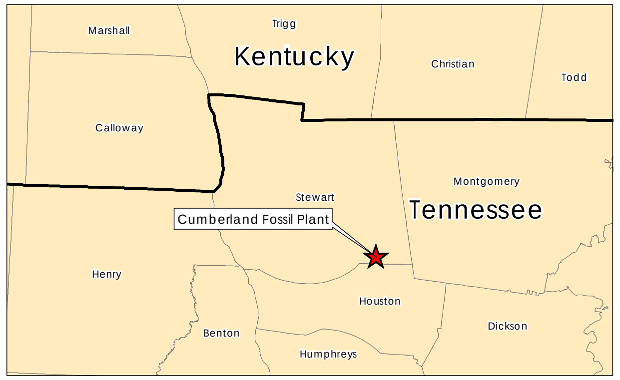
- Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, Geotechnical Data)(Screened Interval)
- Boring (Geotechnical Data)
- Boring with Piezometer Vibrating Wire
- Existing Boring
- Existing CPT

Proposed Boring Locations for Other Ongoing TVA Projects

- Seismic Stability Evaluation Boring or CCR Rule Boring
- Proposed Closure Instrumentation Boring
- Historical Wells Creek Alignment (Approximate)
- 1990's Perimeter Dike and Foundation Soil Grouting Alignment (Approximate)
- 1980's Interior Bottom Ash Dike (Approximate)
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)
3. Geotechnical data includes CCR thickness, clay foundation soil thickness, top of rock elevation, and rock coring (RQD).



Stantec

TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
CCR Material Characteristics Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Water level indicator meter
Peristaltic pump
Tubing
Multi-parameter Sonde
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for drilling-specific field equipment

APPENDIX J
HYDROGEOLOGICAL INVESTIGATION SAP

Hydrogeological Investigation Sampling and Analysis Plan Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

HYDROGEOLOGICAL INVESTIGATION
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Hydrogeological Investigation
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ____________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	6/25/18 Date
TVA Investigation Field Lead	6/25/18 Date
Health, Safety, and Environmental (HSE) Manager	6/25/18 Date
Investigation Consultant Project Manager	06/22/18 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.06.21 15:54:50 -04'00' QA Oversight Manager	Date
Ryan Jones Laboratory Project Manager	06/22/18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

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1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, TVA has developed this Hydrogeological Investigation Sampling and Analysis Plan (SAP) to install monitoring wells for measuring groundwater levels and to provide locations to collect groundwater samples. The plan provides procedures and methods necessary to conduct investigation activities at the CUF Plant (Plant).

2.0 OBJECTIVES

The objectives of this Hydrogeological Investigation SAP are to further characterize the groundwater flow direction at the Plant, and to install monitoring wells to provide locations to collect groundwater samples for analysis of CCR constituents. The Plant-specific Quality Assurance Project Plan (QAPP) will provide the procedures necessary to conduct investigation activities associated with the hydrogeological investigation.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 MONITORING WELL LOCATIONS

TVA has investigative activities underway at CUF for the CCR Rule, TDEC permitting requirements and capital projects that will provide information that can be used to characterize the hydrogeology of CUF. Some of this work has been conducted, but final reports have not been produced and the results of those investigations are not yet available to identify final locations in order to evaluate the need for additional monitoring wells. However, TVA will incorporate pertinent data from these investigations that meet the Quality Assurance/Quality Control (QA/QC) requirements of the QAPP into the identification of proposed monitoring well locations. Monitoring wells installed as part of this investigation will be used to collect groundwater samples and elevations to further characterize the groundwater flow direction between the CCR units and the main plant. Sampling frequency and procedures are provided in the Groundwater Investigation SAP.

The approach is to install three background monitoring wells at locations expected to provide samples of groundwater that have not been affected by the CCR units. (see Figure 1, Attachment A). In addition, one well will be installed near the eastern boundary of the Gypsum Storage Area and two monitoring wells will be installed in the area between the CCR units and the Plant to evaluate groundwater flow direction and quality in these areas.

TVA plans to install the three background monitoring wells in unconsolidated soils. Background well locations CUF-1000 and CUF-1001 were discussed and selected during an onsite CUF meeting with TDEC prior to the EIP Rev 1 submittal. During the meeting, the locations of background wells CUF-1000 and CUF-1001 were identified with consideration of geologic formations by TDEC as locations that would provide groundwater quality that is representative of background conditions. The third background monitoring well (CUF-1004) will be installed south of the CCR units.

One location is between the CCR units and the main plant northeast of the CCR units. This location is inferred to be in an area that will provide background groundwater samples in relation to the CCR units based on preliminary groundwater elevation contours and was located to be above the Stones River Group. Groundwater in this area may flow to the southwest beneath the CCR units to Wells Creek. The second location is west of the CCR units in alluvial deposits. This area is in the flood plain of Wells Creek and is intended to be located in a depositional setting similar to the native soils beneath the CCR units. The third location is south/southwest of the CCR units and Wells Creek. This location is proposed to characterize groundwater quality above the Knox Dolomite, if saturated unconsolidated materials exist. The existing monitoring well network for the CCR units is in unconsolidated materials; therefore, TVA does not propose to install background monitoring wells within bedrock at this time.

In addition, TVA will install one monitoring well (CUF-1005) along the eastern boundary of the Gypsum Storage Area in the unconsolidated materials to characterize groundwater flow direction near the eastern boundary of the CCR units. The screened interval and sand pack will be placed below CCR materials, if observed during drilling. Two additional monitoring wells (CUF-1002 and CUF-1003) will be installed between the CCR units and the main plant as an initial step to characterize groundwater flow direction and quality in the unconsolidated materials between the CCR units and the Cumberland River. After groundwater levels are collected from these monitoring wells and groundwater flow between the CCR units and the plant is better understood, TVA will develop a plan, in collaboration with TDEC, to install monitoring wells in other locations, if necessary.

Based on the information gathered at these locations, additional monitoring wells may be needed to fully characterize groundwater flow direction.

Figure 1 shows the areas for installation of the monitoring wells, Figure 2 shows the preliminary groundwater elevation contours, and Table 1 shows the proposed well construction details. The exact location of the monitoring wells will be dependent on being able to safely access each area and the results of ongoing investigations.

TVA will evaluate the data collected and assess the suitability of the proposed monitoring well locations during the initial investigative phase. Based on the information gathered at the locations described above, additional monitoring wells may be needed to fully characterize groundwater flow direction. If additional wells are needed, TVA, in communication with TDEC, will install these wells to obtain additional groundwater information. Results of investigations to characterize groundwater flow direction will be included and described in the EAR.

The target depths and estimated screened intervals of the proposed wells are presented in Table 1.

Table 1. Proposed Well Construction Details

Well ID	Estimated Total Depth (Feet below Ground Surface)	Estimated Screen Interval (Feet below Ground Surface)	Target Screen Lithology
CUF-1000	20	10 - 20	Overburden - Alluvium
CUF-1001	10	2.5 - 10	Overburden - Alluvium
CUF-1002	10	2.5 – 10	Overburden - Alluvium
CUF-1003	10	2.5 – 10	Overburden - Alluvium
CUF-1004	10	2.5 – 10	Overburden - Alluvium
CUF-1005	20	10 – 20	Overburden - Alluvium

*All total depths and screen intervals are dependent on specific conditions at each proposed well location

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, install groundwater monitoring wells, and assist in providing scientifically defensible results.

Monitoring well installation will adhere to applicable American Society for Testing and Materials (ASTM) and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Investigation Consultant Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer and a Tennessee-licensed Professional Geologist
- Complete required health and safety paperwork and confirm field team members have completed required training.
- Coordinate activities with the drilling subcontractor.
- Clear Access – Proposed monitoring well locations will be marked using a wooden stake or survey flag with the position surveyed using the global positioning system (GPS). Suitability of each location will be evaluated for logistical issues including access, grubbing needs, overhead and underground utility clearance, and proximity to Plant features. Access improvements, including clearing and grubbing or road building, will be completed prior to the investigation start date.
- Perform Environmental Review – As required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC will require a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, plant staff will not issue an excavation permit ahead of the completed environmental review.

- Complete Utility Locate(s) / Excavation Permit(s) - Prior to initiating subsurface activities, subsurface utility clearance will be sought via the plant engineering department and/or the TN 811 service. At locations within the Plant, engineering will provide primary utility clearance assurance in addition to TN 811 being notified. At all other drilling locations where underground obstructions or utilities are expected nearby, TVA or 3rd party underground locators will be engaged to clear boring locations. For drilling locations outside the plant (e.g., along public roads and rights-of-way), utility avoidance assurance will be supplemented by the TN 811 service and the TVA or 3rd party underground locators. An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the drilling locations with pertinent TVA staff.

- Identify Water Source – During implementation of the EIP, a source of potable water will be required to complete several investigation tasks, including certain drilling methods and decontamination procedures.

- Obtain required calibrated field instruments, including health and safety equipment.

- Discuss project objectives and potential hazards with project personnel.

5.2 DRILLING AND SAMPLING METHODS AND PROTOCOL

Drilling activities performed at the Plant during implementation of this SAP will include advancing subsurface boreholes using auger techniques or other compatible technology based on field conditions and rig availability. If drilling methods that require the use of water are used for the installation of monitoring wells, then only potable water will be used.

The following sections present drilling and soil sampling procedures required to complete the tasks presented. Once completed, borings will be surveyed for horizontal and vertical control by survey grade GPS.

5.2.1 Drilling, Logging, and Survey

The monitoring well borings are proposed to be advanced utilizing hollow-stem augering techniques (ASTM D6151-08) until designed boring termination depth or auger refusal, whichever is shallower. In some situations, drilling with a casing advancer may be a suitable alternative to augering.

TVA proposes to perform continuous soil sampling during drilling to allow for visual logging of the materials encountered at each location. The soil boring logs will provide additional understanding of the subsurface profile including the saturated soils. Drilling and sampling activities will be performed under the direction of a Professional Geologist, licensed in the State of Tennessee, who has sufficient experience to execute the work.

The field geologist will prepare a written field log for each boring. In addition to describing each recovered soil sample, the log will document boring location, drilling personnel, tooling/equipment used, drilling performance, depth to water, sample number, sample recovery, Standard Penetration Test (SPT) blow counts, and other relevant observations. Soil color will be logged per the appropriate Munsell soil color chart.

Similarly, the field geologist will prepare a written installation log for each well. The log will document well location, well materials, well depth, depth interval for each backfill material, and surface completion details (protective casing, concrete pad, bollards, etc.).

Once the boring is completed and the well is installed It will be surveyed for horizontal and vertical control by survey grade GPS to the vertical datum used by the Plant. The survey data will be added to the final boring logs once available.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. Boring log forms will be used to document lithologic conditions and field observations at each boring location. Monitoring well diagrams will be prepared for each well.

Field documentation will also be prepared for development of each monitoring well.

5.2.3.3 Chain-of-Custody Forms

Chain-of-custody (COC) forms are not applicable to this SAP. Refer to the Groundwater Investigation SAP for groundwater sampling and monitoring procedures.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

5.2.4.1 Standard Penetration Test Sampling

The SPT samples will provide information for developing continuous boring logs/soil profiles. The SPT sampling will be conducted in accordance with ASTM D 1586 *Standard Method for Penetration Testing and Sampling for Soils*, and consists of dropping a 140-pound hammer from a height of 30 inches, to drive a standard size 2-inch diameter split-spoon sampler to a depth of 18-inches.

5.2.4.2 Monitoring and Sampling

Monitoring or sampling of wells is not addressed in this SAP. Refer to the Groundwater Investigation SAP for groundwater sampling and monitoring procedures.

5.2.5 Preservation and Handling

5.2.5.1 SPT Samples

SPT samples will be logged and placed in glass jars. Once each jar is filled, the rim and threads will be cleaned, the jar capped, and a label (Section 5.2.5.2) will be applied to the jar. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean before placing the sample container in a box for transport.

5.2.5.2 Sample Labels and Identification System

Each SPT jar will have a sample label affixed. Sample labels will contain the following information recorded in waterproof, non-erasable ink. Rock core boxes will have similar information written directly on the wooden core box in waterproof, non-erasable ink:

- Project number
- Sample location
- Boring ID number
- Depth of sampling interval
- Date of sample collection
- Sampler's initials

5.2.5.3 Packaging and Shipping

At appropriate intervals, assigned personnel will transport the samples to the testing laboratory or designated storage facility. SPT and other disturbed bulk samples (if any) will be treated as Group B samples as discussed in ASTM D4220.

5.2.6 Sample Analyses

Select soil samples obtained during the investigation will be subjected to geotechnical laboratory testing. Testing will be assigned to characterize the predominant soil materials recovered in each boring. The laboratory tests will be performed in accordance with applicable ASTM standard testing procedures.

The laboratory analyses are expected to include natural moisture content determinations (D2216), sieve and hydrometer analyses (D422), specific gravity (D854), and Atterberg Limits (D4318). The results of the testing will be used to assist in subsurface characterization and correlation with existing data. If other tests are found to be necessary, they will also be performed in accordance with applicable ASTM standard testing procedures. The Plant-specific laboratory testing program will be developed based on the recovery and spatial distribution of samples from the drilling and sampling program.

5.2.7 Equipment Decontamination Procedures

Documented decontamination will be performed for drilling equipment, tooling, and instruments in contact with subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Decontamination pads will be constructed for decontamination of large downhole tooling (augers, drill rods, etc.) using a high-pressure washer/steam cleaner.

Decontamination pads will be constructed at locations designated by TVA personnel using poly sheeting with sufficient berms to contain decontamination fluids and prevent potential runoff to uncontrolled areas. Following decontamination, fluids will be disposed of in accordance with Section 5.2.8. Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using potable water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instrument (e.g., split spoons, water level meters, pumps for well development, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Soil cuttings
- Well development water
- Purge water
- Personal Protective Equipment

- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

5.3 MONITORING WELL INSTALLATION

Monitoring wells will be installed at the boring locations by qualified drill crews under the direction of a licensed Tennessee driller. TVA and contractor personnel will assist by providing excavation (drill) permitting, utility clearances, and access to locations along with other coordination.

Monitoring wells will be installed in accordance with TVA TI ENV-TI-05.80.25, *Monitoring Well and Piezometer Installation and Development*.

5.3.1 Materials and Installation

The monitoring wells will be installed using current industry and regulatory protocols to reduce potential for introducing contaminants during the drilling and installation process. Decontamination processes will be in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*. These procedures include, in part, decontamination of the drilling equipment and tools before and after each well by washing with hot, potable water delivered under high pressure, using new well screen and riser that have been cleaned and sealed in plastic at the factory, and placing washed filter pack sand that is certified by NSF International.

Other steps employed during the installations include the workers donning clean, nitrile gloves during the handling of downhole equipment and well materials, and using potable water for grouting purposes.

Monitoring wells will consist of a four-inch diameter Schedule 40 PVC pre-packed well screen (0.010-inch slots) and riser. The screen and riser will consist of flush-joint, threaded PVC pipe. The screen length will be selected based on the results of the boring and the target stratum, but will not be longer than 10 feet. A four-inch diameter Schedule 40 PVC bottom well plug measuring approximately six inches in length will be threaded onto the bottom of the screen. The PVC riser will extend above (2.5 feet minimum) the ground surface and will be capped with a temporary plug or slip cap. The annular space will be backfilled with a sand filter pack (20/40 mesh) extending a minimum of two feet above and six inches below the screen. A minimum two-foot thick bentonite pellet seal will be placed on top of the sand filter pack.

After the bentonite pellet seal has sufficiently hydrated, (minimum of eight hours of hydration time when using cement grouts above the seal), the remaining annular space will be backfilled with a non-shrink, bentonite-cement grout.

It should be noted that the bentonite-cement grout, sand filter zones, and bentonite pellets will be placed by tremie method through one-inch diameter PVC pipe. The bentonite-cement grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process.

Subsequent wellhead construction will consist of an above-grade, steel locking protective cover anchored to a concrete surface pad. The protective cover will extend above the concrete pad and the annular space will be filled with sand or pea gravel to about six-inches below the top of PVC casing. Steel protective bollards filled with concrete will be installed near each corner of the concrete pad. The top of each well casing will be surveyed and correlated to the vertical datum used by the Plant.

An example installation log is shown on Figure 3. A drawing of the wellhead construction is shown on Figure 4.

5.3.2 Well Development

Each new monitoring well will be developed by a combination of bailing, surging, and pumping after a minimum of 24 hours following completion. Equipment will be decontaminated per TVA TI ENV-TI-05.80.05. First, a bailer will be lowered and raised within the screened intervals to create a slight surging action to dislodge particles within the wells and sand filter packs. A baseline reading of turbidity, pH, temperature, and specific conductance will be measured using a properly calibrated Oakton® turbidity and PCSTestr 35 water testing meters (or equivalents). If the well contains heavy sediment, further bailing will be performed before continuation of development with surge blocks and submersible pumps. A surge block will be used within the screened interval to move water and particles through the screen and sand filter packs. This process may be repeated several times to decrease the water turbidity within the wells.

Lastly, a submersible pump will be employed to further develop the wells until an acceptable level of turbidity is achieved. Target turbidity value of less than or equal to ten (10) Nephelometric turbidity units (NTUs) will be utilized for the wells per TVA-ENV-TI-05.80.42. If the target turbidity value cannot practically be achieved, well development will be conducted according to the requirements listed in TVA-ENV-TI-05.80.25, *Monitoring Well and Piezometer Installation and Development*.

5.3.3 Slug Testing

After development, TVA will perform slug testing in each monitoring to measure hydraulic conductivity. Equipment will be decontaminated per TVA TI ENV-TI-05.80.05. The slug tests will be performed in accordance with ASTM D 4044, *Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*. A pressure transducer with a data recorder will be used to collect water level information from the wells.

As part of the slug testing, each well will be tested by taking an initial measurement of the static water level followed by the insertion of the pressure transducer into the well. After the transducer has been installed, a solid slug (e.g., PVC pipe filled with sand) will be introduced into the well to cause a nearly instantaneous change in the water level. The water levels will then be recorded at regular intervals until reaching near static levels. After reaching static levels, the test will be terminated and a second slug test will be conducted by instantaneously removing the slug and monitoring water levels until static levels are reached again. The results will be recorded electronically and downloaded into a data collector. Raw data will be checked in the field for discrepancies prior to demobilizing from the Plant.

The field data, once collected and returned to the office, will be reduced using a software program to estimate the hydraulic conductivity of the in-situ soils.

5.4 INSTALLATION OF DEDICATED SAMPLING PUMPS

New dedicated sampling pumps will be installed in the new groundwater monitoring wells after well development and slug testing are completed. The well depths and static groundwater levels will be measured during well development to place the pumps at the proper intake depths for future well sampling. The pump intake depth will be located at approximately the mid-point of the well screen or the mid-point of the saturated portion of the well screen. Well pump placement depths and additional pump installation calculations and details will be recorded on field forms in the field.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to the installation of groundwater monitoring wells.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

The accuracy of the drilling, monitoring well installation and slug testing processes must be maintained throughout the investigation. In addition, planned drilling and installation methods must be confirmed during field activities to provide confidence that groundwater samples and water level measurements collected as part of other SAPs provide representative analytical results and data.

Field personnel will be responsible for performing checks to confirm that the SAP has been followed. This consists of the completion of applicable field forms and documentation of field activities.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 2. Preliminary Schedule for Hydrogeological Investigation SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Hydrogeological Investigation SAP Submittal		Completed
Prepare for Field Activities	20 Days	Following EIP Approval
Conduct Field Activities	20 Days	Following Field Preparation

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Field locations may be adjusted based on actual field conditions;
- Proposed monitoring well locations can be safely accessed; and

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017a. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Monitoring Well and Piezometer Installation and Development." Technical Instruction ENV-TI-05.80.25, Revision 0000. May 8.

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ATTACHMENT A
FIGURES

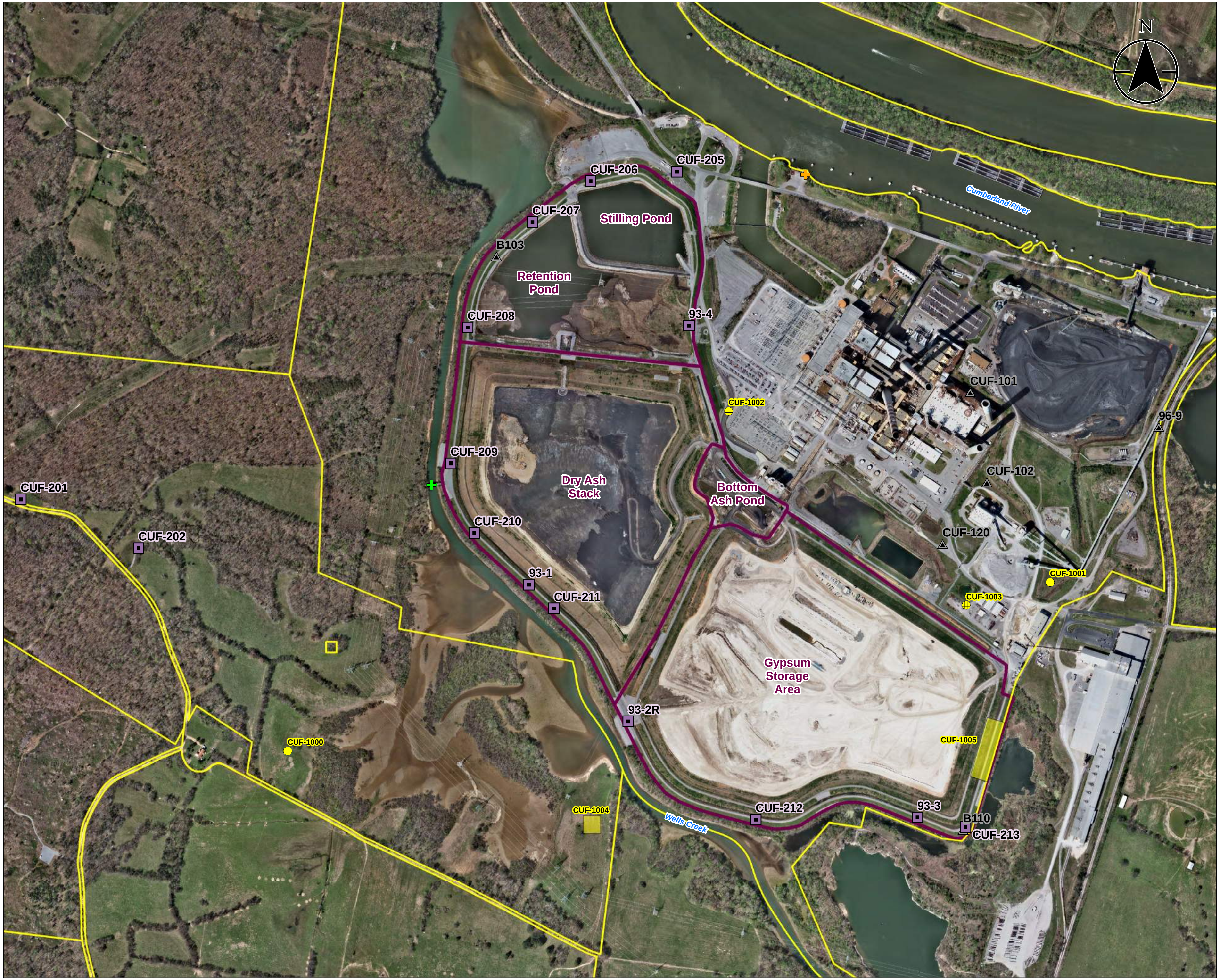

Figure No.
1

Title
Groundwater Sampling Locations

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by MW on 2018-01-23
Technical Review by JG on 2018-01-23

0 400 800 1,200 1,600
Feet
1:4,800 (At original document size of 22x34)

Legend

- Existing Observation Well
- Existing Groundwater Monitoring Well
- Proposed Monitoring Well
- Proposed Background Monitoring Well
- Proposed Wells Creek Gage
- River Gage
- Proposed Well Area
- TVA Property Boundary
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)

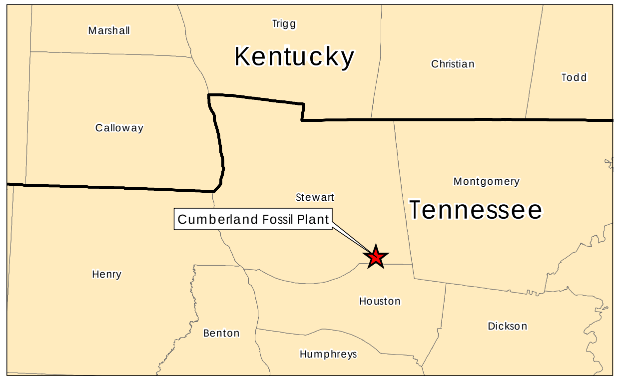

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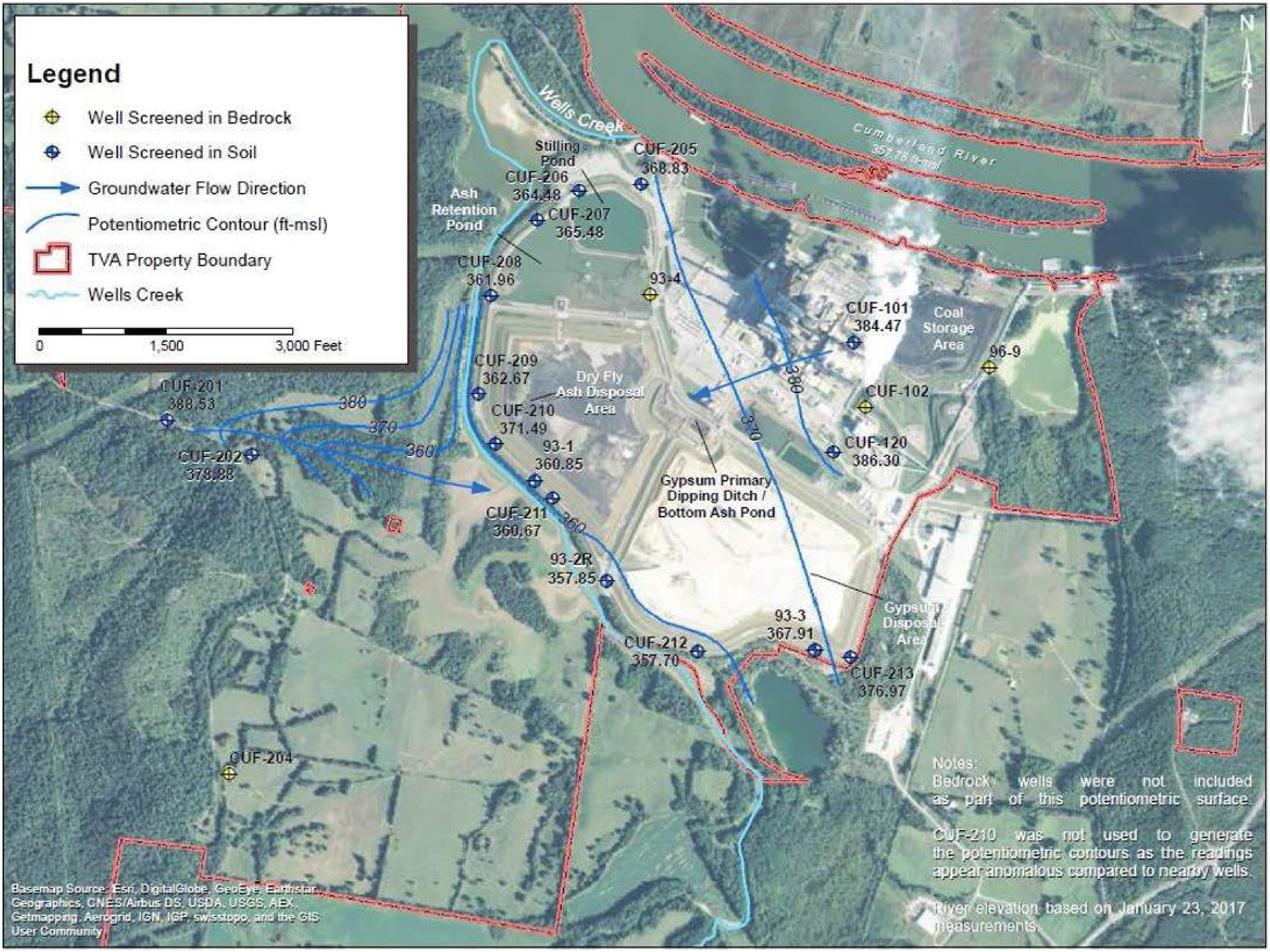
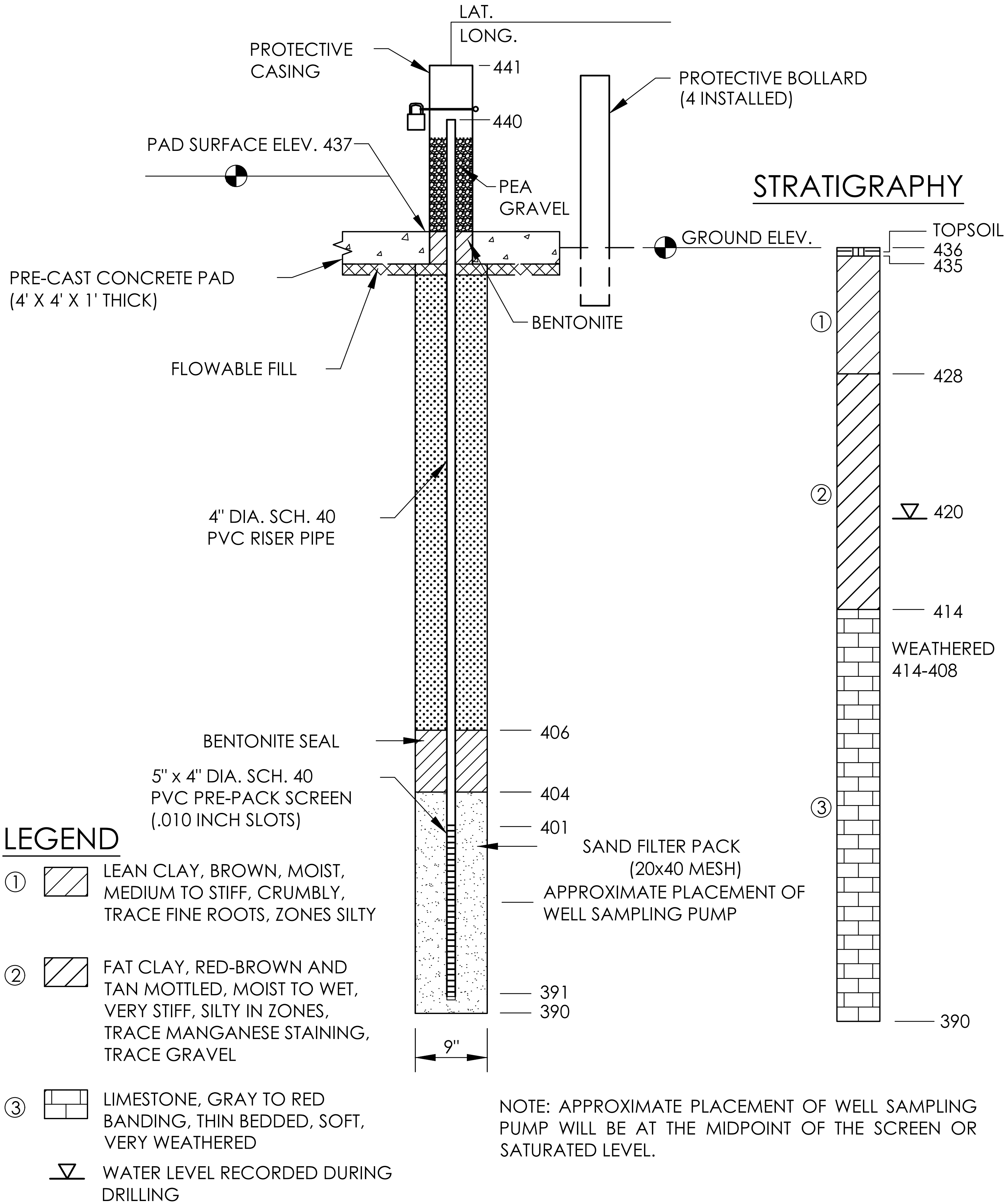
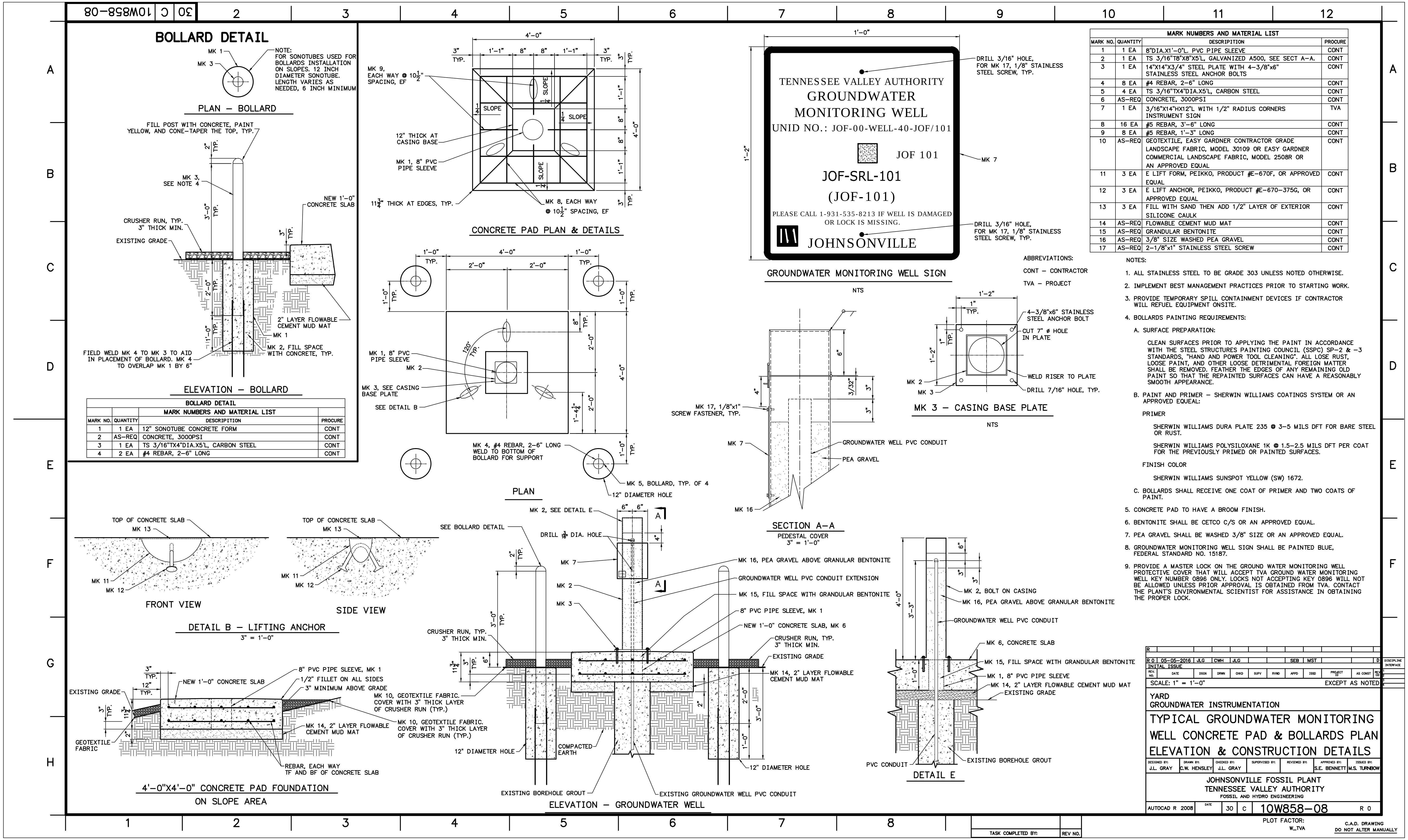
FIGURE 2. Groundwater Potentiometric Surface on January 23, 2017





NOTE: THIS FIGURE IS AN EXAMPLE MONITORING WELL LOG PROVIDED FOR REFERENCE PURPOSES AND DOES NOT REPRESENT CURRENT SITE CONDITIONS.

FIGURE 3. EXAMPLE MONTORING WELL INSTALLATION LOG



BOLLARD DETAIL — MARK NUMBERS AND MATERIAL LIST

MARK NO.	QUANTITY	DESCRIPTION	PROCURE
1	1 EA	12" SONOTUBE CONCRETE FORM	CONT
2	AS-REQ	CONCRETE, 3000PSI	CONT
3	1 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
4	2 EA	#4 REBAR, 2-6" LONG	CONT

MARK NUMBERS AND MATERIAL LIST

MARK NO.	QUANTITY	DESCRIPTION	PROCURE
1	1 EA	8"DIA.X1'-0"L. PVC PIPE SLEEVE	CONT
2	1 EA	TS 3/16"T8"X8"X5'L, GALVANIZED A500, SEE SECT A-A.	CONT
3	1 EA	14"X14"X3/4" STEEL PLATE WITH 4-3/8"x6" STAINLESS STEEL ANCHOR BOLTS	CONT
4	8 EA	#4 REBAR, 2-6" LONG	CONT
5	4 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
6	AS-REQ	CONCRETE, 3000PSI	CONT
7	1 EA	3/16"X14"HX12"L WITH 1/2" RADIUS CORNERS INSTRUMENT SIGN	TVA
8	16 EA	#5 REBAR, 3'-6" LONG	CONT
9	8 EA	#5 REBAR, 1'-3" LONG	CONT
10	AS-REQ	GEOTEXTILE, EASY GARDNER CONTRACTOR GRADE LANDSCAPE FABRIC, MODEL 30109 OR EASY GARDNER COMMERCIAL LANDSCAPE FABRIC, MODEL 2508R OR AN APPROVED EQUAL	CONT
11	3 EA	E LIFT FORM, PEIKKO, PRODUCT #E-670F, OR APPROVED EQUAL	CONT
12	3 EA	E LIFT ANCHOR, PEIKKO, PRODUCT #E-670-375G, OR APPROVED EQUAL	CONT
13	3 EA	FILL WITH SAND THEN ADD 1/2" LAYER OF EXTERIOR SILICONE CAULK	CONT
14	AS-REQ	FLOWABLE CEMENT MUD MAT	CONT
15	AS-REQ	GRANDULAR BENTONITE	CONT
16	AS-REQ	3/8" SIZE WASHED PEA GRAVEL	CONT
17	AS-REQ	2-1/8"x1" STAINLESS STEEL SCREW	CONT

NOTES:

1. ALL STAINLESS STEEL TO BE GRADE 303 UNLESS NOTED OTHERWISE.
2. IMPLEMENT BEST MANAGEMENT PRACTICES PRIOR TO STARTING WORK.
3. PROVIDE TEMPORARY SPILL CONTAINMENT DEVICES IF CONTRACTOR WILL REFUEL EQUIPMENT ONSITE.
4. BOLLARDS PAINTING REQUIREMENTS:
   A. SURFACE PREPARATION:
      CLEAN SURFACES PRIOR TO APPLYING THE PAINT IN ACCORDANCE WITH THE STEEL STRUCTURES PAINTING COUNCIL (SSPC) SP-2 & -3 STANDARDS, "HAND AND POWER TOOL CLEANING". ALL LOSE RUST, LOOSE PAINT, AND OTHER LOOSE DETRIMENTAL FOREIGN MATTER SHALL BE REMOVED. FEATHER THE EDGES OF ANY REMAINING OLD PAINT SO THAT THE REPAINTED SURFACES CAN HAVE A REASONABLY SMOOTH APPEARANCE.
   B. PAINT AND PRIMER – SHERWIN WILLIAMS COATINGS SYSTEM OR AN APPROVED EQUEAL:
      PRIMER
      SHERWIN WILLIAMS DURA PLATE 235 @ 3-5 MILS DFT FOR BARE STEEL OR RUST.
      SHERWIN WILLIAMS POLYSILOXANE 1K @ 1.5-2.5 MILS DFT PER COAT FOR THE PREVIOUSLY PRIMED OR PAINTED SURFACES.
      FINISH COLOR
      SHERWIN WILLIAMS SUNSPOT YELLOW (SW) 1672.
   C. BOLLARDS SHALL RECEIVE ONE COAT OF PRIMER AND TWO COATS OF PAINT.
5. CONCRETE PAD TO HAVE A BROOM FINISH.
6. BENTONITE SHALL BE CETCO C/S OR AN APPROVED EQUAL.
7. PEA GRAVEL SHALL BE WASHED 3/8" SIZE OR AN APPROVED EQUAL.
8. GROUNDWATER MONITORING WELL SIGN SHALL BE PAINTED BLUE, FEDERAL STANDARD NO. 15187.
9. PROVIDE A MASTER LOCK ON THE GROUND WATER MONITORING WELL PROTECTIVE COVER THAT WILL ACCEPT TVA GROUND WATER MONITORING WELL KEY NUMBER 0896 ONLY. LOCKS NOT ACCEPTING KEY 0896 WILL NOT BE ALLOWED UNLESS PRIOR APPROVAL IS OBTAINED FROM TVA. CONTACT THE PLANT'S ENVIRONMENTAL SCIENTIST FOR ASSISTANCE IN OBTAINING THE PROPER LOCK.

R 0 05-05-2016 JLG CWH JLG SEB MST — INITIAL ISSUE

SCALE: 1" = 1'-0" EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

TYPICAL GROUNDWATER MONITORING WELL CONCRETE PAD & BOLLARDS PLAN ELEVATION & CONSTRUCTION DETAILS

DESIGNED BY: J.L. GRAY; DRAWN BY: C.W. HENSLEY; CHECKED BY: J.L. GRAY; REVIEWED BY: S.E. BENNETT; ISSUED BY: M.S. TURNBOW

JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2008 | 30 | C | 10W858-08 | R 0

PLOT FACTOR: W_TVA
C.A.D. DRAWING DO NOT ALTER MANUALLY

Figure 4. Typical Groundwater Monitoring Well Construction Details

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Hydrogeological Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Pressure transducer and data recorder
Data collector
Dedicated well sampling pumps, fittings, and tubing
Stainless steel clamps
Pump controller and power supply
Generator (if needed)
Acoustic Televiewer
Heat Pulse Flow Meter
Multi-parameter sonde
Rubber packers
Solid Slug (e.g. PVC filled with sand)
Well pump (purging well) and tubing
Water level indicator meter
Oil/water interface meter
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for other drilling-specific field equipment

APPENDIX K
WATER BALANCE SAP

Water Balance
Sampling and Analysis Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

WATER BALANCE
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Water Balance
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ____________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

____________________	6/25/18
TVA Investigation Project Manager	Date
____________________	6/25/18
TVA Investigation Field Lead	Date
____________________	6/25/18
Health, Safety, and Environmental (HSE) Manager	Date
____________________	06/22/18
Investigation Consultant Project Manager	Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.06.21 15:56:49 -04'00'	
QA Oversight Manager	Date
N/A	N/A
Laboratory Project Manager	Date
____________________	
Charles L. Head TDEC Senior Advisor	Date
____________________	
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, this Water Balance Sampling and Analysis Plan (SAP) has been developed to evaluate the water balance for the National Pollutant Discharge Elimination System (NPDES) permitted surface impoundment at the CUF Plant (Plant).

2.0 OBJECTIVES

The objective of this Water Balance SAP is to compare hydrologic inputs and outputs of the impoundment system described in Section 4.0 and evaluate if there is a net balance between them. The final deliverable will include an evaluation of the impoundment system water balance over the three-month duration of the study.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 MONITORING

Hydrologic inputs and outputs of the impoundment system are illustrated on Figure 1 (Attachment A). To satisfy the objectives of this water balance analysis, inflow and outflow parameters will be quantified and used to solve the water budget as expressed in the equation below. The parameters of precipitation, transpiration, and permitted discharge are currently known or can be calculated with existing information. Additional data is needed to quantify process discharge water, surface water runoff, and evaporation.

$$\underbrace{Q_{process} + P + Q_{sw}}_{\text{(Inflows)}} = \underbrace{E + ET + Q_{out}}_{\text{(Outflows)}}$$

$Q_{process}$: Process Discharge Water
P: Precipitation
Q_{sw}: Surface Water Runoff
E: Evaporation
ET: Evapotranspiration
Q_{out}: Permitted Surface Water Discharge

4.1.1 Quantified Parameters

Precipitation

An automated precipitation gage is currently installed at the weather monitoring station located at CUF. Data is collected on 5 minute intervals. Precipitation that falls into the pond will be treated as inflow for this analysis.

Evapotranspiration

Evapotranspiration from plants located within the impoundment system will be calculated using the methods of Sanford and Selnick (2012). This method requires climate and land cover data. Precipitation and temperature data will be measured at the CUF weather monitoring station. Estimates of vegetative cover within the impoundment system will be made from aerial photographs. Evapotranspiration will be treated as an outflow parameter for this analysis. Evapotranspiration equations are provided in Attachment B.

4.1.2 Unquantified Parameters

Process Discharge Water

This impoundment system inflow point receives process discharge water from the Bottom Ash Pond and Flue Gas Desulfurization area. Water is accumulated in the North Ditch and enters the impoundment via two 72-inch reinforced concrete pipes located in the southeast corner of the impoundment system. The flow through these pipes will be continuously monitored for this analysis.

Surface Water Runoff

This impoundment system inflow point receives surface water runoff from the Dry Ash Stack and Gypsum Disposal Area. Runoff is accumulated in the perimeter ditch and enters the impoundment via two 36-inch high-density polyethylene (HDPE) pipes located just west of the southeast corner of the impoundment system. The flow through these pipes will be continuously monitored for this analysis.

Evaporation

Evaporation from the impoundment system will be calculated using the methods presented by Chapra (2008) and McNoldy (2001) (Attachment C). This method requires knowledge of wind speed, dew point, water vapor pressure, latent heat of vaporization, water density, and impoundment surface area. All parameters are known or can be calculated with current data except latent heat of vaporization and water vapor pressure. Calculation of these unknown parameters requires water temperature data. The water temperature of the impoundment system will be continuously monitored for this analysis.

Permitted Surface Water Discharge

Surface water is conveyed out of the impoundment system via four 36-inch reinforced concrete drop inlet spillway pipes which discharge to the Cumberland River via NPDES Outfall IMP001. Flow through these pipes must be continuously monitored. Additionally, flow through these pipes can be calculated using published rating curves (Stantec 2016) and compared to direct flow measurements. Water level data that is currently gathered by pressure transducers within the impoundment will be used with the rating curves to calculate flows. Riser rating curves are provided in Attachment D.

4.1.3 Proposed Monitoring Locations

Locations for temperature and flow monitoring stations have been selected and are illustrated on Figure 1. Examples of the proposed instrumentation are provided in Attachment E.

One thermometer will be installed at a representative location within the impoundment system. The location will be assessed and the thermometer will be installed as close to the location indicated ion Figure 1 as is easily accessible.

Four flow meters will be installed to monitor the inflow of process discharge water and surface water runoff to the impoundment system. One meter will be installed in each of the two 72-inch reinforced concrete process discharge water pipes and two 36-inch HDPE surface water runoff pipes.

Four flow meters will be installed to monitor the outflow of impoundment water to the Cumberland River via NPDES Outfall IMP001. One meter will be installed in each of the four drop inlet spillway discharge pipes. These pipes are thought to be 36 inches in diameter and constructed of reinforced concrete.

Data from the currently installed weather station and newly installed instruments will be gathered and used along with hydrogeological equations to calculate the water balance.

Note: Inaccuracies in each flow or temperature measurement may cause uncertainty in the water balance. Uncertainty in the water balance will be evaluated and taken into consideration when determining whether a water imbalance exists.

5.0 DATA COLLECTION AND FIELD ACTIVITY PROCEDURES

5.1 EXECUTION

The Plant impoundment system water balance analysis will be executed by means of monitoring existing equipment, installing and monitoring flow meters and thermometers, and analyzing the collected data.

Water balance data collection will adhere to applicable United States Environmental Protection Agency (EPA 2001) and TVA Environmental Technical Instruction (TI) documents. The related TVA TIs follow:

- ENV-TI-05.80.03, *Field Record Keeping*
- ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*
- ENV-TI-05.80.61, *pH and Temperature Measurement*

Field activities will be documented according to Section 5.1.2.

5.1.1 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment F. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the Quality Assurance Project Plan (QAPP).

Prior to installation of flow meters, pipes will be cleared of sediment and debris to prevent accumulation of sediment and debris during the study period. Flow meters and thermometers will be installed per manufacturer's instructions and recommendations and programmed to record on 5-minute intervals.

Maintenance will initially be performed on a weekly basis to ensure that instruments have been installed and calibrated correctly. Maintenance will include data collection, manual flow and temperature measurements, inspection of metered pipes, and clearing of debris from pipes and instruments. Manual flow and temperature readings will be compared to automated measurements to confirm accuracy of the instrument and to assess the need for recalibration. Maintenance is expected to be minimal.

5.1.2 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system/global positioning system (GIS/GPS) documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.1.2.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.1.2.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.1.2.3 Chain-of-Custody

This section is not applicable to the Water Balance SAP.

5.1.2.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.1.3 Data Collection

Data will be collected for a period of approximately three months. Data from precipitation gages, flow meters, transducers, and thermometers will be recorded on 5-minute intervals. Data from flow meters and thermometers will be retrieved manually during weekly visits.

5.1.4 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Sediment and debris
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

5.2 DATA ANALYSIS

Instrumentation calibration, location, and functionality will be reviewed during data analysis to verify that field conditions have been accurately monitored. Inflow and outflow data will be entered into the water balance equation and a water balance will be evaluated for the impoundment system. The results of the water balance will be compared to the uncertainty of the instrumentation and other existing data. This information will then be considered when evaluating whether an imbalance exists within the system.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to this Water Balance SAP.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

The accuracy of the impoundment system water balance analysis procedures must be maintained throughout the investigation. Field and office personnel will be responsible for performing checks to confirm that the SAP has been followed. This consists of the completion of applicable field forms and documentation of field and office activities.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 1. Preliminary Schedule for Water Balance Activities

Project Schedule		
Task	**Duration**	**Notes**
Water Balance SAP Submittal		Completed
Field Activities Preparation	30 Days	Following EIP Approval
Field Activities Implementation	95 Days	Following Field Preparation

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Inaccuracies in each flow or temperature measurement may cause uncertainty in the water budget. Uncertainty in the water budget will be evaluated and taken into consideration when determining whether a water imbalance exists.

9.0 REFERENCES

Alduchov, O A. and Eskridge, R.E. 1996. Improved Magnus' form approximation of saturation vapor pressure." J. Appl. Meteor., 35, 601–609.

Brady, D. K., Graves, W. L., and Geyer, J.C.B. 1969. Surface heat exchange at power plant Cooling lakes, Cooling Water Discharge project report, No. 5, Edison Electric Inst. Publication No. 69-901, New York.

Chapra, S. C. 2008. "Surface water-quality modeling." Long Grove, IL: Waveland Press.

McNoldy, B. 2001. "Temperature, Dewpoint, and Relative Humidity Calculator." Retrieved April 21, 2017, from http://andrew.rsmas.miami.edu/bmcnoldy/ Humidity.html. August 20.

Raudkivi, A.J. 1979. "Hydrology." Pergamon, Oxford, England

Sanford, Ward E., and David L. Selnick. 2012. "Estimation of Evapotranspiration Across the Conterminous United States Using a Regression with Climate and Land-Cover Data." Journal of the American Water Resources Association (JAWRA) 49(1): 217-230. DOI: 10.1111 / jawr.12010.

Stantec Consulting Services Inc. (Stantec). 2016." Initial Inflow Design Flood Control System Plan: Cumberland Fossil Plant – Stilling Pond (including Retention Pond) Cumberland City, Tennessee." Prepared for Tennessee Valley Authority.

Tennessee Valley Authority (TVA). 2016. "pH and Temperature Measurement." Technical Instruction ENV-TI-05.80.61, Revision 0000. October 28.

Tennessee Valley Authority (TVA). 2017a. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

ATTACHMENT A
SCHEMATIC OF WATER BUDGET

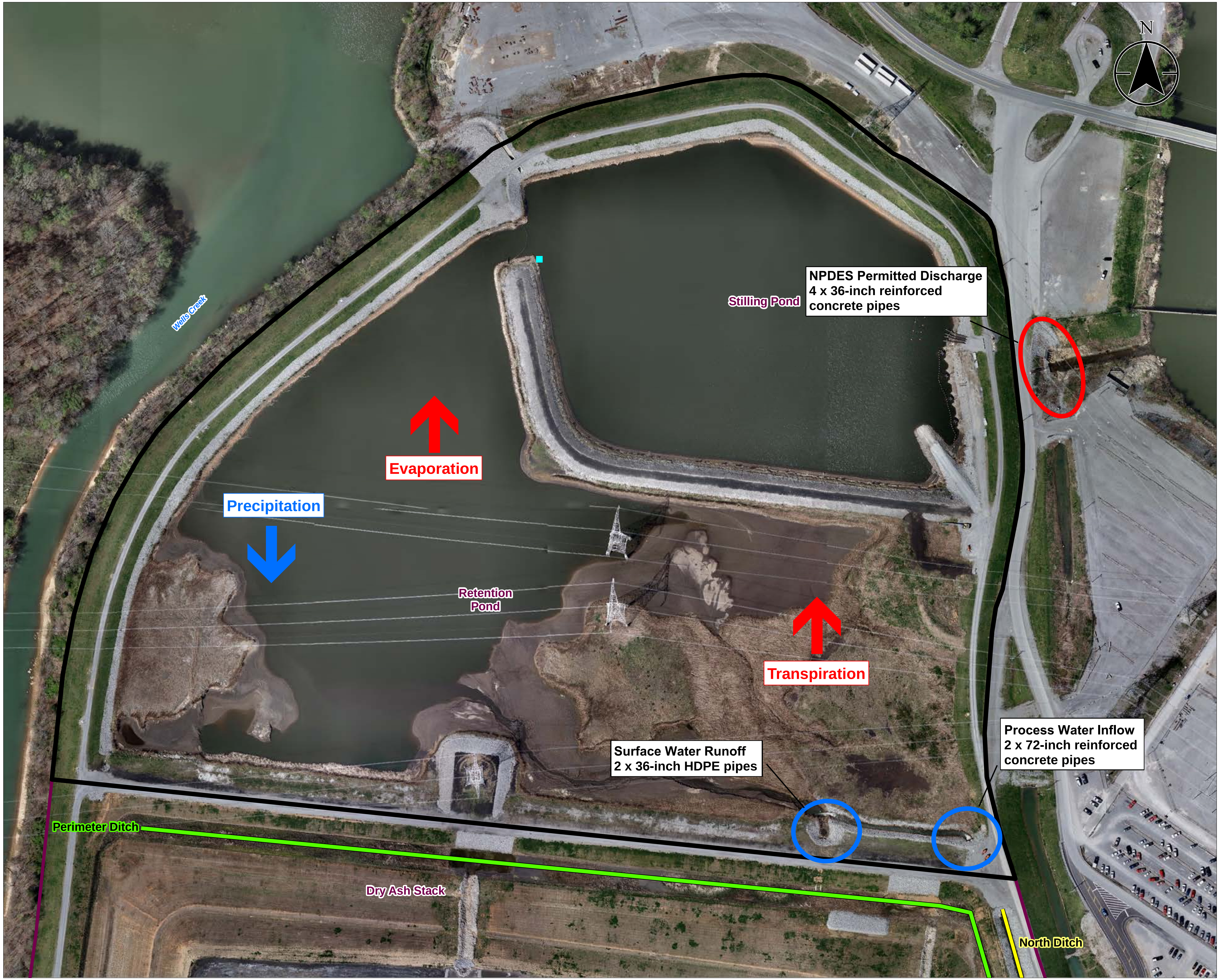


Figure No.
1

Title
Impoundment System Conceptual Model

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

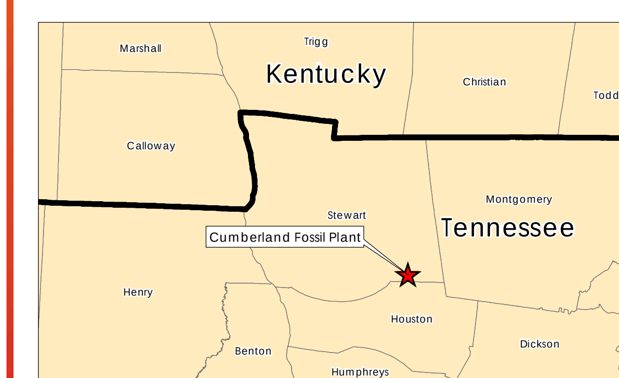
175566329
Prepared by MW on 2017-10-17
Technical Review by AS on 2017-10-17

0 100 200 300 400 Feet
1:1,200 (At original document size of 22x34)

Legend

- Impoundment System
- CCR Unit Area (Approximate)
- Input Parameter
- Output Parameter
- Proposed Thermometer Location

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

U:\TVA-EP\175566329\gis\mxds\REV2\CUF_StillingPond_Model.mxd Revised: 2017-10-17 By: mbough

ATTACHMENT B
EVAPOTRANSPIRATION CALCULATIONS

Water leaving the pond via evapotranspiration from plants will be quantified using the equations of Sanford and Selnick (2012) shown below.

TABLE 1. Regression Equation, Variables, Parameters, and Their Values Used to Estimate the Ratio ET/P for the Conterminous U.S.

Regression equation	$\mathrm{ET}/P = \Lambda(\tau\Delta/(\tau\Delta+\Pi))$ $\tau = (T_m+T_o)^m/((T_m+T_o)^m+a), \Delta = (T_x-T_n)/((T_x-T_n)+b), \Pi = (P/P_o)^n$
Climate variables	T_m, mean annual daily temperature (°C); T_x, mean annual maximum daily temperature (°C); T_n, mean annual minimum daily temperature (°C); P, mean annual precipitation (cm)
Land-cover variables	$\Lambda = (1 + cL_d + eL_f + hL_s + jL_g + kL_a + rL_m)$, where L_i is the fraction of landcover type i within the area of calculation, and subscripts d, developed; f, forest; s, shrubland; g, grassland; a, agriculture; m, marsh

	Climate Parameters						**Land-Cover Parameters**					
Parameter	To	Po	m	n	a	b	c	e	h	j	k	r
Parameter value for climate-only regression	13.735	505.87	2.4721	1.9044	10,000	18.262	0.000	0.000	0.000	0.000	0.000	0.000
Parameter value for climate- and land-cover-based regression	17.737	938.89	1.9897	2.4721	10,000	18.457	0.173	0.297	0.094	0.236	0.382	0.400

ATTACHMENT C
EVAPORATION CALCULATIONS

Evaporation will be calculated using the following formulas once impoundment water temperature (T_w) has been measured. Equation shaded in grey indicate formulas for which water temperature data is needed.

$$Q_e = 0.01\,\frac{f(U_w)(e_s - e_{air})}{L_e \rho_w}\,A_s$$ (Chapra 2008)

Q_e = evaporative water flow ($m^3\ d^{-1}$)
$f(U_w)$ = a function reflecting the effect of wind on evaporation
e_s = water vapor pressure (mmHg)
e_{air} = dew point vapor pressure (mmHg)
L_e = the latent heat of vaporization ($cal\ g^{-1}$)
ρ_w = density of water = 1 g/ml
A_s = impoundment surface area (m^2)

$$f(U_w) = 19.0 + 0.95(U_w^2)$$ (Brady, Graves, and Geyer 1969)

$f(U_w)$ = a function reflecting the effect of wind on evaporation
U_w = wind speed ($m\ s^{-1}$)

$$e_s = 4.596e^{\frac{17.27T_w}{237.3 + T_w}}$$ (Chapra 2008)

e_s = water vapor pressure
T_w = water temperature

$$e_{air} = 4.596e^{\frac{17.27T_d}{237.3+T_d}}$$ (Chapra 2008)

e_{air} = dew point vapor pressure
T_d = dew point temperature

$$T_d = \frac{b\,[\ln\left(\frac{RH}{100}\right) + \frac{17.625T}{243.04+T}]}{17.625 - \ln\left(\frac{RH}{100}\right) - \frac{17.625T}{243.04+T}}$$ (Alduchov, O.A., and R.E. Eskridge, 1996)

T_d = dew point temperature
RH = relative humidity (%)
T = air temperature

$$L_e = 597.3 - 0.57(T_w)$$ (Raudkivi 1979)

L_e = the latent heat of vaporization ($cal\ g^{-1}$)
T_w = water temperature

ATTACHMENT D
RISER RATING CURVES

The weir flow rating curve will be used to calculate flow through the risers due to the nearly constant elevation of the pond just above the riser crests.

Rating Curve - Discharge
Stilling Pond (Including Retention Pond)

Overflow 1										
	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve for HEC-HMS	
Elevation	H (ft)	$Q=CLH^{1.5}$ (cfs)	H (ft)	$Q=C_dA(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_dA(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
381.00	3.00	213.52	3	104.80	18.63	123.42	381	0.00	381.00	0.00
381.50	3.50	269.07	3.5	113.20	19.13	125.07	381	18.88	381.50	18.88
382.00	4.00	328.74	4	121.01	19.63	126.69	381	27.02	382.00	27.02
382.50	4.50	392.26	4.5	128.35	20.13	128.30	381	33.19	382.50	33.19
383.00	5.00	459.42	5	135.30	20.63	129.88	381	38.44	383.00	38.44
383.50	5.50	530.03	5.5	141.90	21.13	131.45	381	43.00	383.50	43.00
384.00	6.00	603.93	6	148.21	21.63	132.99	381	47.16	384.00	47.16
384.50	6.50	680.97	6.5	154.26	22.13	134.52	381	50.90	384.50	50.90
385.00	7.00	761.04	7	160.09	22.63	136.03	381	54.31	385.00	54.31
385.50	7.50	844.01	7.5	165.70	23.13	137.53	381	57.72	385.50	57.72
386.00	8.00	929.81	8	171.14	23.63	139.01	381	60.93	386.00	60.93

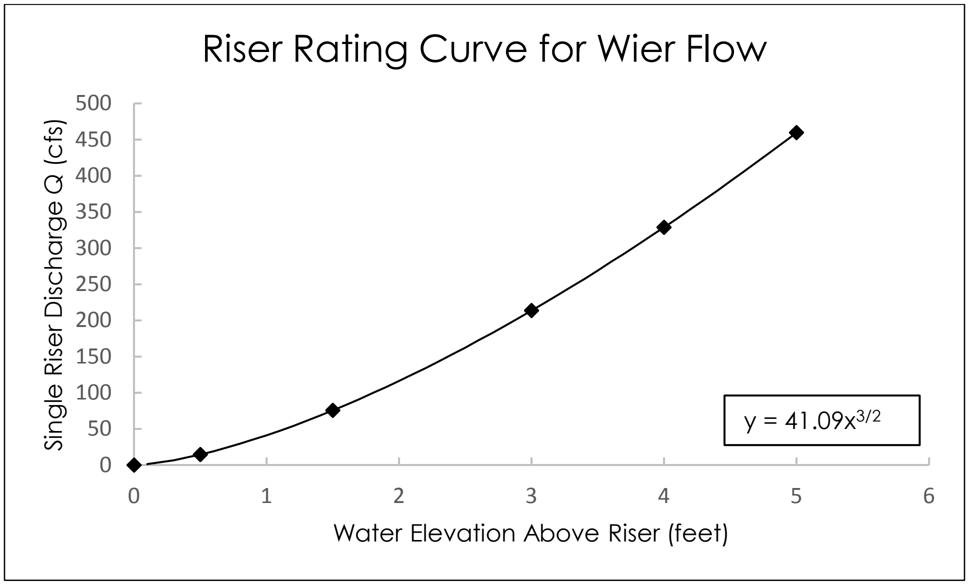
Overflow 2										
	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve for HEC-HMS	
Elevation	H (ft)	$Q=CLH^{1.5}$ (cfs)	H (ft)	$Q=C_dA(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_dA(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
381.00	3.00	213.52	3	104.80	18.63	123.42	381	0.00	381.00	0.00
381.50	3.50	269.07	3.5	113.20	19.13	125.07	381	19.05	381.50	19.05
382.00	4.00	328.74	4	121.01	19.63	126.69	381	27.26	382.00	27.26
382.50	4.50	392.26	4.5	128.35	20.13	128.30	381	33.48	382.50	33.48
383.00	5.00	459.42	5	135.30	20.63	129.88	381	38.79	383.00	38.79
383.50	5.50	530.03	5.5	141.90	21.13	131.45	381	43.39	383.50	43.39
384.00	6.00	603.93	6	148.21	21.63	132.99	381	47.59	384.00	47.59
384.50	6.50	680.97	6.5	154.26	22.13	134.52	381	51.36	384.50	51.36
385.00	7.00	761.04	7	160.09	22.63	136.03	381	54.80	385.00	54.80
385.50	7.50	844.01	7.5	165.70	23.13	137.53	381	58.24	385.50	58.24
386.00	8.00	929.81	8	171.14	23.63	139.01	381	61.49	386.00	61.49

Overflow 3										
	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve for HEC-HMS	
Elevation	H (ft)	$Q=CLH^{1.5}$ (cfs)	H (ft)	$Q=C_dA(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_dA(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
381.00	3.00	213.52	3	104.80	18.63	123.42	381	0.00	381.00	0.00
381.50	3.50	269.07	3.5	113.20	19.13	125.07	381	19.05	381.50	19.05
382.00	4.00	328.74	4	121.01	19.63	126.69	381	27.26	382.00	27.26
382.50	4.50	392.26	4.5	128.35	20.13	128.30	381	33.48	382.50	33.48
383.00	5.00	459.42	5	135.30	20.63	129.88	381	38.79	383.00	38.79
383.50	5.50	530.03	5.5	141.90	21.13	131.45	381	43.39	383.50	43.39
384.00	6.00	603.93	6	148.21	21.63	132.99	381	47.59	384.00	47.59
384.50	6.50	680.97	6.5	154.26	22.13	134.52	381	51.36	384.50	51.36
385.00	7.00	761.04	7	160.09	22.63	136.03	381	54.80	385.00	54.80
385.50	7.50	844.01	7.5	165.70	23.13	137.53	381	58.24	385.50	58.24
386.00	8.00	929.81	8	171.14	23.63	139.01	381	61.49	386.00	61.49

Overflow 4										
	Weir Flow		Orifice Flow		Pipe Orifice Flow		Outlet Pipe Flow (from HY-8)		Rating Curve for HEC-HMS	
Elevation	H (ft)	$Q=CLH^{1.5}$ (cfs)	H (ft)	$Q=C_dA(2gH)^{0.5}$ (cfs)	H_c (ft)	$Q=C_dA(2gH_c)^{0.5}$ (cfs)	Assumed TW (ft)	Q (cfs)	HW Elevation (ft)	Q (cfs)
381.00	3.00	213.52	3	104.80	18.63	123.42	381	0.00	381.00	0.00
381.50	3.50	269.07	3.5	113.20	19.13	125.07	381	18.84	381.50	18.84
382.00	4.00	328.74	4	121.01	19.63	126.69	381	26.96	382.00	26.96
382.50	4.50	392.26	4.5	128.35	20.13	128.30	381	33.11	382.50	33.11
383.00	5.00	459.42	5	135.30	20.63	129.88	381	38.36	383.00	38.36
383.50	5.50	530.03	5.5	141.90	21.13	131.45	381	42.90	383.50	42.90
384.00	6.00	603.93	6	148.21	21.63	132.99	381	47.05	384.00	47.05
384.50	6.50	680.97	6.5	154.26	22.13	134.52	381	50.79	384.50	50.79
385.00	7.00	761.04	7	160.09	22.63	136.03	381	54.19	385.00	54.19
385.50	7.50	844.01	7.5	165.70	23.13	137.53	381	57.59	385.50	57.59
386.00	8.00	929.81	8	171.14	23.63	139.01	381	60.79	386.00	60.79

Notes:

1. Cells highlighted in yellow indicate selected flow condition.

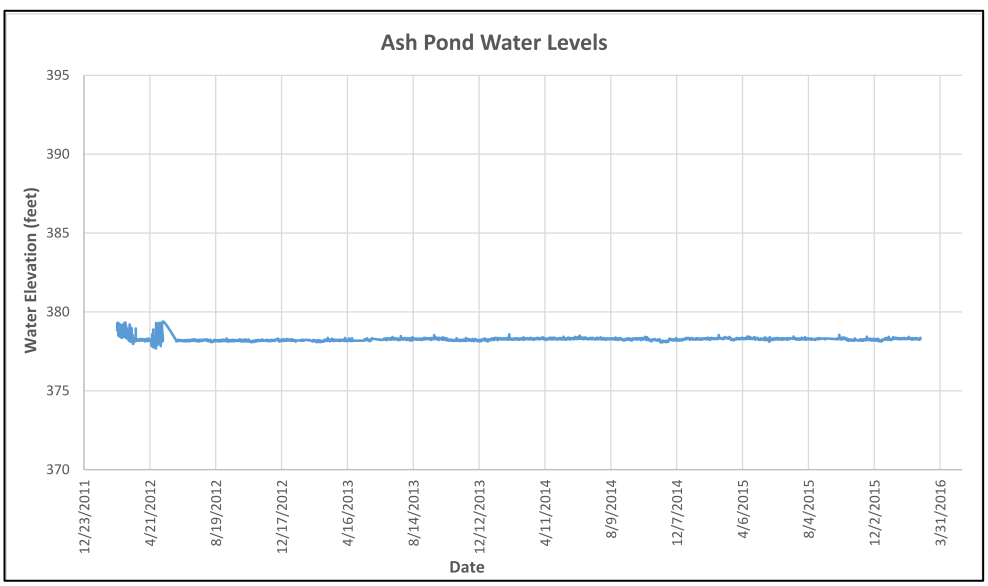


Riser – Weir flow

Flow just above the riser crest behaves as weir flow and was computed using:

$$Q = C_w L H^{\frac{3}{2}} \qquad \textbf{Eqn. 1}$$

Where: Q = discharge (cubic feet per second); C_w = weir coefficient; L = weir length (feet); and H = head above the riser crest (feet). The weir was assumed to behave as a sharp-crested weir with a weir coefficient of 3.27 (Chow 1959).



ATTACHMENT E
INSTRUMENT SPECIFICATIONS

FLOWSHARK™

The new FlowShark™ from ADS is an open channel flow monitor for use in sanitary, combined and storm sewers. It is designed for ultimate performance and versatility, including single pipe or dual pipe flow measurement, small and large pipe application and industry-leading data collection, analysis, alarming and management.

FlowShark Features

- Supports two complete sensor arrays for a total of six sensors, measuring flow in two pipes - ideal for CSO monitoring.
- Integrated wireless or telephone communication for field versatility.
- Two 4-20 mA inputs for logging and reporting data from industry standard water quality primary sensing instruments.
- Two 4-20 mA outputs for SCADA integration providing variables such as flow rate, depth, and velocity.
- Industry leading 18 month battery life for reliability and low cost of maintenance.
- Monitor-Level Intelligence (MLI®) improves accuracy and allows the FlowShark to operate in a wide range of hydraulic conditions.
- Superior noise reduction design for maximizing acoustic signal detection from depth and velocity sensors.
- Seven communication and reporting modes for accessing flow information including Profile® collection and reporting software; Intelliserve™ web-based alarming, Sliicer.com for I/I analysis, and FlowView Portal™ for online access to flow data.
- Intrinsically-Safe (IS) Certification to Class 1, Div. 1 (C & D) and ATEX Zone 0. *
- Armored marine-grade aluminum canister ensuring maximum protection and reliability in harsh sewer environments.
- Compatible with Telog's Telogers™ Communications Module.

About ADS

A leading technology and service provider, ADS® Environmental Services has established the industry standard for open channel flow monitoring and has the only ETV verified flow monitoring technology for wastewater collection systems. These battery-powered monitors are specially designed to operate with reliability, durability, and accuracy in sewer environments.

Applications

The FlowShark is designed for a multitude of project applications, including:

- Billing
- Trending
- Capacity Analysis
- CSOs
- SCADA networks
- Annexation and planning studies
- SSO monitoring
- CMOM/Operations and Maintenance programs
- Storm sewer/water quality characterization
- I/I studies
- Monitoring of selected pumping/treatment process varibles
- Driving process instruments with flow information

ADS® ENVIRONMENTAL SERVICES

INNOVATION • FLEXIBILITY • AFFORDABILITY

Available Sensors

The following ADS sensors work interchangeably with the FlowShark and all ADS flow monitors. Together they provide a complete flow monitoring system with the highest accuracy and reliability. Detailed specifications for each sensor are also available from ADS.

Quad-redundant Ultrasonic Level Sensor

This non-intrusive, zero-drift sensing method results in a stable, accurate & reliable flow depth calculation. Four independent ultrasonic transceivers allow up to twelve sensor pair configurations for independent crosscheck, which provides built-in confidence and reliability. Advanced software filtering helps compensate for adverse monitoring conditions such as waves foam, debris, etc.

Function: Measures elapsed time for an ultrasonic signal to travel to the flow surface and back and records the distance to the flow surface. The sensor is composed of 4 independent piezoelectric crystals. Resident software evaluates sensor readings and discards aberrant data.
Range: Up to 12.5 ft (3.8 m) in typical installations.

Pressure Depth Sensor

This sensor is used to measure surcharge levels, or to provide a redundant depth reading when used in conjunction with the ultrasonic level sensor.

Function: Measures depth of flow by recording the difference in atmospheric and water pressure.
Range: 0.0 - 5.0 psi: up to 11.5 ft (3.5 m);
0.0 - 15.0 psi: up to 34.5 ft (10.5 m);
0.0 - 30.5 psi: up to 69.0 ft (21.0 m)

Peak Velocity Sensor

Readings from this sensor are used to calculate average flow velocity. Its miniature size and streamlined design minimize fouling and prevent flow disruption.

Function: An ultrasonic signal is transmitted out into the flow. The reflected signal is digitally analyzed for Doppler shift to measure the peak flow velocity.
Range: -15.0 to +15.0 ft/sec (-4.5 to +4.5 m/sec)

Monitor Interfaces

Water Quality Sampler Interface
- Flow proportional or time-based

Rain Fall Measurement
- Tipping bucket

Analog Input
- PH, salinity, conductivity, other flow device

Analog Output
- Flow, ultrasonic level, pressure level, velocity

Product Specifications

Housing
0.13 in. (0.30 cm) thick seamless marine-grade aluminum with stainless steel hardware.

Dimensions
Cylinder is 20.0 in. long x 6.38 in. diameter (50.80 cm x 16.21 cm).

Weight
35 lbs.

Connectors
U.S. Military spec. MIL-C 26482 series 1, for environmental sealing, with gold plated contacts.

Electronics
Ultra-low power Digital Signal Processor architecture.

Power
Battery pack can power unit for more than 18 months at the standard 15 - minute sample rate or can be powered with an external DC power source (11 - 15 vdc).

Measurement Intervals
A crystal oscillator timer activates depth intervals and velocity measurements at preset intervals such as 1.0, 2.0, 2.5, 5.0, 7.5, and 15 minutes. Time is synchronized to a central station computer.

Available Memory
2 Megabytes of available data storage, furnishing up to 12 months of data storage capacity with full sensor configuration at 15-minute sample rate.

Intrinsic Safety Certification *
U.S.: Class 1, Division 1, Groups C & D.
International: ATEX Zone 0.

Operating Temperature
32 degrees to 140 degrees F
(0 degrees to 60 degrees C).

Warranty
One-Year Limited Warranty.

* Certification Pending

ADS® ENVIRONMENTAL SERVICES
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Levelogger Junior Edge

Model 3001

The Levelogger Junior Edge provides an inexpensive alternative for measuring groundwater and surface water levels and temperature. The Levelogger Junior Edge combines pressure and temperature sensors, a datalogger, and 5-year battery in one compact 7/8" x 5.6" (22 mm x 142 mm) stainless steel housing.

The Levelogger Junior Edge records absolute pressure using the same durable Hastelloy pressure sensor as the Levelogger Edge. The Hastelloy sensor has excellent performance in harsh environments with better temperature compensation and thermal response time, and can withstand 2 times overpressure without permanent damage.

The Levelogger Junior Edge features FRAM memory, with an increased capacity of 40,000 sets of temperature and water level data points. Readings are linear at a user-defined interval between 0.5 second to 99 hours. Accuracy is 0.1% FS, with 20 bit resolution and lifetime factory calibration.

If greater accuracy, more sampling options, or wider depth ranges are required, the Solinst Levelogger Edge has the functionality to suit your application (see Model 3001 Data Sheet). For conductivity datalogging, Solinst also offers the LTC Levelogger Junior (see Model 3001 LTC Levelogger Junior Data Sheet).

Technical Specifications	
Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Ranges:	F15/M5, F30/M10
Accuracy (typical):	0.1% FS
Units of Measure:	cm, m, ft, psi, kPa, mBar, ºC, ºF
Resolution:	20 Bit Resolution
Normalization:	Automatic Temp Compensation
Temp Compensation Range:	0ºC to 40ºC
Temperature Sensor:	Platinum RTD
Accuracy:	± 0.1ºC
Resolution:	0.1ºC
Battery Life:	5 Years
Operating Temperature:	- 20ºC to 80ºC
Clock Accuracy:	± 1 minute/year (- 20ºC to 80ºC)
Memory:	FRAM
Maximum Readings:	40,000 sets of readings
Communication:	Optical Infrared to USB, RS232, or SDI-12
Size:	7/8" x 5.6" (22 mm x 142 mm)
Weight:	4.2 oz. (119 grams)
Wetted Materials:	316 Stainless Steel, Delrin®, Viton®, Hastelloy
Sampling Mode:	Linear and Real Time View
Measurement Rates:	0.5 sec to 99 hours
Barometric Compensation:	Software Wizard and Barologger Edge

Features

- Low cost
- 5 year battery life
- Accuracy of 0.1% FS
- Increased memory to 40,000 data points
- New robust Hastelloy pressure sensor
- Compatible with Solinst Telemetry Systems and SDI-12

Operation

Programming the Levelogger Junior Edge is the same as with the Levelogger Edge. An Optical Reader or PC Interface Cable connects the Levelogger to a laptop or desktop PC. The intuitive Levelogger Software automatically detects the type of Levelogger that is connected. Programming, downloading, data management and export are intuitive tasks. The Real Time View option allows immediate viewing of live water level and temperature readings, independent of the scheduled programming intervals.

The Levelogger Junior Edge outputs temperature and temperature compensated water level readings. Using the Data Compensation Wizard in the Levelogger Software, you can barometrically compensation multiple Levelogger Junior Edge files simultaneously, with just one Barologger Edge file.

The Levelogger Junior Edge is compatible with Levelogger Series accessories, including the Leveloader Gold data transfer device, SDI-12 Interface Cable, and Solinst Telemetry Systems (see Model 9100/9200 Data Sheet).

These compact dataloggers are straightforward to deploy. Installation can be with direct read cables, by stainless steel wireline or Kevlar® cord suspension, with the option of using Solinst 2" Locking Well Caps.

Applications

- Monitoring water levels in wells and surface water
- Pump and slug tests
- Reservoir and stormwater runoff management
- Watershed and drainage basin monitoring
- Stream gauging, lake and wetland monitoring
- Tank level measurement

Solinst®

Levelogger Edge Comparison

Model 3001	Levelogger Edge	Levelogger Junior Edge
Backwards Compatible	YES (with limitations) See http://www.solinst.com/Downloads/	YES (with limitations) See http://www.solinst.com/Downloads/
Warranty	3 Years	1 Year
Pressure Transducer	Piezoresistive Silicon with Hastelloy Sensor	Piezoresistive Silicon with Hastelloy Sensor
Calibrated Ranges:	15, 30, 65, 100, 300 ft, Atmospheric Barologger 5, 10, 20, 30, 100 m, Atmospheric Barologger	15, 30 ft 5, 10 m
Accuracy (typical)	± 0.05% FS (Barologger Edge ±0.05 kPa)	± 0.1% FS
Resolution	24 Bit Resolution	20 Bit Resolution
Normalization	Automatic Temperature Compensation	Automatic Temperature Compensation
Calibration	Factory – Lifetime calibration	Factory – Lifetime calibration
Response Time (90% Thermal Δ)	1 minute/10ºC change	1 minute/1ºC change
Temp Comp Range	0 to +50°C (Barologger Edge -10 to +50ºC)	0 to +40°C
Over-pressure Range	2 X	2 X
Temperature Sensor	Platinum RTD	Platinum RTD
Temperature Accuracy	± 0.05°C	± 0.1°C
Temperature Resolution	0.003°C	0.1°C
Operating Temp Range	-20 to +80°C	-20 to +80°C
Clock Accuracy	± 1 minute / year (-20ºC - +80ºC)	± 1 minute / year (-20ºC - +80ºC)
Battery Life	10 Years (based on 1 reading/minute)	5 Years (based on 1 reading/minute)
Size	7/8" x 6.25" (22 mm x 159 mm)	7/8” x 5.6” (22 mm x 142 mm)
Weight	4.6 oz. (129 grams)	4.2 oz. (119 grams)
Memory	40,000 readings in FRAM memory, or up to 120,000 readings using data compression option	40,000 readings in FRAM memory, no data compression option
Communication Speed	9600 bps, 38,400 bps with HS USB Optical Reader	9600 bps
Com Interface	Optical infra-red: USB, RS232, SDI-12	Optical infra-red: USB, RS232, SDI-12
Memory Modes	Continuous or Slate	Slate
Logging Rates	0.125 sec to 99 hours	0.5 sec to 99 hours
Logging Modes	Linear, Event & User-Selectable Schedules with Repeat Mode, Future Start, Future Stop, Real Time View	Linear, Real Time View
Barometric Compensation	Barologger Edge	Barologger Edge
Corrosion Resistance	Titanium based PVD coating and Hastelloy Sensor	316 L Stainless Steel and Hastelloy Sensor
Other Wetted Materials	Delrin, Viton, Hastelloy, 316L Stainless Steel	Delrin, Viton, Hastelloy, 316L Stainless Steel
Direct Read Capability	Yes	Yes
Leveloader Compatible	Yes (ensure the latest firmware is installed)	Yes (ensure the latest firmware is installed)

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ATTACHMENT F
FIELD EQUIPMENT LIST

Field Equipment List
Water Balance

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Flow measurement supplies (for example: graduated cylinder and stop watch)
Automated flow meters
Automated surface water thermometer/transducer
Flow meter and thermometer/transducer installation supplies (i.e. appropriate tools and safety gear)
Rain Gage (currently installed)
Automated air-temperature thermometer (currently installed)
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for other drilling-specific field equipment

ATTACHMENT G
FIELD DATA COLLECTION FORM AND CHECKLIST

Equipment Installation Field Report

Site Information

Site Name: ______________________ **Address:** ______________________

MH Number: ______________________ ______________________

Date: ______________________ **Crew:** ______________________

Weather: ______________________ **Paperwork Completed By:** ______________________

Physical Installation (Measurements in Metric or Imperial) circle One

Meter Type and Serial / Tag #: ______________ Pipe Size: W: ________ H: ________

Ultrasonic Probe Serial / Tag #: ______________ Programmed Pipe Size: ______________

Pressure Probe Serial / Tag #: ______________ Pipe Direction: __________ Butt of Pipe: __________

Velocity Probe Serial / Tag #: ______________ Clock Position: __________ Probe Set: US / DS

Band Tag #: ______________ US Offset: ______________

IP Address: (ADS) ______________ Press Offset: ______________

Wireless Signal: (ISCO) IP Address:207.34.120.94:1700 ________ Safety Cable Attached: Y / N

Cleared Old Data: Y / N Activated Meter: ________ Probe Cables Secured: Y / N

ISCO: Next Data Push: ________ Tube and Battery Desiccant: Y / N

Computer and Measurements (Measurements in Metric or Imperial) circle One

Computer Time: Meter Time: **VELOCITY:** Raw Velocity Measured

________ / ________ ________ / ________ / ________

Do Times Match: Y / N **PVM:** Peak: Avg:

Changed Time: Y / N **PVM:** ADS HV / MMB **Taken:** US / DS of probe

Time Step: ________ **DEPTH:** Ultrasonic Pressure Measured

Changes to Meter Parameters: Y / N ________ / ________ / ________

After Adjustment ________ / ________ / ________

Battery Volt: ________ Variance: ________

Battery 2 Volt: ________ Debris/Silt Depth: ________

Debris/Silt Type: ________

Photo Log

Site: ______________ Incoming 1: ______________

Manhole: (DS Pipe at 3 o'clock) ______________ Incoming 2: ______________

US / Installed: ______________ Other / Misc: ______________

Downstream: ______________ Other / Misc: ______________

Comments

All Special Maintenance Complete: Y / N / NA

Comments:

____

____

____

____

____

Site Visit Field Report

Stantec

Flow Monitoring

Site Name: ____
Address: ____

Crew: ____ Date: ____
Weather: ____ Paperwork complete by: ____

Meter Type: ____ Primary Device: ____
IP Address/Cell No.: ____ (MS stands for Multi Sensor)
Programmed Pipe Size: ____ US Offset: ____ Pressure Offset: ____

Current Readings Page (Monitor Status) Download Only ☐

Host Computer Time: Before / After
Sample Rate: Before: ____ After: ____
Sample Rate must be checked at each site visit and after any battery change

Monitor Time: Before / After
Battery Voltage: Before: ____ After: ____
Do Times Match: YES / NO
Changed Time: YES / NO
Radio Batt. Voltage: Before: ____ After: ____

Number of Downloads: ____
Data File Complete (no missing Data) Yes / No
Data Span: ____
Check for Missing Data: Yes / No

Ultrasonic Depth: Before / After
Use for ADS Flowshark Meters
Raw Velocity: Before / After
Pressure Depth: Before / After
Use for All other Meter Types
Velocity: Before / After
Velocity Signal: ____

Field Measurements Technician's Physical Measurements

Standing In Flow: YES / NO
PVM: ADS HV MMB (circle one)
MeasuredDepth: Before / After
PVM Taken: US / DS of Probe
Variance +/- : Before / After
PVM Peak: Before / After
Debris / Silt Depth: Before / After
PVM Avg: Before / After
Debris/Silt Type: ____
PVM at Probe: Before / After

Scrubbed/Cleaned All Sensors: YES / NO
Verified All Programmed Offsets and Pipe Sizes YES / NO

TOLERENCES FOR SITE	
Level Tolerences:	0.25 in.
Velocity Tolerences:	10 %

Meter Activated / Re-Activated: Yes / No   Changes to Meter Parameters: Yes / No   Equipment Replaced: Yes / No

If any changes are made to the parameters, the meter must be downloaded a 2nd time and post change calibration must be provided

Comments: ____

Crew Response:
Reason for error unknown ☐
No observable drift or change, previous measurements wrong ☐
Site has observable Lev or Vel change ☐
Tolerences need to be wider for this site ☐

Equipment Removal Field Report

Stantec

Site Name: ______________________
Address: ______________________

Crew: ______________ Date: ______________
Weather: ______________ Paperwork complete by: ______________

Permanent Removal ☐ Temporary Removal ☐

Meter Type: ______________ Primary Device: ______________
Meter Serial No.: ______________ Pressure/AV Probe Serial No.: ______________
Meter Tag No.: ______________ Pressure /AV Probe Tag No.: ______________
Ultrasonic Serial No.: ______________ Velocity Probe Serial No.: ______________
Ultrasonic Tag No.: ______________ Velocity Probe Tag No.: ______________

Meter tagged with Site Name, Date of Removal, Reason for Removal and Crew: ☐

Reason for Removal: ______________________

Current Readings Page (Monitor Status)

Host Computer Time: ______________ Data File Complete (no missing Data) Yes / No

Monitor Time: ______________ Check for Missing Data: Yes / No

Do Times Match: YES / NO

Changed Time: YES / NO

Number of Downloads: ______________

Data Span: ______________

Ultrasonic Depth: ______________ Raw Velocity: ______________

Use for ADS Flowshark Meters

Pressure Depth: ______________ **Velocity:** ______________

Use for All other Meter Types

Velocity Signal: ______________

Current Readings Probe Fired Readings at time of physical Measurements for Level Check

Ultrasonic Depth: ______________ **Raw Velocity:** ______________ Fired Time: ______________

Use for ADS Flowshark Meters

Pressure Depth: ______________ **Velocity:** ______________

Use for All other Meter Types

Field Measurements Technician's Physical Measurements

Standing In Flow: YES / NO **PVM:** ADS HV MMB ← (circle one)

Measured Depth: ______________ **PVM Taken:** US / DS of Probe

Variance +/- : ______________ **PVM Peak:** ______________

Debris / Silt Depth: ______________ **PVM Avg:** ______________

Debris / Silt Type: ______________ **PVM at Probe:** ______________

Comments: ______________________

APPENDIX L
HISTORICAL NPDES OUTFALL MONITORING DATA

Summary of NPDES Outfall Analytical Results
Cumberland Fossil Plant
Cumberland City, Tennessee

Chloride (mg/L)

DATCOL	DATAN	TIMCOL	TIMAN	SYM	VALUE
01/19/2016	01/20/2016	0820	2328		319
01/03/2017	01/06/2017	0835	1415		325

T. Chromium (mg/L)

DATCOL	DATAN	TIMCOL	TIMAN	SYM	VALUE
04/07/2015	04/10/2015	0830	0216		0.013
07/07/2015	07/10/2015	0835	1307		0.011
10/06/2015	10/08/2015	0815	1126		0.0024
01/19/2016	01/25/2016	0820	1415		0.0574
04/06/2016	04/11/2016	0810	1053		0.00177
07/07/2016	07/13/2016	0820	1514		0.00112
10/04/2016	10/07/2016	0835	0441		0.001
01/03/2017	01/07/2017	0835	1842		0.00103
04/06/2017	04/10/2017	0835	1649		0.00105
07/12/2017	07/18/2017	0638	0118		0.001
10/03/2017	10/06/2017	0855	1546	<	0.001

Fluoride (mg/L)

DATCOL	DATAN	TIMCOL	TIMAN	SYM	VALUE
01/19/2016	01/20/2016	0820	2312		4.25
01/03/2017	01/06/2017	0835	1400		2.25

T. Lead (mg/L)

DATCOL	DATAN	TIMCOL	TIMAN	SYM	VALUE
04/07/2015	04/10/2015	0830	0216	<	0.001
07/07/2015	07/10/2015	0835	1307	<	0.001
10/06/2015	10/08/2015	0815	1126	<	0.001
01/19/2016	01/25/2016	0820	1415		0.0427
04/06/2016	04/11/2016	0810	1053	<	0.001
07/07/2016	07/13/2016	0820	1514	<	0.001
10/04/2016	10/07/2016	0835	0441	<	0.001
01/03/2017	01/07/2017	0835	1842	<	0.001
04/06/2017	04/10/2017	0835	1649	<	0.001
07/12/2017	07/18/2017	0638	0118	<	0.001
10/03/2017	10/06/2017	0855	1546	<	0.001

Summary of NPDES Outfall Analytical Results

Cumberland Fossil Plant

Cumberland City, Tennessee

T. Mercury (mg/L)

DATCOL	DATAN	TIMCOL	TIMAN	SYM	VALUE
04/07/2015	04/09/2015	0830	1347		0.0034
07/07/2015	07/09/2015	0835	1309		0.0014
10/06/2015	10/08/2015	0815	0844		0.000237
01/19/2016	01/23/2016	0820	1012	<	0.0002
04/06/2016	04/08/2016	0810	1000	<	0.0002
07/07/2016	07/09/2016	0820	0632	<	0.0002
10/04/2016	10/06/2016	0835	1231	<	0.0002
01/03/2017	01/05/2017	0835	1715	<	0.0002
04/06/2017	04/10/2017	0835	1116	<	0.0002
07/12/2017	07/14/2017	0638	1001	<	0.0002
10/03/2017	10/05/2017	0855	1856	<	0.0002

T. Selenium (mg/L)

DATCOL	DATAN	TIMCOL	TIMAN	SYM	VALUE
04/07/2015	04/10/2015	0830	0216		0.088
07/07/2015	07/10/2015	0835	1307		0.091
10/06/2015	10/08/2015	0815	1126		0.0505
01/19/2016	01/25/2016	0820	1415	<	0.002
04/06/2016	04/11/2016	0810	1053		0.0266
07/07/2016	07/13/2016	0820	1514		0.0285
10/04/2016	10/07/2016	0835	0441		0.017
01/03/2017	01/07/2017	0835	1842		0.015
04/06/2017	04/10/2017	0835	1649		0.00452
07/12/2017	07/18/2017	0638	0118		0.0267
10/03/2017	10/06/2017	0855	1546		0.0312

T. Cadmium (mg/L)

DATCOL	DATAN	TIMCOL	TIMAN	SYM	VALUE
01/19/2016	01/22/2016	0820	1018		0.0034
01/03/2017	01/07/2017	0835	1845		0.00265

Sulfate (mg/L)

DATCOL	DATAN	TIMCOL	TIMAN	SYM	VALUE
01/19/2016	01/20/2016	0820	2328		688
01/03/2017	01/06/2017	0835	1415		460

APPENDIX M
GROUNDWATER MONITORING DATA

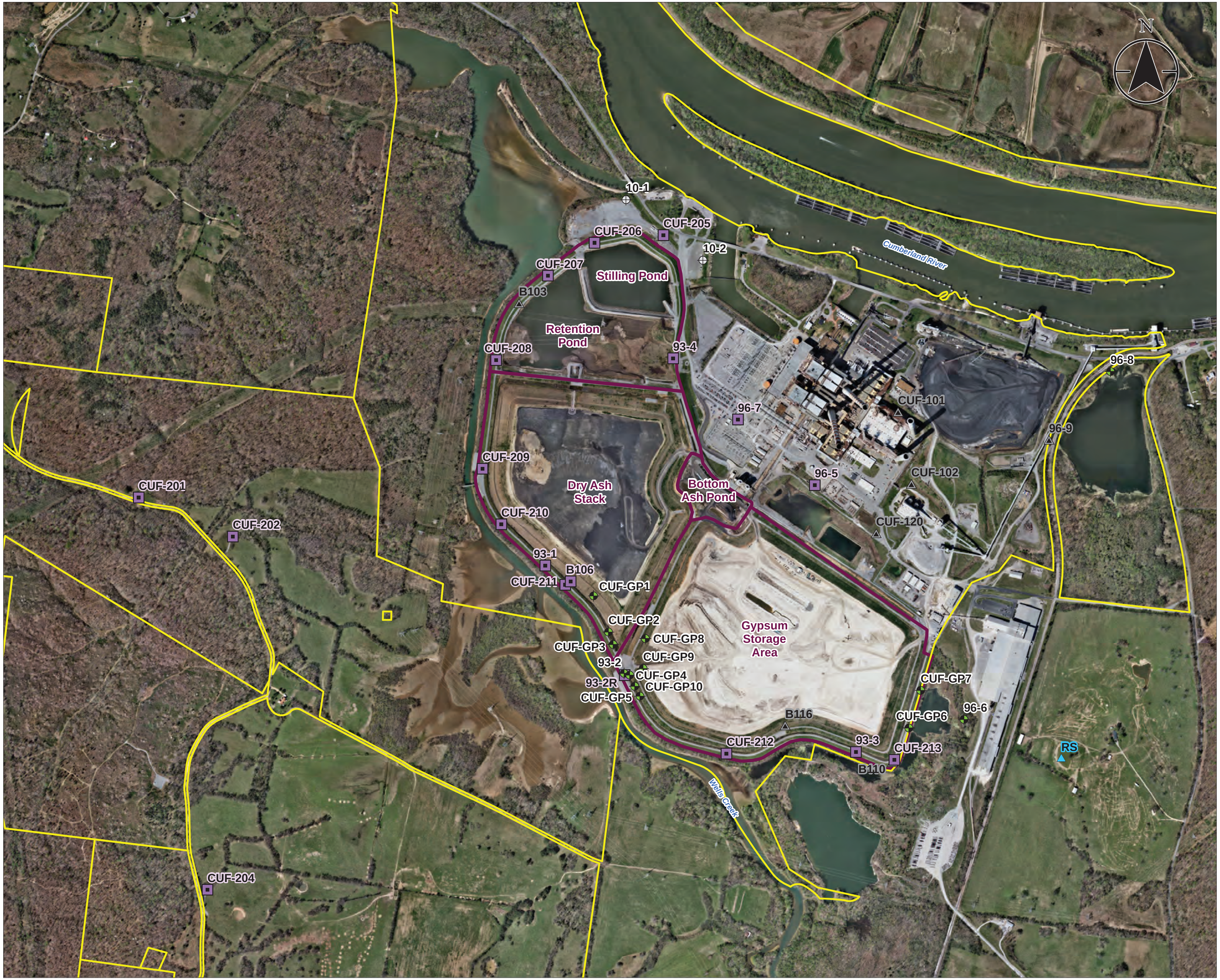


Figure No.
1

Title
Existing and Abandoned Groundwater Wells

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

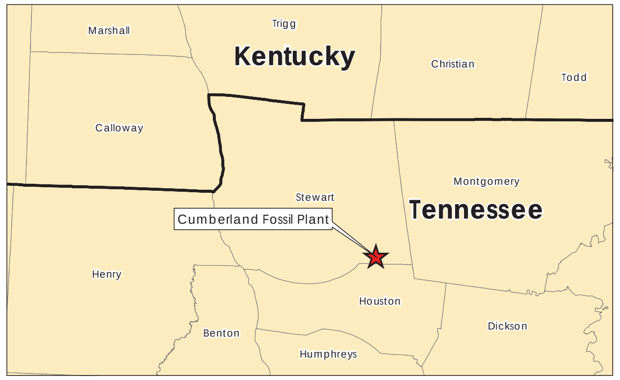
175566329
Prepared by MW on 2017-11-07
Technical Review by JG on 2017-11-07

0 500 1,000 1,500 2,000 Feet
1:6,000 (At original document size of 22x34)

Legend

- Existing Groundwater Monitoring Well
- Abandoned Groundwater Monitoring Well
- Existing Observation Well
- Abandoned Observation Well
- Surface Water
- TVA Property Boundary
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec TVA

Well ID	Program	Date	Metals																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
MCLs		TDEC		6	10	2000	4		5		100				15				2		100	10		50		100			2						4	
		EPA			50	1000			10		50				50				2			10		10		50									4	
CUF-93-2R	TDEC and CCR	Jan-06	1900	3	5	<10	<1	16000	0.6	850	4	4	<10	9600	<1	--	150	18000	<0.1	<20	3	<0.01	29	1	--	<10	1700	62	<2	--	--	<10	<10	920	0.65	1322
		Jul-06	200	<3	4	60	<1	12000	1.1	1100	1	1	<10	4000	<1	--	59	15000	<0.1	30	3	<0.01	27	2	--	<10	1300	64	<2	--	--	<10	<10	930	0.18	1200
		Jan-07	3200	<3	7	70	<1	12000	2	900	13	3	<10	6500	<1	--	54	16000	<0.1	30	9	<0.01	29	1	--	<10	1400	53	<2	--	--	<10	<10	1100	<0.1	1183
		Jul-07	<100	<5	**12**	41	<1	37000	1.2	1100	<1	3.7	3.6	4000	<1	--	250	2200	<0.2	620	22	<0.1	53	<1	--	0.51	2800	37	<1	--	--	<10	<10	1000	<0.1	1200
		Jan-08	480	<1	9.1	58	<2	10000	1.9	840	1.7	2.5	4.8	1900	<1	--	53	18000	<0.2	<5	24	<0.1	34	22	--	0.83	1200	56	<1	--	--	<10	<10	1000	<0.1	1200
		Jul-08	1500	<1	**16**	64	<2	14000	3.1	860	7	4.6	7.4	3600	1.5	--	57	18000	<0.2	<5	52	<0.1	39	<2	--	<0.5	1400	54	<1	--	--	<10	14	1000	0.16	1200
		Jan-09	350	<1	8.7	60	<2	15000	2.9	940	5.9	5.2	6.4	2200	<1	--	64	18000	<0.2	<5	56	<0.1	34	<2	--	<0.5	1400	56	<1	--	--	<10	64	1100	0.11	1200
		Apr-09	--	<1	6.4	57	<1	--	1.8	--	2	2.9	<1	--	<1	--	--	--	<0.2	--	33	--	--	29	--	<0.5	--	--	<1	<1	--	7.5	<10	--	<0.1	--
		Jul-09	250	<1	**20**	53	<2	14000	1.3	860	3.6	3.5	<2	1300	<1	--	60	16000	<0.2	<5	48	<0.1	36	42	--	<1	1400	56	<1	--	--	<10	<10	1100	0.11	1300
		Oct-09	540	<1	**11**	63	<2	15000	<2.5	960	<10	<5	<10	2000	<1	--	67	18000	<0.2	<5	24	<0.1	37	30	--	<5	1400	59	<1	--	--	<10	<50	1100	<0.1	1300
		Jan-10	120	<1	**12**	54	<2	13000	1.7	890	<2	9	6	1300	<1	--	68	14000	<0.2	<5	24	<0.1	32	14	--	<1	1400	58	<1	--	--	<10	<10	1100	<0.1	1400
		Apr-10	190	<1	<10	53	<2	12000	1.3	860	3.4	6.5	<2	1300	<1	--	67	14000	<0.2	<5	29	--	31	<10	--	<1	1400	58	<1	--	--	<10	<10	1100	<0.1	1300
		Jul-10	230	<1	6.4	47	<2	13000	1.5	860	<2	2.1	<2	1100	<1	--	72	12000	<0.2	<5	26	<0.1	29	30	--	<1	1300	58	<1	--	--	<10	<10	1100	0.12	1300
		Oct-10	640	<1	**14**	56	<2	16000	1.5	920	3.3	2.6	<2	1500	<1	--	69	15000	<0.2	<5	24	<0.1	32	3.5	--	<1	1500	57	<1	--	--	4.4	<10	1200	<0.1	1400
		Jan-11	700	<1	3.4	54	<2	16000	1.3	960	<2	1.1	<2	1500	<1	--	80	14000	<0.2	<5	<1	<0.1	31	<1	--	<1	1500	62	<1	--	--	<2	<10	1100	0.11	1300
		Apr-11	440	<1	9.6	41	<2	14000	1.7	910	<2	3.6	<2	1300	<1	--	73	13000	<1	8.7	65	<0.1	29	21	--	1.2	1400	58	<1	--	--	8.4	<10	1200	0.13	1300
		Jul-11	390	<1	5.1	50	<2	14000	2.2	940	<2	1.8	<2	1400	<1	--	80	12000	<0.2	13	13	<0.1	30	24	--	1.1	1400	60	<1	--	--	<2	<10	1200	<0.1	1200
		Oct-11	240	<1	8.2	51	<2	14000	3	890	16	3.9	<2	1200	<1	--	73	14000	<0.2	8.1	41	<0.1	32	30	--	<1	1400	56	<1	--	--	3.2	<10	1200	<0.1	1300
		Jan-12	480	<1	4.8	53	<2	14000	2.8	990	<2	3.1	<2	1400	<1	--	82	13000	<0.4	7.2	23	<0.1	31	<1	--	1.2	1500	62	<1	--	--	6.7	<10	1200	<0.1	1300
		Apr-12	--	<2	5.8	57	<2	--	2.9	--	5.2	2	<4	--	<2	--	--	--	<0.4	--	25	--	--	1.5	--	<2	--	--	<2	--	--	7.7	<20	--	<0.1	--
		Jul-12	--	<1	3.2	48	<2	--	1.8	--	2.5	3.5	5.8	--	<1	--	--	--	<0.2	--	35	--	--	<1	--	<1	--	--	<1	--	--	5.8	<10	--	<0.1	--
		Oct-12	430	<1	6.3	47	<2	14000	2.2	910	3.8	4.1	<2	1400	<1	--	88	11000	<0.2	--	29	<0.1	28	1.2	--	<1	1400	57	<1	--	--	3.2	<10	1200	0.24	1300
		Jan-13	--	<1	**58**	48	<2	--	1.9	--	4.1	5.1	<2	--	<1	--	--	--	<1	--	32	--	--	<1	--	<1	--	--	<1	--	--	5.6	<10	--	<0.1	--
		Apr-13	140	<1	**11**	48	<2	13000	1.8	930	5.2	5.4	<2	1200	<1	--	74	13000	<0.2	<5	28	<0.1	32	<1	--	<1	1600	59	<1	--	--	8.7	<10	1200	0.13	1300
		Jul-13	--	<1	9.6	48	<2	--	1.5	--	<2	2.1	<2	--	<1	--	--	--	<0.2	--	23	<0.1	--	20	--	<1	--	--	<1	--	--	2	<10	--	<0.1	--
		Oct-13	<5000	<1	<4	46.7	<4	13000	2.2	991	<20	<4	<20	<5000	<1	--	78.7	12900	<0.2	<1	<20	<0.25	31.4	<1	--	<0.5	1390	53.9	<1	--	--	<20	<200	1170	--	1220
		Jan-14	--	<2	2.35	<100	<2	--	2.87	--	<2	2.03	<2	--	<2	--	--	--	<0.2	--	5.75	<0.1	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	<0.1	--
		Apr-14	--	<2	<2	<100	<2	--	2.33	--	<2	2.49	<2	--	<2	--	--	--	<0.2	--	5.53	<0.1	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.119	--
		Jul-14	--	<2	7.57	47.7	<2	--	2.48	--	<2	2.09	<2	--	<2	--	--	--	<0.2	--	5.48	<0.1	--	<2	--	<2	--	--	<2	--	--	2.9	<25	--	<1	--
		Oct-14	--	<1	7.4	50	<2	--	2.4	--	3.8	2.9	<2	--	<1	--	--	--	<0.2	--	26	--	--	<2	--	2.8	--	--	<1	--	--	4.4	16	--	<0.1	--
		Jan-15	--	<2	<2	48	<2	--	1.9	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	4.8	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.15	--
		Apr-15	--	<2	<2	45	<2	--	1.7	--	<2	2.1	<5	--	<2	--	--	--	<0.2	--	4.5	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		Jul-15	--	<2	<2	42.7	<2	--	1.52	--	<2	2.02	<5	--	<2	--	--	--	<0.2	--	5.32	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		Oct-15	--	<2	<2	46.4	<2	--	2.16	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	5.17	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Jan-16	--	<2	<2	43.3	<2	--	2.16	--	<2	2.03	<5	--	<2	--	--	--	<0.2	--	5.5	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Apr-16	--	<2	<2	46	<2	--	1.84	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	5.43	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Jul-16	--	<2	<2	48.2	<2	--	2.6	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	5.34	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Oct-16	--	<2	<2	45.6	<2	21300	1.56	1040	<2	<2	<5	--	<2	15.7	--	--	<0.2	<5	5.53	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	1330
		Nov-16	0.075	0.257	1.54	42.7	<1	17500	1.4	999	<2	2.02	1.13	1630	0.163	3.84	52.6	18300	<0.2	1.37	5.06	--	39.8	0.362	--	--	1700	52.4	0.155	--	--	--	--	626	<0.5	1170
		Nov-16	0.061	0.174	1.34	38	<1	17500	1.24	893	<2	1.79	1.05	1480	0.09	3.11	47.1	16600	<0.2	0.985	4.75	--	35.9	0.482	--	--	1540	47.8	0.118	--	--	--	--	1100	<0.5	1190
		Jan-17	0.04	<2	3.02	38.6	<1	23000	<1	900	<2	1.86	<2	2370	<1	<5	40.2	20000	<0.2	<5	4.59	--	40.8	<5	--	<1	1670	46.3	<1	--	--	<1	<5	1020	<0.25	1310
CUF-96-9	TDEC and CCR	Jul-96	2200	<1	**12**	320	<1	<500	0.3	280	18	8	<10	35000	4	--	31	7200	--	--	25	--	50	<1	--	--	670	160	--	--	--	10	10	490	--	60
		Jan-97	5100	<1	**17**	420	<1	<500	2	360	5	--	<10	55000	6	--	35	7700	--	--	10	--	70	1	--	--	670	200	--	--	--	<10	30	490	--	67
		Jul-97	9600	<1	**32**	520	<1	<500	0.7	350	11	10	<10	73000	6	--	43	9500	--	--	20	--	89	<1	--	--	880	240	--	--	--	10	40	620	--	60
		Feb-99	2100	3	**59**	520	<1	<200	2.7	370	3	9	<10	91000	2	--	43	9300	<0.2	--	10	--	67	<1	--	<10	840	260	<2	--	--	<10	20	660	0.1	96
		Jul-99	1400	3	**41**	520	<1	<200	1.6	360	2	5	<10	88000	8	--	44	9600	<0.2	--	16	--	45	1	--	<10	930	270	<2	--	--	40	20	700	0.5	52
		Jul-00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CUF-201	CCR	Nov-16	<0.03	0.352	4.6	33.1	<1	8.59	<1	27	<2	1.15	1.2	3760	<1	1.93	3.79	329	<0.2	3.29	0.862	--	0.751	<5	--	--	76.1	3.95	<1	--	--	--	--	1.33	0.15	1.12
		Jan-17	<0.03	<2	<1	25.7	<1	<80	<1	25	<2	<0.5	<2	1110	<1	<5	3.59	250	<0.2	<5	<1	--	0.66	<5	--	--	255	3.4	<1	--	--	--	--	1.65	0.141	1.93
CUF-202	CCR	Nov-16	<0.03	0.84	0.443	37.8	<1	20.2	<1	61.1	<2	3.59	0.879	32.1	<1	3.06	6.76	1910	<0.2	7.28	5	--	1.21	<5	--	--	107	1.86	0.91	--	--	--	--	1.45	0.196	15.6
		Jan-17	<0.03	<2	<1	25.7	<1	<80	<1	61.9	<2	<0.5	<2	<50	<1	<5	7.05	32.9	<0.2	<5	<1	--	1.18	<5	--	--	114	2.02	<1	--	--	--	--	1.55	0.191	17
CUF-204	CCR	Oct-16	--	<2	<2	19.3	<2	<200	<1	108	<2	<2	<5	--	<2	<15	--	--	<0.2	<5	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	8.47
		Nov-16	<0.03	0.341	0.3	17.5	<1	6.05	<1	100	<2	0.12	0.828	68.1	<1	2.25	7.99	15	<0.2	<5	<1	--	0.597	0.463	--	--	85	3.19	<1	--	--	--	--	1.35	<0.1	7.61
		Jan-17	<0.03	<2	<1	15.5	<1	<80	<1	93.3	<2	<0.5	<2	63.9	<1	<5	7.6	7.51	<0.2	<5	<1	--	0.571	<5	--	<1	75.7	2.73	<1	--	--	<1	<5	2.18	<0.1	9.99
CUF-205	CCR	Nov-16	<0.03	0.509	0.398	80	<1	142	0.183	138	<2	0.968	1.47	<50	<1	2	12.8	538	<0.2	1.08	7.65	--	2.65	<5	--	--	428	2.94	<1	--	--	--	--	3.69	0.1	154
		Jan-17	<0.03	<2	<1	76.5	<1	178	<1	125	<2	<0.5	2.44	<50	<1	<5	11.3	301	<0.2	<5	6.33	--	2.38	<5	--	--	386	2.85	<1	--	--	--	--	5.87	0.105	132
CUF-206	CCR	Nov-16	<0.03	0.249	**10.2**	91.6	<1	21000	<1	581	<2	0.464	1.03	108000	<1	1.99	90.7	20200	<0.2	<5	<1	--	4.34	0.961	--	--	1510	28.7	<1	--	--	--	--	647	<0.5	942
		Jan-17	<0.03	<2	**10.2**	98.4	<1	24700	<1	579	<2	0.56	2.14	114000	<1	<5	94.1	21600	<0.2	<5	<1	--	4.21	<5	--	--	1500	29	<1	--	--	--	--	623	<0.25	993

Well ID	Program	Date	Metals																														Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
MCLs		**TDEC**		**6**	**10**	**2000**	**4**		**5**		**100**				**15**				**2**		**100**	**10**		**50**		**100**			**2**						**4**	
		EPA			**50**	**1000**			**10**		**50**				**50**				**2**			**10**		**10**		**50**									**4**	
CUF-207	CCR	Nov-16	<0.03	0.185	0.783	50.6	<1	27400	<1	488	<2	0.311	0.955	62100	<1	1.53	179	19100	<0.2	22.4	0.463	--	8.1	0.531	--	--	1600	32.6	<1	--	--	--	--	684	<0.5	1040
		Jan-17	<0.03	<2	1.51	55.6	<1	32400	<1	493	<2	<0.5	2.82	64900	<1	<5	178	19800	<0.2	21.6	<1	--	8.15	<5	--	--	1680	33.1	<1	--	--	--	--	600	<0.25	1090
CUF-208	CCR	Nov-16	0.011	0.138	2.45	39	<1	16900	<1	777	<2	8.27	0.804	2890	<1	1.88	64.9	5650	<0.2	6.85	3.45	--	1.49	<5	--	--	761	50.6	<1	--	--	--	--	1080	<0.5	1100
		Jan-17	<0.03	<2	2.16	37.9	<1	19000	<1	743	<2	6.99	<2	2670	<1	<5	63.6	5470	<0.2	<5	3	--	1.4	<5	--	--	627	48.4	<1	--	--	--	--	668	<0.25	1220
CUF-209	CCR	Nov-16	0.047	0.163	7.76	54.9	<1	2820	<1	207	<2	3.04	0.769	3630	<1	1.49	17.7	6510	<0.2	49.2	1.87	--	1.61	0.348	--	--	409	23.7	<1	--	--	--	--	116	0.126	164
		Jan-17	<0.03	<2	**10.5**	57.8	<1	4340	<1	247	<2	3.23	<2	5360	<1	<5	19.9	8300	<0.2	39.9	<1	--	1.49	<5	--	--	508	23.2	<1	--	--	--	--	95.9	0.157	105
CUF-210	CCR	Nov-16	0.01	0.272	0.973	80.4	<1	100	<1	83.4	<2	1.43	0.929	170	<1	1.4	8.83	1070	<0.2	20	2.07	--	0.953	0.375	--	--	124	19	0.063	--	--	--	--	22.7	0.155	15.1
		Jan-17	<0.03	<2	2.54	127	<1	173	<1	101	<2	2.85	<2	1460	<1	<5	12.8	2000	<0.2	13.9	1.37	--	0.997	<5	--	--	137	19.3	<1	--	--	--	--	43.6	0.158	16
CUF-211	CCR	Nov-16	0.011	0.129	9.96	183	<1	5090	0.243	214	<2	6.68	0.644	35700	<1	4.31	9.06	11200	<0.2	5.33	3.35	--	12.5	<5	--	--	570	50.2	0.04	--	--	--	--	179	0.087	204
		Jan-17	<0.03	<2	8.64	193	<1	6290	<1	209	<2	7.2	<2	35400	<1	6.05	8.6	11200	<0.2	6.06	3.69	--	12.2	<5	--	--	464	47.9	<1	--	--	--	--	174	0.108	211
CUF-212	CCR	Nov-16	0.082	0.33	7.09	58.1	<1	36800	<1	780	<2	3	0.874	4070	0.21	1.94	56.1	11500	<0.2	94.9	1.58	--	32.4	0.586	--	--	2020	60.3	<1	--	--	--	--	687	0.157	1310
		Jan-17	0.075	<2	8.37	48.3	<1	47100	<1	766	<2	10.8	<2	5480	<1	<5	54.3	11900	<0.2	41.2	1.33	--	34.9	<5	--	--	2180	46.5	<1	--	--	--	--	674	<0.25	1370
CUF-213	CCR	Nov-16	0.204	2.01	**11.7**	63.5	<1	26000	0.323	892	<2	0.052	1.23	20.4	<1	105	3.59	46.4	<0.2	1750	1.22	--	80	3.47	--	--	2040	40.8	0.213	--	--	--	--	517	<0.5	1300
		Jan-17	0.166	2.54	9.41	57.1	<1	26100	<1	716	<2	<0.5	<2	<50	<1	94	3.34	20.1	<0.2	1350	1.51	--	65.4	<5	--	--	1660	33	<1	--	--	--	--	447	<0.25	1310
CUF-93-1	TDEC	Sep-93	1400000	<1	**310**	**14000**	**68**	<500	**53**	1500	**940**	--	870	1800000	**1000**	80	190	35000	**2.6**	370	**890**	--	120	<1	--	<10	7700	69	--	--	--	4100	4400	16	--	99
		Jan-94	54000	2	**17**	1200	<1	960	2	200	30	17	40	65000	**33**	110	14	8800	<0.2	190	42	<0.01	89	<1	40000	<10	3600	76	<50	--	--	160	180	13	0.3	68
		Apr-94	40000	<1	**16**	420	<1	<500	2	590	64	19	40	6300	**28**	20	14	2900	<0.2	<20	54	0.09	30	<1	20000	<10	1600	15	<50	--	--	100	170	25	0.4	82
		Jul-94	5100	2	**14**	290	<1	800	0.6	120	3	4	<10	7000	4	20	11	6900	<0.2	50	7	0.58	19	<1	15000	<10	570	29	<50	--	--	10	10	18	0.2	20
		Jan-95	1200	1	**12**	540	<1	1000	0.5	110	2	<1	<10	2600	5	--	10	3700	<0.2	--	10	--	34	<1	--	<10	1600	33	<2	--	--	<10	10	17	0.3	14
		Jul-95	450	2	**12**	390	<1	700	<0.1	100	<1	<1	<10	2200	<1	--	11	3700	<0.2	--	3	--	26	<1	--	<10	1200	30	<2	--	--	<10	<10	17	0.2	16
		Jan-96	1700	<1	**12**	280	<1	<500	0.7	130	3	<1	<10	2600	1	--	15	3700	<0.2	--	10	--	17	<1	--	<10	870	26	<2	--	--	<10	10	17	0.2	14
		Jul-96	860	<1	7	180	<1	600	0.7	110	15	<1	11	1500	6	--	7.3	1900	0.4	--	6	--	30	<1	--	<10	690	38	<2	--	--	<10	10	16	0.2	16
		Jan-97	280	<1	8	220	<1	<500	0.4	130	<1	4	<10	2900	1	--	12	7200	<0.2	--	<1	--	9.6	<1	--	<10	510	21	<1	--	--	<10	60	17	0.2	23
		Jul-97	930	<1	10	290	<1	<500	2	150	7	<1	<10	4300	3	--	14	8400	<0.2	--	8	--	7.2	<1	--	<10	720	25	<2	--	--	<10	10	18	0.2	22
		Jan-98	220	<1	5	130	<1	<500	0.6	120	<1	3	<10	1800	<1	--	11	9400	<0.2	--	4	--	4.9	<1	--	<10	470	26	<2	--	--	<10	<10	17	0.2	29
		Jul-98	130	<1	<1	120	<1	400	0.4	44	<1	<1	<10	270	<1	--	4.1	1300	<0.2	--	4	--	25	<1	--	<10	790	34	<2	--	--	<10	<10	17	0.1	28
		Jan-99	1300	<1	8	150	<1	300	1	120	1	4	10	4800	1	--	11	8400	<0.2	--	6	--	5.3	<1	--	<10	450	27	<2	--	--	<10	20	19	0.2	46
		Jul-99	560	<1	9	240	<1	400	1.9	180	2	3	<10	2600	<1	--	13	11000	<0.2	--	6	--	3.9	<1	--	<10	880	30	<2	--	--	<10	10	22	0.2	44
		Jan-00	1400	<1	**11**	170	<1	500	0.15	120	3.6	3.6	<10	4300	1.3	--	10	8400	<0.2	<20	1.6	--	3.2	<1	16000	<10	550	28	<2	<50	23	<10	<10	29	0.2	40
		Jul-00	5000	<1	**14**	190	<1	320	0.83	120	22	<1	<10	6100	2.3	--	11	7900	<0.2	<20	15	--	3.5	<1	16000	<10	530	25	<2	<50	160	10	31	34	0.17	35
		Jan-01	1400	<1	**13**	180	<1	430	1.3	130	4	8	<10	5600	<1	--	14	8300	<0.2	<20	5.6	--	4.3	<1	7600	<10	490	34	<2	--	19	<10	22	38	0.17	53
		Jul-01	890	<1	10	230	<1	560	0.47	160	<1	1.9	20	5500	<1	--	13	7500	<0.2	<20	<1	--	3.3	<1	8000	<10	840	30	<2	<50	21	<10	18	40	0.17	36
		Jan-02	1200	<1	**41**	200	<1	570	1	140	<1	3.7	<10	6100	<1	--	14	7200	<0.1	22	<1	<0.01	2.7	<1	--	<10	540	28	<2	<50	31	<10	25	44	0.14	43
		Jul-02	1400	<1	<1	390	<1	750	0.73	130	3	<1	11	3400	12	--	12	7900	<0.1	<20	18	<0.01	8.1	<1	--	<10	1200	39	<2	<50	36	<10	19	74	0.14	56
		Jan-03	1100	<1	10	200	<1	300	4.3	130	2.8	<1	<10	7700	3	--	11	6700	<0.1	<20	3.9	<0.01	3.2	<1	--	<10	540	26	<2	1000	14	<10	30	65	0.15	52
		Jul-03	510	0.3	**11.1**	250	<1	500	0.88	150	1.4	4.2	<10	7500	1	--	14	6300	<0.1	<20	6.7	<0.01	3.5	0.6	--	<10	710	27	0.1	1100	7	<10	20	67	0.16	42
		Jan-04	650	<0.6	**12.3**	270	<1	470	1.17	160	<0.1	3.9	10	10000	0.6	--	13	7000	<0.1	<20	4.1	<0.01	2.6	1.1	--	<10	690	30	0.2	<50	13	<10	<10	86	0.11	74
		Jul-04	1000	<3	**11**	330	<1	500	0.8	160	3	6	<10	8300	<1	--	16	7400	<0.1	<20	2	0.02	3.6	<1	--	<10	820	31	<2	<50	8	<10	<10	100	0.15	65
		Jan-05	490	<3	**13**	260	<1	470	0.6	170	<1	6	10	10000	<1	--	14	7400	<0.1	<20	3	<0.01	4.4	1	--	<10	670	34	<2	<50	<5	<10	<10	120	0.13	70
		Jul-05	610	<3	**11**	270	<1	500	0.5	170	1	6	<10	8100	2	--	18	6400	<0.1	<20	4	<0.01	4.7	<1	--	<10	780	38	<2	<50	8	<10	<10	150	0.15	81
		Jan-06	320	<3	**12**	270	<1	700	0.7	180	3	5	<10	10000	1	--	18	7900	<0.1	<20	2	0.03	5.5	<1	--	<10	780	42	<2	--	--	<10	<10	160	0.14	91
		Jul-06	600	<3	**11**	270	<1	700	1.8	200	1	6	10	11000	2	--	23	8000	<0.1	<20	4	<0.01	4.8	<1	--	<10	900	46	<2	--	--	<10	10	190	0.15	97
		Jan-07	600	<3	**14**	250	<1	500	0.4	210	1	7	<10	11000	<1	--	21	7900	<0.1	<20	2	<0.01	3.6	<1	--	<10	860	41	<2	--	--	<10	<10	200	0.12	111
		Jul-07	1400	<1	**14**	270	<1	650	1.7	210	3.9	6.2	8.8	12000	2.5	--	22	8000	<0.2	21	10	<0.1	4.6	<1	--	<0.5	970	44	<1	--	--	<10	34	210	<0.1	120
		Jan-08	2300	<1	**14**	250	<2	690	1.6	240	2.8	5.8	6	12000	2.6	--	24	9700	<0.2	<5	7.4	<0.1	4.7	4.6	--	0.74	960	52	<1	--	--	<10	24	280	<0.1	160
		Jul-08	920	<1	**17**	220	<2	560	0.94	220	5.3	7.3	8.1	10000	3.3	--	23	9000	<0.2	5.3	13	<0.1	3.8	--	--	1.1	860	46	<1	--	--	<10	29	270	<0.1	130
		Jan-09	350	<1	**13**	230	<2	650	1.5	240	1	7.9	7.8	11000	1.6	--	23	9200	<0.2	17	12	<0.1	3.8	--	--	0.76	940	50	<1	--	--	<10	60	300	<0.1	150
		Mar-09	--	--	**15**	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Apr-09	--	<1	6.6	400	<1	--	<0.5	--	1.1	6.1	1.5	--	<1	--	--	--	<0.2	--	9.6	--	--	6	--	<0.5	--	--	<1	<1	--	<2	28	--	0.1	--
		Jul-09	480	<1	**14**	310	<2	620	0.88	240	3	6	4.9	3500	2.6	--	28	9200	<0.2	9.3	15	<0.1	5.2	6.2	--	<1	1200	50	<1	--	--	<10	55	330	0.14	160
		Oct-09	600	<1	9.1	330	<2	600	0.63	290	4.2	5.6	18	5000	1.6	--	27	9100	<0.2	<5	10	<0.1	5.6	8.6	--	2.4	1500	53	<1	--	--	<10	27	350	<0.1	160
		Jan-10	<100	<1	8.4	310	<2	1100	<0.5	260	<2	6.9	<4	5400	<1	--	27	9500	<0.2	<5	8.2	<0.1	3.5	5.2	--	<1	1000	51	<1	--	--	<10	10	370	<0.1	160
		Apr-10	270	3.5	6.6	280	<2	510	0.62	260	<2	5.4	<2	4600	<1	--	30	6500	<0.2	<5	10	<0.1	7.1	1.5	--	3.3	1300	51	<1	--	--	<10	15	350	<0.1	160
		Jul-10	340	<1	9.6	300	<2	680	<0.5	290	2.3	8.7	<2	4100	<1	--	27	9400	<0.2	<5	25	<0.1	6.6	**68**	--	<1	1500	54	<1	--	--	<10	<10	390	<0.1	200
		Oct-10	240	<1	3.2	320	<2	640	<0.5	280	<2	1.4	<2	1600	<1	--	32	3100	<0.2	7.5	7.5	<0.1	7.8	1.4	--	<1	2200	54	<1	--	--	<2	14	430	0.13	200
		Jan-11	220	<1	7.7	280	<2	740	1.9	320	<2	7.3	2.3	9000	<1	--	32	14000	<0.2	<5	2.1	<0.1	4.8	3	--	<1	1200	68	<1	--	--	4.7	16	440	0.14	230
		Apr-11	590	<1	9.2	230	<2	590	<0.5	260	2.4	2.8	2.3	1900	<1	--	25	2700	<0.2	14	28	<0.1	13	3.9	--	<1	1600	55	<1	--	--	4	<10	430	<0.1	190
		Jul-11	200	<1	6.8	260	<2	760	<0.5	290	4.7	2.4	<2	1900	<1	--	30	5000	<0.2	15	16	<0.1	10	8.4	--	<1	1600	60	<1	--	--	<2	<10	450	0.15	240
		Oct-11	540	<1	**13**	240	<2	530	0.62	300	16	7.8	3.3	8900	1.4	--	30	7700	<0.2	11	20	<0.1	5.1	8.2	--	<1	1400	56	<1	--	--	4.8	14	250	<0.1	120

Table 1A
Groundwater Chemical Data

Well ID	Program	Date	Metals																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
MCLs		TDEC		6	10	2000	4		5		100				15				2		100	10		50		100			2						4	
		EPA			50	1000			10		50				50				2			10		10		50									4	
CUF-93-1 cont.		Jan-12	240	<1	3	170	<2	530	0.55	330	11	2	5	1600	<1	--	5.2	1000	<0.2	21	22	<0.1	12	<1	--	<1	3000	52	<1	--	--	7.8	<10	540	<0.1	170
		Apr-12	--	<1	2.8	230	<2	--	0.65	--	6.3	1	4.8	--	<1	--	--	--	<0.2	--	11	--	--	1	--	<1	--	--	<1	--	--	<2	12	--	0.12	--
		Jul-12	--	<1	1.8	240	<2	--	2	--	5.1	2.8	8	--	<1	--	--	--	<0.2	--	17	--	--	<1	--	<1	--	--	<1	--	--	2.2	17	--	0.19	--
		Oct-12	400	<1	**11**	300	<2	560	<0.5	320	<2	10	3	6800	<1	--	36	11000	<0.2	7.8	12	<0.1	3.9	<1	--	<1	1200	59	<1	--	--	<2	<10	510	<0.1	250
		Jan-13	--	<1	**28**	210	<2	--	0.53	--	<2	8.9	2.7	--	<1	--	--	--	<0.2	--	21	--	--	<1	--	<1	--	--	<1	--	--	4.4	12	--	<0.1	--
		Apr-13	560	<1	7.5	250	<2	480	0.52	300	4.6	3.6	3.9	1900	<1	--	25	3500	<0.2	8.7	11	<0.1	12	--	--	<1	1900	60	<1	--	--	2.8	<10	490	<0.1	220
		Jul-13	--	<1	5.5	190	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	9.1	<0.1	--	5	--	<1	--	--	<1	--	--	<2	<10	--	<0.1	--
		Oct-13	<500	<1	2.6	294	<2	436	<1	336	2.6	5.5	3.2	2080	<1	--	34.5	6640	<0.2	3.4	7.6	<0.25	5.67	<1	--	<0.5	1630	58.3	<1	--	--	<2	<20	543	<2	248
		Jan-14	--	<2	9.68	303	<2	--	1.21	--	7.6	12.4	4.98	--	<2	--	--	--	<0.2	--	9.75	<0.1	--	<2	--	<2	--	--	<2	--	--	<20	<25	--	0.109	--
		Apr-14	--	<2	<2	182	<2	--	<1	--	<2	<2.03	<2	--	<2	--	--	--	<0.2	--	3.6	<0.1	--	<2	--	<2	--	--	<2	--	--	<20	<25	--	0.244	--
		Jul-14	--	<2	4.17	189	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	5.84	<0.1	--	<2	--	<2	--	--	<2	--	--	2.31	<25	--	<0.5	--
		Oct-14	--	<1	6	250	<2	--	<0.5	--	<2	2.1	2.6	--	<1	--	--	--	<0.2	--	11	--	--	<2	--	<1	--	--	<1	--	--	2.9	16	--	<0.1	--
		Jan-15	--	<2	<2	230	<2	--	<1	--	2.9	<2	<5	--	<2	--	--	--	<0.2	--	4.4	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		Apr-15	--	<2	<2	200	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	3	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		Jul-15	--	<2	<2	193	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	3.24	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		Oct-15	--	<2	<2	279	<2	--	<1	--	<2	5.63	<5	--	<2	--	--	--	<0.2	--	5.35	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Jan-16	--	<2	<2	172	<2	--	<1	--	<2	3.23	<5	--	<2	--	--	--	<0.2	--	3.86	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Apr-16	--	<2	3.41	237	<2	--	<1	--	2.33	4.03	<5	--	<2	--	--	--	<0.2	--	4.25	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Jul-16	--	<2	2.93	276	<2	--	<1	--	<2	10.4	<5	--	<2	--	--	--	<0.2	--	5.79	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Oct-16	--	<2	**13.6**	190	<2	1040	<1	518	<2	16	<5	--	<2	<15	--	--	<0.2	<5	5.13	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	482
		Jan-17	--	<2	**12**	<200	<4	937	<1	456	<2	23.1	<2	--	<1	<5	--	--	<0.2	<5	5.85	--	--	<5	--	<1	--	--	<1	--	--	<50	11.1	694	<0.5	395
CUF-93-3	TDEC	Sep-93	5200	<1	**16**	230	<1	3400	0.8	350	21	--	<10	10000	**21**	30	24	920	<0.2	260	13	--	4.7	<1	--	<10	770	56	--	--	--	60	50	18	--	300
		Jan-94	2700	2	5	180	<1	1600	0.2	200	2	<1	<10	6600	3	50	21	600	<0.2	270	5	<0.01	6.7	<1	8700	<10	640	62	<50	--	--	<10	<10	19	0.4	280
		Apr-94	870	<1	4	140	<1	1300	0.1	190	2	<1	<10	5000	2	40	21	660	<0.2	240	2	<0.01	6.6	<1	3900	<10	670	60	<50	--	--	<10	10	20	0.4	310
		Jul-94	1100	3	4	140	<1	3800	0.1	200	3	<1	<10	5000	1	40	21	670	<0.2	190	2	0.3	7.6	<1	10000	<10	540	60	<50	--	--	10	<10	20	0.3	290
		Jan-95	370	3	8	130	<1	4100	0.1	220	1	<1	<10	4100	3	--	26	650	<0.2	--	2	--	6.1	<1	--	<10	650	59	<2	--	--	<10	<10	20	0.4	14
		Jul-95	1400	2	2	140	<1	3900	<0.1	180	<1	<1	<10	4900	2	--	22	770	<0.2	--	1	--	3.3	<1	--	<10	710	57	<2	--	--	10	<10	20	0.4	310
		Jan-96	320	<1	2	110	<1	4000	0.2	180	<1	<1	<10	3800	<1	--	21	740	<0.2	--	<1	--	3.2	1	--	<10	630	56	<2	--	--	<10	<10	18	0.5	250
		Jul-96	100	<1	2	130	<1	3700	<0.1	180	6	1	1	3100	<1	--	21	670	<0.2	--	3	--	2.3	<1	--	<10	600	58	<2	--	--	<10	<10	19	0.4	280
		Jan-97	<50	<1	2	120	<1	3300	0.1	180	<1	2	<10	3200	<1	--	20	660	<0.2	--	<1	--	2.7	2	--	<10	570	56	<1	--	--	<10	<10	20	0.3	270
		Jul-97	<50	<1	1	130	<1	3700	<0.1	170	<1	<1	<10	3100	1	--	21	820	<0.2	--	2	--	4.1	<1	--	<10	630	55	<2	--	--	<10	<10	21	0.3	220
		Jan-98	290	<1	1	140	<1	4000	0.2	170	7	<1	<10	3400	<1	--	21	740	<0.2	--	5	--	3.2	<1	--	<10	650	61	<2	--	--	<10	<10	19	0.4	280
		Jul-98	360	<1	2	130	<1	4200	<0.1	170	2	2	<10	3200	<1	--	20	780	<0.2	--	3	--	2.1	<1	--	<10	610	54	<2	--	--	<10	<10	19	0.4	250
		Jan-99	<50	2	<1	120	<1	4300	<0.1	170	1	12	<10	3000	<1	--	21	710	<0.2	--	16	--	2.7	<1	--	<10	610	57	<2	--	--	<10	<10	19	0.4	400
		Jul-99	600	2	1	130	<1	4300	<0.1	170	4	3	<10	3400	<1	--	21	840	<0.2	--	7	--	1.8	<1	--	<10	680	55	<2	--	--	<10	<10	20	0.4	340
		Jan-00	7400	<1	7.3	210	<1	4100	0.42	170	13	2.5	<10	9300	9.1	--	20	950	<0.2	80	5.7	--	2.6	<1	33000	<10	690	57	<2	<50	170	40	50	21	0.4	250
		Jul-00	<50	<1	4	130	<1	4600	<0.1	160	2.7	<1	<10	2700	<1	--	20	780	<0.2	90	2.2	--	2.6	<1	9900	<10	670	60	<2	<50	<5	<10	<10	26	0.38	240
		Jan-01	87	<1	<1	120	<1	4300	<0.1	180	5	<1	<10	3100	12	--	23	880	<0.2	75	2.5	--	2.2	<1	8800	<10	600	45	<2	--	<5	<10	11	20	0.41	230
		Jul-01	280	<1	<1	120	<1	4500	<0.1	160	<1	<1	17	2900	<1	--	21	770	<0.2	77	<1	--	1.7	<1	9500	<10	680	61	<2	<50	11	<10	<10	21	0.43	190
		Jan-02	1600	<1	<1	160	<1	4400	0.18	180	5	<1	12	3900	<1	--	22	860	<0.1	78	<1	0.12	5.4	<1	--	<10	880	42	<2	<50	47	<10	21	32	0.3	210
		Jul-02	1900	<1	<1	170	<1	4100	0.36	160	3	<1	13	3600	3.4	--	19	830	<0.1	68	7	0.67	7	<1	--	<10	980	56	<2	<50	78	<10	15	38	0.35	210
		Jan-03	<50	<1	<1	130	<1	4300	0.4	160	1.9	<1	<10	2600	<1	--	21	870	<0.1	40	<1	<0.01	1.6	<1	--	<10	670	76	<2	920	<5	<10	<10	24	0.4	200
		Jul-03	1200	0.6	0.9	160	<1	5000	0.15	160	7.1	0.7	<10	3700	1.7	--	20	940	<0.1	40	8.4	<0.01	3.2	1.2	--	<10	760	54	0.1	1100	40	<10	10	31	0.39	200
		Jan-04	2500	<0.6	0.5	160	<1	5000	0.06	170	2.2	3.5	10	3000	0.7	--	21	960	<0.1	40	4.1	0.12	1.9	0.9	--	<10	840	54	<0.1	<50	21	<10	<10	30	0.38	200
		Jul-04	180	<3	1	150	<1	4900	<0.1	180	1	<1	<10	3000	<1	--	23	950	<0.1	40	<1	<0.01	0.87	<1	--	<10	810	54	<2	<50	<5	<10	<10	25	0.4	210
		Jan-05	150	<3	2	160	<1	5600	<0.1	180	2	<1	10	3000	<1	--	24	1100	<0.1	35	1	<0.01	2.9	2	--	<10	820	59	<2	<50	<5	<10	<10	25	0.36	208
		Jul-05	<50	<3	<1	130	<1	4900	<0.1	170	<1	<1	<10	2600	<1	--	22	910	<0.1	30	<1	<0.01	2.6	<1	--	<10	820	57	<2	<50	<5	<10	<10	26	0.42	206
		Jan-06	540	<3	<1	140	<1	4900	<0.1	160	4	<1	<10	2400	<1	--	21	870	<0.1	<20	2	<0.01	2.6	<1	--	<10	730	61	<2	--	--	<10	<10	31	0.44	195
		Jul-06	500	<3	<1	140	<1	5100	<0.1	170	<1	<1	<10	2600	<1	--	22	920	<0.1	50	1	<0.01	2.1	<1	--	<10	790	65	<2	--	--	<10	<10	30	0.41	210
		Jan-07	<200	<3	1	130	<1	5200	<0.1	170	1	<1	<10	2600	<1	--	22	920	<0.1	50	<1	<0.01	1.9	1	--	<10	750	54	<2	--	--	<10	<10	24	0.37	222
		Jul-07	170	<1	2.9	150	<1	5600	<0.5	170	2.4	<1	1.9	2800	<1	--	22	920	<0.2	47	5.4	<0.1	2.6	6.1	--	<0.5	880	58	<1	--	--	<10	<10	35	0.41	180
		Jan-08	170	<1	1.6	130	<2	5100	<0.5	170	2	<1	<1	2700	<1	--	24	960	<0.2	29	4.2	<0.1	2.1	1	--	<0.5	780	56	<1	--	--	<10	<10	29	0.41	200
		Jul-08	640	<1	3.4	150	<2	5400	<0.5	170	2.4	<1	1.8	3400	<1	--	23	870	<0.2	33	9.1	<0.1	2.4	<2	--	<0.5	870	56	<1	--	--	<10	10	37	0.33	200
		Jan-09	1000	<10	<10	170	<2	5900	<5	190	10	<10	<10	3800	<5	--	25	1200	<0.2	36	18	<0.1	4.3	<2	--	<5	1000	58	<5	--	--	<10	<100	52	0.3	180
		Apr-09	--	<1	2	150	<1	--	<0.5	--	6.8	2.7	2.1	--	1.9	--	--	--	<0.2	--	9.4	--	--	4.5	--	<0.5	--	--	<1	<1	--	10	19	--	0.23	--
		Jul-09	2500	<1	6.7	170	<2	5500	<0.5	170	14	1.6	3.6	4600	3	--	23	1000	<0.2	42	16	<0.1	4	<1	--	<1	960	54	<1	--	--	13	29	55	0.41	190
		Oct-09	1100	<1	2.2	160	<2	6200	<0.5	190	5.9	<1	<2	4200	1.4	--	26	1100	<0.2	30	6.3	<0.1	2.3	1.8	--	<1	820	60	<1	--	--	<10	16	42	0.41	200
		Jan-10	2800	<1	2.6	180		6500	<0.5	180	12	4.4	4.1	6600	3.7	--	24	1100	<0.2	36	11	<0.1	3.3	1.9	--	<1	890	59	<1	--	--	15	19	37	0.51	190
		Apr-10	820	1.9	<10	140	<2	5700	<0.5	180	11	2.7	2.1	3800	1.8	--	24	1000	<0.2	28	16	<0.1	2	<10	--	<1	850	59	<1	--	--	<10	25	38	0.41	200
		Jul-10	2000	<1	1.2	150	<2	5900	<0.5	180	9.3	<1	2.2	5000	2.4	--	25	940	<0.2	31	9.2	<0.1	2.4	<1	--	<1	890	59	<1	--	--	<10	16	44	0.41	200

Table 1A
Groundwater Chemical Data

Well ID	Program	Date	Metals																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
MCLs		TDEC		6	10	2000	4		5		100				15				2		100	10		50		100			2						4	
		EPA			50	1000			10		50				50				2			10		10		50									4	
CUF-93-3 cont.		Oct-10	4500	<1	2.4	180	<2	5800	<0.5	180	12	<1	2	6100	2.7	--	25	1100	<0.2	29	9	<0.1	3	1.4	--	<1	890	59	<1	--	--	11	16	40	0.37	210
		Jan-11	450	<1	<1	140	<2	6000	<0.5	190	<2	<1	<2	3400	<1	--	26	1100	<0.2	24	<1	<0.1	2	3	--	<1	920	61	<1	--	--	<2	<10	46	0.44	190
		Apr-11	7600	<1	3.4	180	<2	5800	<0.5	180	14	1.5	4.9	7300	4.2	--	24	950	<0.2	34	20	<0.1	3.1	<1	--	<1	870		<1	--	--	19	20	57	0.32	190
		Jun-11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jul-11	<100	<1	<1	140	<2	6000	<0.5	180	<2	<1	<2	3000	<1	--	26	1200	<0.2	31	1.3	<0.1	2.1	<1	--	<1	900	64	<1	--	--	<2	<10	46	0.46	190
		Oct-11	<100	<1	1.3	140	<2	5800	<0.5	180	<2	<1	<2	3000	<1	--	25	1200	<0.2	26	3.2	<0.1	1.8	<1	--	<1	860	57	<1	--	--	<2	<10	47	0.39	190
		Jan-12	<100	<1	<1	150	<2	6200	<0.5	200	<2	<1	<2	3100	<1	--	27	1300	<0.2	32	3.8	<0.1	2	<1	--	<1	890	58	<1	--	--	2.2	<10	50	0.45	180
		Apr-12	--	<1	1.4	150	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	3	--	--	<1	--	<1	--	--	<1	--	--	3.2	<10	--	0.38	--
		Jul-12	--	<1	<1	160	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	5.1	--	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	0.44	--
		Oct-12	710	<1	<1	160	<2	6200	<0.5	190	<2	<1	<2	3300	<1	--	27	1300	<1	32	3.7	<0.1	2	<1	--	<1	910	55	<1	--	--	<2	<10	53	0.44	180
		Oct-12	440	<1	<1	160	<2	6100	<0.5	190	<2	<1	<2	3000	<1	--	26	1300	<0.2	31	3.8	<0.1	2	<1	--	<1	920	55	<1	--	--	<2	<10	53	0.42	160
		Jan-13	--	<1	**12**	160	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	4.5	--	--	<1	--	<1	--	--	<1	--	--	3.6	<10	--	0.39	--
		Apr-13	<100	<1	2	160	<2	5800	<0.5	190	<2	<1	<2	3000	<1	--	26	1600	<0.2	24	4.3	--	2	<1	--	<1	970	56	<1	--	--	4.2	<10	62	0.41	160
		Jul-13	--	<1	1.2	160	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	3.1	<0.1	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	0.35	--
		Oct-13	<2500	<1	<4	164	<4	5510	<1	195	<10	<4	<10	2600	<1	--	25.4	1800	<0.2	22.9	<10	0.39	2.51	<1	--	<0.5	896	54.1	<1	--	--	<10	<100	57.4	<0.4	143
		Jan-14	--	<2	<2	161	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	<0.1	--	<2	--	<2	--	--	<2	--	--	<20	<25	--	0.459	--
		Apr-14	--	<2	<2	139	<2	--	<1	--	2.4	<2	<2	--	<2	--	--	--	<0.2	--	2.47	<0.1	--	<2	--	<2	--	--	<2	--	--	<20	<25	--	0.51	--
		Jul-14	--	<2	<2	152	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	<0.1	--	<2	--	<2	--	--	<2	--	--	3.23	<25	--	0.381	--
		Oct-14	--	<1	2.1	160	<2	--	<0.5	--	38	2.5	2.4	--	1.4	--	--	--	<0.2	--	39	--	--	<2	--	<1	--	--	<1	--	--	7.7	16	--	0.39	--
		Jan-15	--	<2	<2	160	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.48	--
		Apr-15	--	<2	<2	150	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	4.1	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.36	--
		Jul-15	--	<2	<2	158	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.418	--
		Oct-15	--	<2	<2	158	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<10	--	<2	--	--	<1	--	--	<5	<25	--	0.45	--
		Jan-16	--	<2	<2	151	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	0.387	--
		Apr-16	--	<2	<2	167	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	0.398	--
		Jul-16	--	<2	2.83	173	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	0.431	--
		Oct-16	--	<2	<2	194	<2	7050	<1	242	<2	<2	<5	--	<2	69.6	--	--	<0.2	18.7	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.325	114
		Jan-17	--	<2	<1	<200	<4	7650	<1	203	<2	<0.5	<2	--	<1	72.1	--	--	<0.2	16	<1	--	--	<5	--	<1	--	--	<1	--	--	<50	<5	100	0.34	124
CUF-93-4	TDEC	Sep-93	2000	<1	4	20	**5**	<500	<0.1	230	7		<10	2400	4	<10	7	410	<0.2	<20	16	--	2.1	<1	--	<10	580	3.8	--	--	--	<10	20	4		64
		Jan-94	43000	1	4	190	<1	<500	0.1	590	9	10	30	66000	9	30	14	1600	<0.2	<20	32	<0.01	9	<1	35000	<10	1400	6.3	<50	--	--	60	120	4	0.5	63
		Apr-94	2800	<1	2	20	<1	<500	<0.1	190	4	<1	<10	6300	2	<10	7	220	<0.2	<20	7	<0.01	6	<1	3900	<10	500	5.2	<50	--	--	<10	20	5	0.4	60
		Jul-94	29000	2	10	100	<1	<500	0.5	400	17	8	10	35000	15	10	11	780	<0.2	<20	43	<0.01	5	<1	20000	<10	710	5.4	<50	--	--	50	110	5	0.2	75
		Feb-95	28000	**12**	**23**	220	<1	500	0.7	820	**270**	<1	20	45000	**17**	--	11	1000	<0.2	--	58	--	350	3	--	<10	3400	45	<2	--	--	40	120	14	0.8	760
		Apr-95	1200	<1	2	20	<1	<500	<0.1	110	2	<1	<10	1600	<1	--	2.8	55	<0.2	--	<1	--	14	<1	--	<10	640	7.2	<2	--	--	<10	<10	18	0.5	160
		Jul-95	8800	2	4	130	<1	<500	0.1	180	3	4	10	13000	7	--	3.9	390	<0.2	--	14	--	14	<1	--	<10	1000	7.9	<2	--	--	10	30	25	0.4	94
		Jan-96	30000	<1	**18**	250	1	500	2	550	37	8	20	43000	**19**	--	15	1000	<0.2	--	24	--	15	3	--	<10	1600	7.8	2	--	--	40	80	31	0.4	100
		Jul-96	1700	<1	2	120	<1	<500	<0.1	120	2	<1	<10	3300	1	--	3.8	53	<0.2	--	1	--	11	<1	--	<10	720	6.4	<2	--	--	<10	<10	28	0.3	92
		Jan-97	420	<1	<1	60	<1	<500	0.2	56	4	<1	<10	560	<1	--	1.6	11	<0.2	--	2	--	8.5	<1	--	<10	610	2	<1	--	--	<10	130	10	0.2	61
		Jul-97	6800	<1	4	150	<1	<500	1	330	12	1	10	9100	4	--	15	370	<0.2	--	14	--	7.7	<1	--	<10	1100	5.7	<2	--	--	<10	20	23	0.2	66
		Jan-98	300	2	<1	50	<1	<500	0.3	160	2	<1	<10	550	<1	--	11	71	0.2	--	6	--	5.1	<1	--	<10	700	5.3	<2	--	--	<10	10	18	0.1	65
		Jul-98	70	<1	<1	40	<1	400	0.2	160	<1	<1	<10	150	<1	--	8.1	21	<0.2	--	<1	--	6.6	<1	--	<10	610	5.4	<2	--	--	<10	<10	25	0.1	80
		Jan-99	780	<1	<1	50	<1	500	1.2	190	<1	2	<10	1100	<1	--	10	160	<0.2	--	4	--	5.1	<1	--	<10	660	5.2	<2	--	--	<10	100	27	0.1	140
		Jan-99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jul-99	1300	3	<1	40	<1	500	0.4	200	<1	<1	<10	1900	<1	--	7.9	140	<0.2	--	4	--	6	<1	--	<10	680	5.9	<2	--	--	<10	330	33	0.1	130
		Jan-00	800	<1	<1	50	<1	620	<0.1	170	2	<1	<10	1000	1.1	--	6.4	140	<0.2	<20	<1	--	3.9	<1	18000	<10	640	5.1	<2	<50	9	<10	<10	39	0.2	86
		Jul-00	2100	2.2	4.5	48	<1	600	1.4	190	3	<1	12	2300	<1	--	7.3	150	<0.2	150	3	--	5.8	<1	13000	<10	600	5.7	<2	<50	44	<10	19	37	0.14	72
		Jan-01	150	<1	<1	34	<1	640	0.4	180	<1	<1	<10	130	4	--	7.3	190	<0.2	<20	<1	--	4.3	<1	7600	<10	520	5.4	<2	--	<5	<10	11	37	0.14	75
		Jul-01	3000	<1	<1	59	<1	630	<0.1	210	<1	<1	19	3400	<1	--	7.7	280	<0.2	<20	<1	--	4.3	<1	12000	<10	680	5.7	<2	<50	36	<10	21	44	0.15	78
		Jan-02	860	<1	<1	38	<1	810	0.27	180	<1	<1	<10	930	3	--	7.3	190	<0.1	<20	<1	0.01	3	<1	--	<10	620	3.4	<2	<50	21	<10	24	40	0.12	78
		Jul-02	890	<1	<1	36	<1	420	0.55	190	<1	<1	<10	920	<1	--	7.3	120	<0.1	<20	<1	0.02	3.9	<1	--	<10	580	4.9	<2	<50	18	<10	<10	56	0.14	71
		Jan-03	3200	<1	<1	60	<1	300	3.6	230	3.6	<1	<10	3500	2.3	--	7.2	460	<0.1	<20	5.7	0.02	4.2	2.2	--	<10	720	4.9	<2	990	12	<10	20	85	0.39	120
		Jul-03	1200	0.5	<0.1	40	<1	800	0.14	200	1.8	0.6	<10	870	0.43	--	7.5	150	<0.1	<20	6.4	0.02	4.3	0.7	--	<10	620	5.4	<0.1	1000	36	<10	<10	93	0.13	92
		Jan-04	4700	<0.6	0.7	60	<1	800	0.57	260	1.4	1.4	10	2700	1.1	--	9	400	<0.1	<20	6.2	0.06	4.4	0.7	--	<10	820	6.4	<0.1	<50	16	<10	<10	130	0.13	130
		Jul-04	1900	<3	<1	50	<1	700	1.7	290	3	<1	<10	2000	<1	--	11	230	<0.1	<20	2	0.02	4.8	<1	--	<10	830	5.7	<2	<50	8	<10	<10	160	0.13	150
		Jan-05	2100	<3	3	60	<1	690	0.3	310	2	1	<10	2500	<1	--	12	320	<0.1	<20	3	<0.01	7.7	2	--	<10	910	7.5	<2	<50	7	<10	<10	220	0.11	179
		Jul-05	1500	3	<1	50	<1	700	0.2	330	1	<1	<10	2000	4	--	12	230	<0.1	<20	2	<0.01	6.1	<1	--	<10	950	7.5	<2	<50	12	<10	<10	200	0.13	199
		Jan-06	830	<3	<1	50	<1	1000	0.6	290	1	<1	<10	930	<1	--	11	110	<0.1	<20	<1	0.07	5.5	<1	--	<10	830	12	<2	--	--	<10	<10	220	0.15	222
		Jul-06	2000	<3	<1	60	<1	1000	0.9	350	2	<1	<10	2300	1	--	12	290	<0.1	<20	2	0.02	5.4	1	--	<10	960	8.7	<2	--	--	<10	<10	240	0.13	240
		Jan-07	2500	<3	2	80	<1	1100	0.6	360	2	<1	<10	2400	<1	--	13	310	<0.1	<20	2	0.02	4.5	1	--	<10	1000	7.1	<2	--	--	<10	<10	250	0.11	250
		Jul-07	1400	<1	4.2	62	<1	1100	0.55	310	3.5	1	4.9	940	1.2	--	12	160	<0.2	17	10	<0.1	7.2	27	--	<0.5	910	10	<1	--	--	<10	10	220	<0.1	220

Table 1A
Groundwater Chemical Data

Well ID	Program	Date	Metals																																Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
MCLs		TDEC		6	10	2000	4		5		100				15				2		100	10		50		100			2						4	
		EPA			50	1000			10		50				50				2			10		10		50									4	
CUF-93-4 cont.		Jan-08	1300	<1	3.3	62	<2	880	<0.5	350	2	<1	2.6	870	<1	--	13	180	<0.2	<5	8.1	<0.1	5.6	4.7	--	<0.5	950	10	<1	--	--	<10	<10	270	0.13	260
		Jul-08	1400	<1	4	67	<2	1200	0.85	380	5.9	1.8	5	2600	1.9	--	14	240	<0.2	<5	13	<0.1	4.9	--	--	1.4	1000	11	<1	--	--	<10	11	280	<0.1	290
		Jan-09	620	<5	7.3	67	<2	2100	3.6	420	6.1	<5	13	940	<5	--	15	470	<0.2	<5	26	<0.1	5.4	<2	--	<2.5	1100	18	<5	--	--	<10	<50	300	<0.1	350
		Apr-09	--	<1	2.6	81	<1	--	<0.5	--	1.7	<1	1.7	--	<1	--	--	--	<0.2	--	15	--	--	12	--	<0.5	--	--	<1	<1	--	4.2	10	--	<0.1	--
		Jul-09	1400	<1	10	70	<2	<200	<0.5	100	3.2	<1	<2	2600	<1	--	6.1	720	<0.2	<5	21	<0.1	6.9	11	--	<1	360	6	<1	--	--	<10	24	350	<0.1	470
		Oct-09	1200	<1	7.9	94	<2	4000	1.2	540	3.6	1.9	4.9	1800	1.1	--	21	260	<0.2	<5	14	<0.1	7.4	11	--	<1	1300	49	<1	--	--	<10	13	360	<0.1	650
		Jan-10	460	<1	5.5	95	<2	5600	<0.5	560	<2	1.1	<4	1000	<1	--	24	320	<0.2	<5	14	<0.1	6.2	6.1	--	<1	1400	65	<1	--	--	<10	<10	390	<0.1	840
		Apr-10	260	2	<10	91	<2	5200	3.2	540	3.7	1.9	12	460	<1	--	24	73	<0.2	<5	37	<0.1	6.9	<10	--	<1	1600	74	<1	--	--	<10	38	390	<0.1	810
		Jul-10	390	<1	2.9	86	<2	4500	<0.5	510	<2	<1	3.7	800	<1	--	23	100	<0.2	<5	14	<0.1	7	8.5	--	<1	1300	60	<1	--	--	<10	36	380	0.1	750
		Oct-10	700	<1	5	100	<2	6200	1.6	570	<2	<1	7.1	420	<1	--	28	160	<0.2	<5	13	<0.1	7.8	3.7	--	<1	1500	88	<1	--	--	<2	13	400	<0.1	900
		Jan-11	540	<1	2.1	100	<2	6900	3.2	600	<2	<1	2.5	340	<1	--	30	140	<0.2	<5	<1	<0.1	7.3	2	--	<1	1500	100	<1	--	--	<2	13	420	<0.1	970
		Apr-11	310	<1	5	78	<2	6300	1.1	560	<2	<1	7.5	220	<1	--	27	31	<0.2	8.4	39	<0.1	6.5	<1	--	<1	1300	79	<1	--	--	2.9	<10	420	<0.1	850
		Jul-11	440	<1	2	77	<2	3900	<0.5	500	<2	<1	<2	810	<1	--	23	120	<0.2	9.8	7.2	<0.1	7	7.7	--	<1	1200	55	<1	--	--	<2	<10	360	<0.1	620
		Oct-11	340	<1	4	79	<2	3800	<0.5	500	<2	<1	<2	540	<1	--	23	190	<0.2	<5	13	<0.1	6.2	6.9	--	<1	1200	54	<1	--	--	<2	<10	220	<0.1	390
		Jan-12	1200	<1	2.4	110	<2	8100	<0.5	660	2.3	<1	2.2	1400	<1	--	34	510	<0.2	<5	19	<0.1	7	<1	--	<1	1500	110	<1	--	--	5.5	<10	440	<0.1	1100
		Apr-12	--	<1	2.3	88	<2	--	<0.5	--	<2	<1	2.7	--	<1	--	--	--	<0.2	--	13	<0.1	--	1.3	--	<1	--	--	<1	--	--	3.6	<10	--	<0.1	--
		Jul-12	--	<1	<1	78	<2	--	<0.5	--	<2	<1	2.1	--	<1	--	--	--	<0.2	--	19	--	--	<1	--	<1	--	--	<1	--	--	2.7	<10	--	<0.1	--
		Oct-12	410	<1	<1	78	<2	6000	<0.5	550	<2	<1	2	300	<1	--	29	330	<0.2	<5	18	--	6.6	<1	--	<1	1400	91	<1	--	--	2	<10	470	0.23	1100
		Jan-13	--	<1	**34**	84	<2	--	1.3	--	<2	1.2	8.9	--	<1	--	--	--	<0.2	--	19	<0.1	--	<1	--	<1	--	--	<1	--	--	4.9	14	--	<0.1	--
		Apr-13	200	<1	6.2	78	<2	7200	<0.5	620	3.2	<1	3.6	190	<1	--	32	92	<0.2	<5	17	<0.1	6.8	<1	--	<1	1600	110	<1	--	--	7	<10	430	0.18	1100
		Jul-13	--	<1	5.9	74	<2	--	<0.5	--	<2	<1	2.2	--	<1	--	--	--	<0.2	--	15	<0.1	--	6.4	--	<1	--	--	<1	--	--	<2	<10	--	<0.1	--
		Oct-13	<2500	<1	<4	67	<4	8780	<1	654	<10	<4	<10	<2500	<1	--	37.3	284	<0.2	<1	<10	<0.25	8.01	<1	--	<0.5	1480	137	<1	--	--	<10	<100	455	<2	1240
		Jan-14	--	<2	2.04	92.6	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	7.38	<0.1	--	<2	--	<2	--	--	<2	--	--	<20	<25	--	0.131	--
		Apr-14	--	<2	<2	<100	<2	--	<1	--	<2	<2	2.35	--	<2	--	--	--	<0.2	--	3.78	<0.1	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	<0.1	--
		Jul-14	--	<2	3.46	58	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	2.9	<0.1	--	<2	--	<2	--	--	<2	--	--	2.25	<25	--	<0.5	--
		Oct-14	--	<1	2.9	58	<2	--	<0.5	--	<2	1.3	2	--	<1	--	--	--	<0.2	--	17	--	--	<2	--	<1	--	--	<1	--	--	3.2	<10	--	<0.1	--
		Jan-15	--	<2	<2	55	<2	--	2	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	4	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.16	--
		Apr-15	--	<2	<2	58	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	6.1	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		Jul-15	--	<2	<2	52.5	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	2.51	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		Oct-15	--	<2	<2	46.4	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	2.85	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Jan-16	--	<2	<2	52.1	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	8.07	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Apr-16	--	<2	<2	61.1	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	6.36	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Jul-16	--	<2	<2	51.7	<2	--	1.26	--	<2	<2	5.03	--	<2	--	--	--	<0.2	--	5.2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Oct-16	--	<2	<2	51.8	<2	11900	<1	670	<2	--	--	--	<2	18.4	--	--	<0.2	<5	10.4	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	1210
		Jan-17	--	<2	<1	<200	<4	11400	<1	590	<2	0.785	<2	--	<1	10.4	--	--	<0.2	<5	10.2	--	--	<5	--	<1	--	--	<1	--	--	<50	<5	388	<0.5	1040
CUF-10-1	N/A	Jan-11	350	<1	<1	66	<2	<200	<0.5	45	<2	7.4	<2	1500	<1	--	7.8	4000	<0.2	<5	6	<0.1	0.56		--	<1	130	43	<1	--	--	<2	<10	17	0.35	70
		Jul-11	120	<1	1.1	59	<2	<200	1.5	47	<2	6.4	<2	1500	<1	--	6.9	4300	<0.2	5.7	11	<0.1	0.9	<1	--	<1	120	46	<1	--	--	<2	10	17	0.28	69
		Jan-12	1800	<1	3.45	69	<2	<200	<0.5	44	2.5	12	<2	3300	<1	--	7.4	4300	<0.2	<5	30	<0.1	0.71	1.3	--	<1	110	46	<1	--	--	3.1	11	17	0.36	69
		Jul-12	--	<1	8.4	60	<2	--	<0.5	--	<2	10	3.9	--	<1	--	--	--	<0.2	--	12	<0.1	--	<1	--	1.9	--	--	<1	--	--	<2	11	--	--	--
		Jan-13	--	<1	1.1	55	<2	--	<0.5	--	<2	8.9	<2	--	<1	--	--	--	<0.2	--	16	<0.1	--	<1	--	<1	--	--	<1	--	--	<2	12	--	0.26	--
		Jul-13	--	<1	<1	51	<1	--	1.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	11	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	0.32	--
		Jan-14	--	<2	<2	54.1	<4	--	<1	--	<2	--	--	--	<2	--	--	--	<0.2	--	11.3	<0.1	--	<2	--	<2	--	--	<2	--	--	--	--	--	0.521	--
		Jul-14	--	<2	<2	53.3	<4	--	<1	--	<2	--	--	--	<2	--	--	--	<0.2	--	10.9	<0.1	--	<2	--	<2	--	--	<2	--	--	--	--	--	0.358	--
		Oct-15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.1	--	--	--	--	--	--	--	--	--	--	--	--	0.377	--
		Apr-16	--	<2	<2	49.8	<2		<1		<2	7.31	<5	--	<2	--	--	--	<0.2	--	10.7	<0.1	--	<2	--	<2			<1	--	--	<5	<25		0.34	--
CUF-10-2	N/A	Jan-11	<100	<1	2	71	<2	<200	<0.5	43	<2	150	<2	18000	<1	--	5.9	16000	<0.2	<5	13	0.14	<0.5	--	--	<1	220	21	<1	--	--	<2	24	52	<0.1	110
		Jul-11	<100	<1	2.2	69	<2	210	<0.5	43	<2	130	<2	26000	<1	--	4.8	17000	<0.2	<5	11	<0.1	0.54	<1	--	<1	220	14	<1	--	--	<2	20	49	<0.1	110
		Jan-12	140	<1	4.7	80	<2	240	<0.5	41	2.3	180	<2	26000	<1	--	5.9	18000	<0.2	<5	17	<0.1	<0.5	<1	--	<1	170	15	<1	--	--	<2	28	47	<0.1	110
		Jul-12	<100	<1	3.15	70	<2	240	<0.5	42	<2	180	<2	27000	<1	--	5.3	18000	<0.2	<5	18	<0.1	<0.5	<1	--	<1	200	15	<1	--	--	<10	26	--	--	--
		Jan-13	<100	<1	1.7	70	<2	240	<0.5	38	2	150	<2	28000	<1	--	5.4	17000	<0.2	5.2	15	<0.1	0.6	<1	--	<1	160	21	<1	--	--	<2	22	--	<0.1	120
		Jul-13	--	<1	2	57	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	11	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	0.14	--
		Jan-14	--	<2	3.5	68.3	<4	--	<1	--	2.94	--	--	--	<2	--	--	--	<0.2	--	11.7	<0.1	--	<2	--	<2	--	--	<2	--	--	--	--	--	0.155	--
		Jul-14	--	<2	3.01	62.5	<4	--	<1	--	<2	--	--	--	<2	--	--	--	<0.2	--	12.5	<0.1	--	<2	--	<2	--	--	<2	--	--	--	--	--	<0.1	--
		Oct-15	--	<2	4.17	72.9	<2	--	<1	--	<2	147	<5	--	<2	--	--	--	<0.2	--	12.4	<0.1	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		Apr-16	--	<2	3.76	65.7	<2	--	<1	--	<2	157	<5	--	<2	--	--	--	<0.2	--	13.9	<0.1	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--

Well ID	Program	Date	Metals																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
MCLs		TDEC		6	10	2000	4		5		100				15				2		100	10		50		100			2						4	
		EPA			50	1000			10		50				50				2			10		10		50									4	
CUF-93-2	N/A	Sep-93	2800	<1	**13**	60	**5**	5000	<0.1	270	22	--	<10	6100	11	30	8.5	980	<0.2	560	17	--	17	<1	--	<10	540	29	--	--	--	<10	20	19	--	400
		Jan-94	3100	1	8	40	<1	2300	0.1	180	2	<1	<10	5400	2	50	7	670	<0.2	560	6	<0.01	18	<1	4400	<10	390	32	<50	--	--	<10	<10	18	0.4	420
		Apr-94	3000	<1	7	50	<1	2100	0.1	250	4	2	<10	6200	2	40	9.4	980	<0.2	510	3	<0.01	20	<1	2600	<10	550	31	<50	--	--	<10	20	19	0.3	390
		Jul-94	1000	3	7	30	<1	5400	0.1	190	3	<1	<10	2900	<1	40	6.5	610	<0.2	550	2	0.55	16	<1	3900	<10	330	28	<50	--	--	<10	<10	18	0.2	410
		Jan-95	390	<1	**16**	30	<1	6200	<0.1	310	8	<1	<10	2700	3	--	12	740	<0.2	--	1	--	20	<1	--	<10	540	29	<2	--	--	<10	<10	86	0.3	20
		Jul-95	500	2	5	20	<1	5700	<0.1	320	<1	<1	<10	5500	<1	--	18	1600	<0.2	--	<1	--	20	<1	--	<10	590	28	<2	--	--	<10	<10	86	0.3	740
		Jan-96	470	<1	**11**	40	<1	8200	0.2	600	<1	<1	<10	5000	<1	--	35	1800	<0.2	--	<1	--	28	2	--	<10	1000	32	<2	--	--	<10	<10	360	0.3	790
		Jul-96	220	<1	4	40	<1	13000	<0.1	790	1	<1	<10	4600	<1	--	80	1700	0.4	--	<1	--	33	<1	--	<10	1300	32	<2	--	--	<10	<10	440	0.2	1400
		Jan-97	120	<1	5	30	<1	12000	<0.1	800	<1	<1	<10	4900	<1	--	82	1800	<0.2	--	<1	--	36	6	--	<10	1300	32	<1	--	--	<10	<10	550	0.2	1100
		Jul-97	90	<1	2	40	<1	12000	<0.1	880	<1	2	<10	11000	<1	--	78	3700	<0.2	--	2	--	36	<1	--	<10	1600	32	<2	--	--	<10	<10	550	0.2	1300
		Jan-98	110	3	1	30	<1	13000	0.2	990	2	3	<10	5900	<1	--	75	2500	<0.2	--	6	--	41	<1	--	<10	1700	36	<2	--	--	<10	<10	410	0.2	1600
		Jul-98	70	<1	2	30	<1	15000	<0.1	760	<1	<1	<10	2500	1	--	63	1500	<0.2	--	3	--	46	<1	--	<10	1700	35	<2	--	--	<10	<10	700	0.2	1700
		Jan-99	50	6	2	30	<1	16000	<0.1	1000	1	2	<10	1600	<1	--	75	1100	<0.2	--	11	--	51	<1	--	<10	1800	35	<2	--	--	<10	<10	340	0.2	2600
		Jul-99	<50	**10**	3	20	<1	23000	<0.1	980	<1	3	<10	4500	<1	--	98	2200	<0.2	--	2	--	48	<1	--	<10	2100	35	<2	--	--	<10	<10	770	0.3	2400
		Jan-00	2200	3.2	**12**	40	<1	21000	<0.1	860	2.6	4.5	<10	14000	<1	--	100	4200	<0.2	570	1.8	--	38	<1	14000	<10	2200	35	<2	<50	25	20	<10	730	0.3	1800
		Jul-00	<50	<1	**16**	36	<1	23000	<0.1	810	8.9	<1	15	10000	<1	--	110	3800	<0.2	590	4.6	--	45	2.3	4400	<10	2300	34	<2	<50	<5	11	<10	900	0.26	1900
		Jan-01	<50	<1	3	31	<1	21000	<0.1	1100	<1	<1	17	3300	<1	--	120	1800	<0.2	630	<1	--	81	<1	2300	10	2100	35	<2	--	<5	<10	19	930	0.31	1900
		Jul-01	<50	<1	<1	35	<1	24000	<0.1	950	<1	<1	31	4300	<1	--	120	2300	<0.2	680	<1	--	43	<1	2900	<10	2400	34	<2	<50	14	<10	<10	990	0.32	1700
		Jan-02	<50	<1	3.5	37	<1	25000	0.33	1100	<1	8.7	39	3200	<1	--	150	2000	0.1	730	<1	1.5	59	3.9	--	10	2700	30	<2	<50	29	<10	14	1100	0.28	1800
		Jul-02	<50	<1	<1	33	<1	20000	0.2	1100	<1	<1	23	2400	2	--	170	1700	<0.1	620	5	1.3	58	<1	--	<10	2300	36	<2	<50	18	<10	<10	1200	0.31	1900
		Jan-03	<50	<1	<1	30	<1	20000	<0.1	1100	<1	<1	20	3500	1.5	--	150	1800	<0.1	630	<1	0.51	48	5.2	--	<10	2500	34	<2	2000	<5	<10	<10	1100	0.39	1800
		Jul-03	<50	2.1	0.4	30	<1	25000	0.35	1100	1.7	2.5	20	1600	<0.1	--	143	1200	<0.1	570	33.1	0.39	52	20.1	--	<10	2300	40	<0.1	2100	<5	10	<10	1100	0.44	2000
		Jan-04	<50	1.4	2.3	30	<1	25000	0.4	1200	1	5.8	<10	3000	<0.1	--	190	1600	<0.1	620	25.7	0.23	47	19	--	<10	2500	37	<0.1	60	<5	10	<10	1200	0.5	1800
		Jul-04	<50	<6	<1	30	<1	25000	<0.1	1200	1	<1	<10	4400	<1	--	200	1800	<0.1	610	<1	0.62	52	6	--	<10	2700	37	<2	<50	<5	10	<10	1300	0.45	1700
		Jan-05	<50	**7**	10	30	<1	23000	<0.1	1200	2	1	<10	6000	<1	--	240	2500	<0.1	570	1	0.63	51	6	--	<10	2500	40	<2	<50	<5	10	<10	980	0.36	1790
		Mar-05	--	**7**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jul-05	<50	6	3	30	<1	35000	<0.1	1100	<1	<1	<10	3500	1	--	250	2000	<0.1	550	<1	0.67	55	1	--	<10	2800	37	<2	<50	<5	<10	<10	1400	0.51	1932
		Jan-06	80	5	2	<10	<1	34000	<0.1	1100	<1	2	<10	3300	<1	--	300	2100	<0.1	560	<1	0.84	65	1	--	<10	3200	40	<2	--	--	<10	<10	1500	0.8	2030
		Jul-06	<200	<3	4	40	<1	31000	<0.1	1400	<1	1	<10	3200	1	--	280	1800	<0.1	550	<1	0.55	55	3	--	<10	2900	41	<2	--	--	10	<10	1500	0.86	2000
		Jan-07	<200	<3	7	40	<1	34000	<0.1	1100	2	4	<10	5700	<1	--	310	2900	<0.1	510	<1	0.65	54	1	--	10	3000	35	<2	--	--	<10	<10	1600	1.2	2005
		Jul-07	730	<1	9	64	<1	13000	1.8	830	3	2.9	2.7	2500	<1	--	55	16000	<0.2	21	22	1.4	31	<1	--	0.53	1300	55	<1	--	--	<10	<10	1300	1	1800
		Jan-08	110	1.8	**13**	41	<2	35000	1.2	1000	1.2	3.5	6.7	4100	<1	--	270	2300	<0.2	490	24	2	58	**98**	--	1.4	2900	40	<1	--	--	<10	<10	1600	1.1	2000
		Mar-08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	40	--	--	--	--	--	--	--	--	--	--	--	--
		Jul-08	<100	<5	**21**	41	<2	38000	<2.5	1000	1.7	6.4	8.7	5600	1.4	--	260	2800	<0.2	520	55	2.4	56	**60**	--	0.6	3200	40	<1	--	--	<10	<10	1500	0.6	1900
		Jan-09	<100	2.2	9.6	42	<2	38000	2.1	1200	3.2	6.6	8.3	5100	<1	--	260	2600	<0.2	550	58	2	60	**70**	--	1.1	3100	42	<1	--	--	<10	<10	1500	0.61	1900
		Mar-09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	--	--	--	--	--
		Apr-09	--	1.6	9.2	39	<1	--	1.6	--	2.4	3.9	<1	--	<1	--	--	--	<0.2	--	36	--	--	**120**	--	<0.5	--	--	<1	<1	--	27	10	--	0.22	--
		Jul-09	<100	1.5	**22**	38	<2	35000	1.6	1000	2.1	7	6.5	4500	<1	--	240	2800	<0.2	500	53	1.9	58	**150**	--	<1	3000	41	<1	--	--	<10	19	1600	0.73	1900
		Oct-09	<100	2.3	**14**	41	<2	38000	<2.5	1100	<10	5.7	<10	4600	<1	--	270	2700	<0.2	540	21	1.6	62	**91**	--	<5	3000	43	<1	--	--	<10	<50	1500	0.66	2000
		Jan-10	<100	2.7	**14**	39	<2	36000	<0.5	1000	<2	6.4	10	5100	<1	--	260	2800	<1	480	23	1.6	55	**64**	--	<1	3100	39	<1	--	--	<10	<10	1400	0.73	2000
		Apr-10	140	1.4	<10	38	<2	34000	0.82	970	3.8	8.7	<2	11000	<1	--	280	4900	<1	420	29	0.96	52	30	--	<1	3400	40	<1	--	--	<10	<10	1400	0.65	2100
		Jul-10	<100	<1	9.3	36	<2	34000	<0.5	950	3.1	9.4	<2	13000	<1	--	270	4900	<1	430	20	0.89	48	**72**	--	<1	3000	38	<1	--	--	<10	<10	1300	0.44	1900
		Oct-10	<100	<1	**17**	40	<2	34000	<0.5	950	<2	8.2	<2	12000	<1	--	270	4800	<0.2	430	18	1.3	47	35	--	<1	3200	37	<1	--	--	5.3	<10	1400	0.74	2000
		Jan-11	210	1.5	7.2	37	<2	33000	<0.5	990	<2	5.5	<2	7800	<1	--	250	3300	<0.4	470	<1	0.92	50		--	<1	3200	38	<1	--	--	17	<10	1300	0.77	1900
		Apr-11	210	<1	**12**	27	<2	34000	<0.5	980	<2	7.2	<2	7600	<1	--	220	3500	<0.2	510	63	0.55	47	25	--	<1	3000	38	<1	--	--	30	<10	1400	0.8	1800
		Jun-11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CUF-96-6	N/A	Jul-96	1300	<1	1	110	<1	600	<0.1	320	25	<1	10	1200	2	--	2.9	46	--	--	14	--	0.1	<1	--	--	1800	83	--	--	--	<10	<10	120	--	410
		Jan-97	4400	<1	<1	180	<1	700	0.2	470	22	--	<10	4200	4	--	19	70	--	--	10	--	11	2	--	--	3100	43	--	--	--	<10	10	50	--	720
		Jul-97	100	<1	<1	60	<1	900	<0.1	340	2	<1	<10	80	<1	--	5.7	14	--	--	4	--	9.8	<1	--	--	1600	89	--	--	--	<10	<10	180	--	710
		Feb-99	5900	**10**	5	150	<1	900	0.3	560	69	31	<10	6800	7	--	59	2300	<0.2	--	52	--	8.9	3	--	<10	2600	47	<2	--	--	10	30	90	0.1	1100
		Jul-99	380	5	<1	50	<1	1200	0.2	340	14	6	<10	440	6	--	49	220	<0.2	--	11	--	10	<1	--	<10	2400	52	<2	--	--	<10	10	93	0.2	1100
CUF-96-7	N/A	Jul-96	280	<1	2	50	<1	800	<0.1	180	<1	3	88	2500	**330**	--	16	4300	--	--	7	--	1	<1	--	--	260	16	--	--	--	<10	<10	13	--	180
		Jan-97	<50	<1	1	100	<1	<500	0.1	190	<1		<10	12000	<1	--	16	3100	--	--	<1	--	1.3	<1	--	--	400	31	--	--	--	<10	<10	11	--	66
		Jul-97	<50	<1	2	110	<1	<500	<0.1	180	<1	<1	<10	13000	<1	--	18	3200	--	--	<1	--	0.9	<1	--	--	450	31	--	--	--	<10	<10	12	--	59
		Jul-00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CUF-96-8	N/A	Jul-96	--	--	**41**	60	<1	<500	1	14	10	94	67	62000	14	--	4.5	2400	--	--	**140**	--	2.2		--	--	140	25	--	--	--	10	330	4	--	14
		Jan-97	630	<1	2	<10	<1	<500	1	9.5	<1	--	<10	1300	<1	--	1.9	1100	--	--	19	--	3	<1	--	--	<50	19	--	--	--	<10	10	5	--	26
		Jul-97	2200	<1	5	<10	<1	<500	2	6	5	34	30	5000	<1	--	1.2	760	--	--	28	--	1.8	<1	--	--	<50	7.2	--	--	--	<10	70	3	--	21
		Feb-99	2300	<1	6	70	<1	<200	0.5	95	5	15	<10	5900	2	--	15	560	<0.2	--	32	--	24	<1	--	<10	570	14	<2	--	--	<10	50	6	0.1	130
		Jul-99	9800	2	**17**	40	<1	<200	0.5	46	16	47	30	27000	<1	--	7.2	740	<0.2	--	83	--	22	1	--	<10	250	11	<2	--	--	10	160	3	<0.1	87
		Jul-00	4100	<1	10	61	<1	<200	0.41	96	30	34	19	9400	1.5	--	13	1100	<0.2	1100	46	--	10	<1	11000	<10	280	8.8	<2	<50	37	<10	71	7.8	<0.1	150

			Metals																																Anions		
Well ID	Program	Date	Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
MCLs		TDEC		6	10	2000	4		5		100				15				2		100	10		50		100			2						4	
		EPA			50	1000			10		50				50				2			10		10		50									4	
CUF-RS	N/A	Jan-94	510	2	<1	30	<1	<500	0.1	110	<1	<1	<10	670	<1	<10	5.8	55	<0.2	<20	<1	2.8	0.7	2	3800	<10	390	5.5	<50	--	--	<10	<10	9	0.4	43
		Apr-94	180	<1	<1	30	<1	<500	<0.1	110	1	<1	<10	470	<1	<10	5.8	76	<0.2	<20	2	1.1	0.7	<1	1700	<10	410	5.3	<50	--	--	<10	10	9	0.4	45
		Jul-94	1900	<1	1	40	<1	<500	0.3	120	1	<1	<10	2100	2	<10	6.1	90	<0.2	<20	3	2.1	0.8	<1	8100	<10	330	5.1	<50	--	--	<10	<10	10	0.2	43
		Jan-95	320	<1	3	10	<1	<500	<0.1	110	<1	<1	<10	370	<1	--	6.5	19	<0.2	--	<1	--	0.5	<1	--	<10	410	5.1	<2	--	--	<10	<10	7	0.3	19
		Jul-95	2400	<1	<1	40	<1	<500	<0.1	110	<1	<1	<10	3500	5	--	6.1	110	<0.2	--	3	--	0.7	<1	--	<10	410	4.9	<2	--	--	<10	10	9	0.4	48
		Jan-96	550	<1	<1	10	<1	<500	<0.1	120	<1	<1	<10	610	<1	--	6	17	<0.2	--	<1	--	0.7	<1	--	<10	350	5	<2	--	--	<10	<10	7	0.4	43
		Jul-96	700	<1	<1	20	<1	<500	<0.1	100	<1	<1	<10	1000	1	--	5.3	55	<0.2	--	<1	--	0.9	<1	--	<10	340	5.3	<2	--	--	<10	<10	9	0.3	44
		Jan-97	550	<1	<1	20	<1	<500	<0.1	110	<1	<1	<10	630	<1	--	5.4	23	<0.2	--	<1	--	0.8	<1	--	<10	310	5	<1	--	--	<10	<10	7	0.3	56
		Jul-97	130	<1	<1	20	<1	<500	<0.1	110	<1	<1	<10	280	<1	--	5.7	44	<0.2	--	<1	--	0.5	<1	--	<10	350	5	<2	--	--	<10	<10	8	<0.1	51
		Jan-98	60	<1	<1	20	<1	<500	0.2	100	<1	<1	<10	90	<1	--	5.4	17	<0.2	--	4	--	0.4	<1	--	<10	350	5.3	<2	--	--	<10	<10	8	0.3	42
		Jul-98	140	<1	<1	20	<1	<200	<0.1	110	<1	<1	<10	160	<1	--	5.7	41	<0.2	--	<1	--	1	<1	--	<10	370	5.2	<2	--	--	<10	<10	8	0.3	55
		Jan-99	<50	<1	<1	20	<1	<200	0.7	100	<1	<1	<10	40	<1	--	5.4	9	<0.2	--	2	--	0.8	<1	--	<10	310	4.7	<2	--	--	<10	<10	12	0.2	72
		Jul-99	730	<1	1	40	<1	<200	<0.1	110	<1	<1	<10	710	<1	--	6.1	610	<0.2	--	2	--	1.4	3	--	<10	430	5.1	<2	--	--	<10	<10	10	0.4	66
		Jan-00	2800	<1	3.4	140	<1	80	0.18	100	6.6	2.3	<10	4300	1	--	7.2	2100	<0.2	<20	2.5	--	3.9	<1	16000	<10	400	5.4	<2	<50	30	<10	<10	11	0.3	54
		Jan-01	190	<1	<1	27	<1	210	0.5	120	<1	<1	33	440	7	--	7.1	300	<0.2	<20	<1	--	1	<1	5500	<10	<50	5.9	<2		<5	<10	31	10	0.27	67
		Jul-01	2300	<1	<1	63	<1	200	<0.1	110	<1	<1	11	2500	4.2	--	6.6	610	<0.2	<20	<1	--	1.7	<1	9100	<10	400	4.9	<2	<50	27	<10	15	11	0.3	51
		Jan-02	660	<1	<1	40	<1	290	<0.1	92	<1	<1	<10	580	<1	--	6.5	450	<0.1	<20	<1	0.55	3.9	<1	--	<10	350	3.6	<2	<50	17	<10	11	14	0.32	44
		Jul-02	3800	<1	<1	160	<1	<200	1.3	70	<1	3	15	3500	2.9	--	8.5	1700	<0.1	<20	7	0.41	24	<1	--	<10	310	5.7	<2	51	95	12	26	22	0.82	38
		Jan-03	370	<1	<1	60	<1	<200	<0.1	95	<1	<1	<10	560	<1	--	6	910	<0.1	<20	<1	1.8	4.9	<1	--	<10	340	5	<2	640	<5	<10	<10	13	0.32	48
		Jul-03	3700	1.2	9.2	230	<1	200	0.12	53	1.8	3.1	<10	6300	3.4	--	7.1	2600	<0.1	<20	5.7	1.4	21	0.8	--	<10	260	5	<0.1	690	140	10	20	18	0.55	22
		Jan-04	1000	<0.6	<0.1	40	<1	<200	0.1	110	0.4	0.6	10	1200	0.8	--	5.8	110	<0.1	<20	2.5	3	0.3	0.4	--	<10	420	5.9	<0.1	<50	24	<10	<10	12	0.26	47
		Jul-04	5700	<3	<1	70	<1	<200	<0.1	120	4	3	<10	6200	<1	--	6.7	320	<0.1	<20	5	2.5	<0.1	1	--	<10	440	4	<2	<50	70	<10	10	11	0.26	50
		Jan-05	250	<3	<1	30	<1	<200	<0.1	120	<1	<1	<10	320	<1	--	6.4	51	<0.1	<20	<1	3.1	2.1	1	--	<10	440	7.4	<2	<50	<5	<10	<10	11	0.24	45
		Jul-05	1800	<3	1	40	<1	<200	<0.1	120	<1	<1	<10	2200	1	--	6.1	290	<0.1	<20	1	2.4	1.8	<1	--	<10	430	6	<2	<50	25	<10	<10	9.8	0.28	45
		Jan-06	1400	<3	<1	40	<1	<200	<0.1	110	2	<1	<10	1200	1	--	5.8	87	<0.1	<20	<1	3.2	0.9	<1	--	<10	420	8.6	<2	--	--	<10	<10	9.6	0.27	49
		Jul-06	4700	<3	<1	80	<1	<200	0.1	120	3	1	<10	4900	3	--	6.7	400	<0.1	<20	4	1.9	1.3	<1	--	<10	430	5.6	<2	--	--	<10	10	8.9	0.27	46
		Jan-07	600	<3	1	40	<1	<200	0.6	110	<1	<1	<10	650	1	--	5.9	110	<0.1	<20	<1	2.8	1.6	<1	--	<10	390	3.5	<2	--	--	<10	<10	6.6	0.23	49
		Jul-07	1400	<1	2	53	<1	<200	<0.5	120	1.5	1	2	1300	<1	--	6.5	280	<0.2	12	3.8	1.8	2.5	3.1	--	<0.5	420	5.4	<1	--	--	<10	<10	7.4	0.25	46
		Jan-08	700	<1	<1	35	<2	<200	<0.5	120	<1	<1	<1	500	<1	--	6.3	56	<0.2	<5	2.6	7.4	1.2	1.6	--	<0.5	390	7	<1	--	--	<10	<10	7.4	0.23	48
		Jan-09	300	<5	<5	34	<2	260	<2.5	130	<5	<5	13	530	<5	--	6.6	58	<0.2	<5	7.4	6.1	1.1	<2	--	<2.5	450	6.6	<5	--	--	<10	150	8	0.22	52
		Apr-09	--	<1	<1	37	<1	--	<0.5	--	1.1	<1	2.9	--	<1	--	--	--	<0.2	--	4.4	--	--	1.3	--	<0.5	--	--	<1	<1	--	3.6	21	--	0.38	--
		Jul-09	330	<1	1.9	68	<2	2200	<0.5	420	3.5	1.5	2.8	270	1.5	--	16	74	<0.2	<5	7.4	4	6.2	<1	--	<1	1100	26	<1	--	--	<10	57	9.7	0.26	38
		Oct-09	570	<1	<1	49	<2	<200	<0.5	130	<2	<1	<2	1400	<1	--	6.8	280	<0.2	<5	3.4	4.4	1.7	1.3	--	<1	420	6.3	<1	--	--	<10	<10	9.6	0.26	50
		Jan-10	770	<1	<1	44	<2	320	<0.5	130	<2	<1	4.2	1800	<1	--	6.8	280	<0.2	<5	3.8	5.9	4.4	<1	--	<1	430	6.6	<1	--	--	<10	13	8.8	0.26	52
		Apr-10	600	<1	<10	55	<2	970	<0.5	210	2.2	<1	7.8	1900	<1	--	10	710	<0.2	<5	4.3	6.8	28	<10	--	<1	570	18	<1	--	--	<10	69	10	0.21	51
		Jan-11	490	<1	<1	33	<2	<200	<0.5	130	<2	<1	<2	550	<1	--	6.8	67	<0.2	<5	<1	8.9	0.71	4	--	<1	430	6.5	<1	--	--	<2	<10	9.2	0.2	55
		Apr-11	600	<1	<1	31	<2	280	<0.5	110	<2	<1	<2	420	<1	--	5.9	17	<0.2	<5	16	5.2	<0.5	<1	--	<1	360	5.9	<1	--	--	<2	<10	7.8	0.19	51
		Jul-11	190	<1	<1	32	<2	<200	<0.5	110	<2	<1	<2	350	<1	--	5.7	61	<0.2	5.7	<1	5.2	0.78	<1	--	<1	390	6.1	<1	--	--	<2	<10	7.3	0.23	48
		Oct-11	180	<1	<1	31	<2	<200	<0.5	110	<2	<1	<2	310	<1	--	5.9	43	<0.2	<5	2.8	4.9	0.8	<1	--	<1	380	5.6	<1	--	--	<2	<10	7.4	0.23	50
		Jan-12	180	<1	<1	36	<2	<200	<0.5	120	<2	<1	<2	320	<1	--	6.3	57	<0.2	<5	2.4	3.8	1.2	<1	--	<1	400	6	<1	--	--	<2	<10	6.5	0.26	52
		Apr-12	--	<1	1.2	31	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	1.8	--	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	0.22	--
		Jul-12	--	<1	<1	43	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	3.9	--	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	0.29	--
		Oct-12	330	<1	<1	37	<2	<200	<0.5	120	<2	<1	<2	510	<1	--	6.2	99	<0.2	5.2	2.9	3	1.1	<1	--	<1	420	5.4	<1	--	--	<2	<10	7.9	0.36	57
		Jan-13	--	<1	5.3	31	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	2.9	4.8	--	<1	--	<1	--	--	<1	--	--	2.3	<10	--	0.22	--

Well ID	Program	Date	Metals																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
MCLs		TDEC		**6**	**10**	**2000**	**4**		**5**		**100**				**15**				**2**		**100**	**10**		**50**		**100**			**2**						**4**	
		EPA			**50**	**1000**			**10**		**50**				**50**				**2**			**10**		**10**		**50**									**4**	
CUF-RS cont.		Apr-13	<100	<1	<1	32	<2	<200	<0.5	110	2.2	<1	<2	140	<1	--	6	34	<0.2	<5	2.3	2.8	1.1		--	<1	400	5.7	<1	--	--	4.2	<10	11	0.31	57
		Jul-13	--	<1	<1	36	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	2.1	2.9	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	0.22	--
		Oct-13	500	<1	<1	33.9	<1	21.8	<1	110	<1	<1	1.4	598	<1	--	5.57	47.4	<0.2	<1	<1	3.1	--	<1	--	<0.5	385	5.22	<1	--	--	<1	<10	6.7	<0.4	57.1
		Jan-14	--	<2	<2	31.6	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	3.07	--	<2	--	<2	--	--	<2	--	--	<20	<25	--	0.276	--
		Apr-14	--	<2	<2	28.5	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	3.57	--	<2	--	<2	--	--	<2	--	--	<20	<25	--	0.182	--
		Jul-14	--	<2	<2	29.6	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	3.29	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.221	--
		Oct-14	--	<1	<1	44	<2	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	2.7	--	--	<1	--	<1	--	--	<1	--	--	2.2	<10	--	0.23	--
		Jan-15	--	<2	<2	30	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.2	--
		Apr-15	--	<2	<2	31	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.21	--
		Jul-15	--	<2	<2	38.3	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.256	--
		Oct-15	--	<2	<2	31.5	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	0.259	--
		Jan-16	--	<2	<2	29.6	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	0.231	--
		Apr-16	--	<2	<2	34.3	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	0.232	--

MCL - Maximum Contaminant Level
EPA - Environmental Protection Agency; MCLs established in 40 CFR Part 257, Appendix I
TDEC - Tennessee Department of Environment and Conservation; MCLs established in Rules of TDEC Solid Waste Management Appendix III
Bold numbers indicate that measured values exceed TDEC MCLs
Grey cells indicate that measured values exceed EPA MCLs
ug/L - micrograml per liter
mg/L - milligrams per liter
cont. - continued
N/A - not available
-- no data

Table 1B
Groundwater Elevation Data

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-101	1/19/2011	--	--	--
	4/4/2011	367.49	49.59	15.78
	7/26/2011	365.75	49.59	17.52
	7/27/2011	0.00	--	--
	7/27/2011	0.00	--	--
	1/10/2012	0.00	--	--
	1/10/2012	366.93	49.59	16.33
	4/17/2012	363.88	--	19.38
	7/18/2012	361.46	49.59	21.81
	7/19/2012	--	--	--
	7/19/2012	--	--	--
	1/15/2013	--	--	--
	1/15/2013	365.56	49.59	17.71
	7/1/2013	--	--	--
	7/2/2013	366.08	49.59	17.19
	10/8/2013	364.47	--	18.79
	1/23/2014	366.41	--	16.86
	1/23/2014	366.41	49.59	16.86
	4/8/2014	366.34	49.59	16.92
	7/22/2014	364.15	49.59	19.12
	10/21/2015	363.46	49.59	19.81
	4/12/2016	365.88	49.59	17.38
	4/13/2016	--	--	--
	1/23/2017	384.49	--	1.21
CUF-10-2	1/19/2011	363.72	36.18	18.53
	1/19/2011	--	--	--
	4/4/2011	364.70	36.18	17.55
	7/26/2011	--	--	--
	7/26/2011	--	--	--
	7/26/2011	365.75	36.18	16.50
	1/10/2012	--	--	--
	1/10/2012	362.70	36.18	19.55
	4/17/2012	363.98	--	18.27
	7/18/2012	--	--	--
	7/18/2012	--	--	--
	7/18/2012	364.34	36.18	17.91
	1/14/2013	--	--	--
	1/14/2013	--	--	--
	1/14/2013	365.85	36.18	16.40
	7/1/2013	--	--	--
	7/1/2013	364.31	36.18	17.94
	10/8/2013	364.54	--	17.71
	1/22/2014	363.88	--	18.37
	1/22/2014	363.88	36.18	18.37
	4/8/2014	364.01	36.18	18.24
	7/21/2014	364.05	36.18	18.20
	10/20/2015	363.72	36.18	18.53
	4/12/2016	363.72	36.18	18.53
CUF-102	1/23/2017	393.06	--	9.84
CUF-120	1/23/2017	386.30	--	6.89
CUF-201	11/9/2016	387.87	--	12.54
	1/23/2017	388.53	--	11.88
CUF-202	11/9/2016	376.73	--	6.55
	1/24/2017	378.88	--	4.40
CUF-204	10/19/2016	407.05	48.74	--
	10/19/2016	--	--	--

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-204 cont.	11/9/2016	406.28	--	33.38
	1/23/2017	417.32	--	22.34
	1/24/2017	--	--	--
CUF-205	11/9/2016	361.93	--	22.58
	1/26/2017	368.83	--	15.68
CUF-206	11/9/2016	362.16	--	36.51
	1/26/2017	364.48	--	34.19
CUF-207	11/8/2016	363.28	--	34.91
	1/26/2017	365.48	--	32.71
CUF-208	11/8/2016	358.88	--	39.50
	1/26/2017	361.96	--	36.42
CUF-209	11/8/2016	360.87	--	37.36
	1/25/2017	362.67	--	35.56
CUF-210	11/8/2016	369.56	--	28.64
	1/25/2017	371.49	--	26.71
CUF-211	11/7/2016	357.63	--	41.13
	1/25/2017	360.67	--	38.09
CUF-212	11/7/2016	354.34	--	44.37
	1/24/2017	357.70	--	41.01
	1/24/2017	--	--	--
CUF-213	11/7/2016	376.90	--	22.15
	1/25/2017	376.97	--	22.08
CUF-93-1	9/25/1993	--	61.07	35.33
	1/11/1994	362.77	--	34.54
	1/11/1994	--	61.07	34.51
	4/5/1994	367.46	61.07	29.85
	4/5/1994	--	61.07	29.85
	7/19/1994	363.39	62.12	33.92
	7/19/1994	--	62.12	33.52
	1/31/1995	360.96	62.12	36.34
	4/6/1995	361.16	61.99	36.15
	7/12/1995	364.18	61.07	33.13
	7/13/1995	--	62.12	33.13
	1/16/1996	--	62.02	34.54
	1/17/1996	--	62.02	34.54
	7/23/1996	364.60	62.09	32.80
	7/24/1996	--	62.09	32.80
	1/15/1997	362.67	62.09	34.74
	1/16/1997	--	62.09	34.74
	7/22/1997	363.85	62.09	33.55
	7/23/1997	--	62.09	33.55
	1/28/1998	361.82	62.06	35.59
	1/29/1998	361.82	62.06	35.59
	7/14/1998	364.34	62.06	33.06
	7/15/1998	364.34	62.06	33.06
	7/15/1998	--	--	--
	1/25/1999	371.07	62.06	26.34
	1/25/1999	371.07	62.06	26.34
	7/20/1999	363.56	0.00	33.85
	7/21/1999	363.56	62.06	33.85
	11/18/1999	360.73	62.06	36.67
	12/17/1999	361.19	62.06	36.21
	1/19/2000	361.26	62.06	36.15
	1/19/2000	361.26	62.06	36.15
	2/25/2000	361.23	62.06	36.18
	3/28/2000	362.37	62.06	35.03

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-1 cont.	4/19/2000	363.75	62.06	33.65
	5/18/2000	364.67	62.06	32.73
	6/23/2000	364.93	62.06	32.47
	7/11/2000	363.85	62.06	33.55
	7/11/2000	363.85	62.06	33.55
	8/30/2000	361.95	62.06	35.46
	9/22/2000	361.29	62.06	36.11
	12/15/2000	361.32	62.06	36.08
	1/29/2001	361.29	62.06	36.11
	1/29/2001	361.29	62.06	36.11
	2/26/2001	363.95	62.06	33.46
	3/26/2001	361.39	62.06	36.01
	4/18/2001	364.31	62.06	33.10
	7/10/2001	364.44	62.06	32.96
	7/10/2001	364.44	62.06	32.96
	1/16/2002	360.77	62.06	36.64
	1/16/2002	360.77	62.06	36.64
	7/9/2002	363.36	62.06	34.05
	7/9/2002	363.36	62.06	34.05
	1/29/2003	360.57	62.06	36.83
	1/29/2003	360.57	62.06	36.83
	7/23/2003	363.10	62.06	34.31
	7/23/2003	--	62.06	34.31
	1/26/2004	362.05	62.06	35.36
	1/26/2004	--	62.06	35.36
	7/14/2004	363.69	62.06	33.72
	7/14/2004	--	62.06	33.72
	1/19/2005	364.90	62.06	32.50
	1/19/2005	--	62.06	32.50
	7/12/2005	362.80	62.06	34.60
	7/12/2005	--	62.06	34.60
	1/25/2006	364.93	62.06	32.47
	1/25/2006	--	62.06	32.47
	7/19/2006	--	--	--
	7/19/2006	362.41	--	35.00
	7/19/2006	--	--	--
	1/23/2007	361.16	62.06	36.24
	7/11/2007	--	--	--
	7/11/2007	361.16	62.06	35.13
	1/23/2008	360.67	62.06	36.74
	1/23/2008	--	--	--
	7/16/2008	362.77	62.06	34.64
	7/16/2008	--	--	--
	1/21/2009	360.77	62.06	36.64
	1/21/2009	--	--	--
	3/4/2009	361.49	62.06	35.92
	4/13/2009	364.47	62.06	32.93
	4/14/2009	--	--	--
	4/14/2009	--	--	--
	7/21/2009	362.51	62.06	34.83
	7/22/2009	--	--	--
	10/6/2009	360.41	62.06	37.00
	10/7/2009	--	--	--
	10/7/2009	--	--	--
	1/14/2010	--	--	--
	1/14/2010	359.62	62.06	37.79

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-1 cont.	4/7/2010	--	--	--
	4/7/2010	362.60	62.06	34.80
	7/22/2010	--	--	--
	7/22/2010	362.64	62.06	34.74
	10/27/2010	--	--	ND
	10/27/2010	359.62	62.06	37.79
	1/18/2011	360.14	62.06	37.26
	1/19/2011	--	--	--
	1/19/2011	--	--	--
	4/4/2011	362.90	62.06	34.51
	4/5/2011	--	--	--
	4/5/2011	--	--	--
	7/26/2011	362.37	62.06	35.03
	7/27/2011	--	--	--
	7/27/2011	--	--	--
	10/4/2011	--	--	--
	10/4/2011	360.01	62.06	37.39
	1/10/2012	--	--	--
	1/10/2012	360.28	62.06	37.13
	4/17/2012	359.55	62.06	37.85
	4/18/2012	--	--	--
	4/18/2012	--	--	--
	7/18/2012	361.39	62.06	36.01
	7/19/2012	--	--	--
	7/19/2012	--	--	--
	10/16/2012	359.65	62.06	37.75
	10/17/2012	--	--	--
	10/17/2012	--	--	--
	1/15/2013	--	--	--
	1/15/2013	365.85	62.06	31.55
	1/15/2013	--	--	--
	4/3/2013	--	--	--
	4/3/2013	361.46	62.06	35.95
	7/2/2013	--	--	--
	7/2/2013	--	--	--
	7/2/2013	--	--	--
	7/2/2013	362.14	62.06	35.26
	10/9/2013	359.39	62.06	38.02
	1/22/2014	361.10	62.06	36.31
	1/22/2014	--	--	--
	4/8/2014	361.29	62.06	36.11
	4/9/2014	--	--	--
	4/10/2014	--	--	--
	7/22/2014	361.69	62.06	35.72
	10/9/2014	--	--	--
	1/14/2015	361.03	62.06	36.38
	4/14/2015	362.21	0.00	35.19
	7/21/2015	363.65	62.06	33.75
	10/21/2015	358.86	62.06	38.54
	1/25/2016	360.87	62.06	36.54
	1/26/2016	--	--	--
	4/12/2016	360.87	62.06	36.54
	4/13/2016	--	--	--
	4/13/2016	--	--	--
	7/19/2016	361.92	62.06	35.49
	7/20/2016	--	--	--

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-1 cont.	10/18/2016	357.85	62.09	39.26
	10/18/2016	--	--	--
	1/24/2017	360.89	--	36.32
CUF-93-2	9/25/1993	--	43.69	13.09
	1/11/1994	381.69	--	15.65
	1/11/1994	--	43.69	15.65
	4/5/1994	381.86	43.69	15.48
	4/5/1994	--	43.69	15.48
	7/19/1994	382.61	45.17	14.73
	7/19/1994	--	45.17	14.73
	7/19/1994	--	--	--
	1/31/1995	387.66	45.17	9.68
	1/31/1995	--	45.17	9.68
	4/6/1995	387.04	45.13	10.30
	7/12/1995	386.84	43.69	10.50
	7/13/1995	--	45.17	10.50
	1/16/1996	388.32	45.13	8.92
	1/17/1996	388.32	45.13	8.92
	1/17/1996	--	--	--
	7/23/1996	389.57	45.17	7.68
	7/23/1996	389.57	45.17	7.68
	1/15/1997	390.32	45.17	6.92
	1/16/1997	390.02	45.17	7.22
	7/22/1997	389.24	45.17	8.00
	7/23/1997	389.24	45.17	8.00
	7/23/1997	--	--	--
	1/28/1998	388.65	45.17	8.59
	1/28/1998	388.65	45.17	8.59
	7/14/1998	388.58	45.17	8.66
	7/14/1998	388.58	45.17	8.66
	1/25/1999	389.20	45.17	8.04
	1/25/1999	389.20	45.17	8.04
	1/25/1999	--	--	--
	3/18/1999	388.42	45.17	8.82
	7/20/1999	387.96	--	9.28
	7/21/1999	387.96	45.17	9.28
	8/23/1999	387.70	45.17	9.54
	9/24/1999	388.42	45.17	8.82
	10/13/1999	388.84	45.17	8.40
	11/18/1999	388.35	45.17	8.89
	12/17/1999	388.02	45.17	9.22
	1/19/2000	388.42	45.17	8.82
	1/19/2000	388.42	45.17	8.82
	2/25/2000	388.06	45.17	9.18
	3/28/2000	388.02	45.17	9.22
	4/19/2000	388.32	45.17	8.92
	5/18/2000	388.19	45.17	9.05
	6/23/2000	388.55	45.17	8.69
	7/11/2000	388.35	45.17	8.89
	7/12/2000	388.35	45.17	8.89
	8/30/2000	388.06	45.17	9.18
	9/22/2000	388.35	45.17	8.89
	12/15/2000	389.14	45.17	8.10
	1/29/2001	389.30	45.17	7.94
	1/29/2001	389.30	45.17	7.94
	1/29/2001	--	--	--

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-2 cont.	2/26/2001	389.40	45.17	7.84
	3/26/2001	389.24	45.17	8.00
	4/18/2001	389.53	45.17	7.71
	7/10/2001	389.11	45.17	8.13
	7/10/2001	352.08	45.17	8.13
	1/16/2002	388.32	45.17	8.92
	1/16/2002	388.32	45.17	8.92
	7/9/2002	388.78	45.17	8.46
	7/9/2002	388.78	45.17	8.46
	7/9/2002	--	--	--
	1/29/2003	388.48	45.17	8.76
	1/29/2003	388.48	45.17	8.76
	7/23/2003	388.16	45.17	9.09
	7/23/2003	--	45.17	9.09
	1/26/2004	388.38	45.17	8.86
	1/26/2004	--	45.17	8.86
	7/14/2004	388.42	45.17	8.82
	7/14/2004	--	45.17	8.82
	7/14/2004	--	--	--
	1/19/2005	388.19	45.17	9.05
	1/19/2005	--	45.17	9.05
	3/10/2005	--	45.17	9.91
	7/12/2005	389.14	45.17	8.10
	7/12/2005	--	45.17	8.10
	1/25/2006	388.84	45.17	8.40
	1/25/2006	--	45.17	8.40
	1/25/2006	--	--	--
	7/19/2006	--	--	--
	7/19/2006	388.55	--	8.69
	7/19/2006	--	--	--
	1/23/2007	387.40	45.17	9.84
	7/11/2007	387.40	45.17	9.71
	1/23/2008	--	--	--
	1/23/2008	387.07	45.17	10.17
	1/23/2008	--	--	--
	1/23/2008	--	--	--
	1/23/2008	--	--	--
	3/18/2008	387.34	45.17	9.91
	3/18/2008	--	--	--
	7/16/2008	387.11	45.17	10.14
	7/16/2008	--	--	--
	1/21/2009	--	--	--
	1/21/2009	387.07	45.17	10.17
	1/21/2009	--	--	--
	3/4/2009	--	--	--
	3/4/2009	387.17	45.17	10.07
	4/13/2009	--	--	--
	4/13/2009	--	--	--
	4/13/2009	387.53	45.17	9.71
	4/14/2009	--	--	--
	4/14/2009	--	--	--
	7/22/2009	386.55	45.17	10.69
	10/7/2009	--	--	--
	10/7/2009	386.09	45.17	11.15
	1/14/2010	--	--	--
	1/14/2010	--	--	--

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-2 cont.	1/14/2010	385.20	45.17	12.04
	1/14/2010	--	--	--
	4/7/2010	--	--	--
	4/7/2010	--	--	--
	4/7/2010	384.94	45.17	12.30
	7/22/2010	--	--	--
	7/22/2010	385.30	45.17	11.94
	10/27/2010	--	--	--
	10/27/2010	384.78	45.17	12.60
	1/19/2011	--	--	--
	1/19/2011	--	--	--
	1/19/2011	384.81	44.97	12.43
	1/19/2011	--	--	--
	4/5/2011	--	--	--
	4/5/2011	385.27	44.97	11.97
	4/5/2011	--	--	--
	6/7/2011	385.79	44.97	11.45
	1/10/2012	383.69	0.00	--
	4/17/2012	382.38	0.00	--
	7/18/2012	384.25	45.17	12.99
	10/16/2012	383.63	45.17	13.61
	1/14/2013	385.24	--	--
	7/1/2013	384.84	--	12.40
	10/8/2013	384.58	--	12.66
	1/22/2014	384.91	--	12.33
	4/8/2014	384.91	--	12.33
	7/21/2014	385.14	--	12.10
	10/8/2014	384.78	--	12.46
	4/13/2015	385.30	--	11.94
	7/20/2015	385.73	--	11.51
CUF-93-2R	1/25/2006	360.83	72.55	37.00
	1/25/2006	--	72.55	37.00
	7/19/2006	--	--	--
	7/19/2006	358.24	--	39.59
	7/19/2006	--	--	--
	7/19/2006	--	--	--
	1/23/2007	356.77	72.55	41.07
	7/11/2007	356.77	72.55	39.36
	1/23/2008	--	--	--
	1/23/2008	355.91	72.55	41.92
	1/23/2008	--	--	--
	7/16/2008	358.77	72.55	39.06
	7/16/2008	--	--	--
	1/21/2009	--	--	--
	1/21/2009	356.04	72.55	41.79
	1/21/2009	--	--	--
	1/21/2009	--	--	--
	1/21/2009	--	--	--
	4/13/2009	--	--	--
	4/13/2009	360.41	72.55	37.42
	7/22/2009	358.31	72.55	39.52
	7/22/2009	--	--	--
	10/7/2009	--	--	--
	10/7/2009	356.27	72.55	41.56
	1/14/2010	--	--	--
	1/14/2010	354.93	72.55	42.90
	4/7/2010	--	--	--
	4/7/2010	--	--	--

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-2R cont.	4/7/2010	--	--	--
	4/7/2010	358.50	72.55	39.33
	4/7/2010	--	--	--
	7/22/2010	--	--	--
	7/22/2010	358.80	72.55	39.03
	10/27/2010	--	--	--
	10/27/2010	354.96	72.55	42.74
	1/19/2011	--	--	--
	1/19/2011	355.62	72.55	42.21
	4/5/2011	--	--	--
	4/5/2011	--	--	--
	4/5/2011	358.80	72.55	38.38
	4/5/2011	--	--	--
	7/26/2011	--	--	--
	7/26/2011	--	--	--
	7/26/2011	358.24	72.55	39.59
	7/26/2011	--	--	--
	10/4/2011	--	--	--
	10/4/2011	355.62	72.55	42.21
	1/10/2012	--	--	--
	1/10/2012	--	--	--
	1/10/2012	356.27	72.55	41.56
	1/10/2012	--	--	--
	4/18/2012	--	--	--
	4/18/2012	--	--	--
	4/18/2012	355.95	72.55	41.92
	4/18/2012	--	--	--
	7/19/2012	--	--	--
	7/19/2012	358.08	72.55	39.82
	10/17/2012	--	--	--
	10/17/2012	355.75	72.55	42.08
	1/14/2013	--	--	--
	1/14/2013	--	--	--
	1/14/2013	364.51	72.55	33.32
	1/14/2013	--	--	--
	1/14/2013	--	--	--
	1/14/2013	--	--	--
	4/3/2013	--	--	--
	4/3/2013	358.11	72.55	40.05
	7/1/2013	--	--	--
	7/1/2013	--	--	--
	7/1/2013	--	--	--
	7/1/2013	358.73	72.55	39.10
	10/8/2013	355.42	72.55	42.41
	10/8/2013	--	--	--
	1/22/2014	357.36	72.55	40.48
	4/8/2014	357.72	72.55	40.11
	4/8/2014	--	--	--
	7/21/2014	358.50	72.55	39.33
	10/8/2014	--	--	--
	10/8/2014	--	--	--
	1/14/2015	357.68	72.55	40.15
	4/14/2015	358.90	0.00	38.93
	7/21/2015	360.47	72.55	37.36
	10/21/2015	355.06	72.55	42.77
	10/21/2015	--	--	--
	1/25/2016	357.39	72.55	40.44
	4/13/2016	357.52	72.55	40.31

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-R cont.	4/13/2016	--	--	--
	7/19/2016	358.77	72.55	39.06
	7/19/2016	--	--	--
	10/19/2016	354.34	72.78	43.46
	10/19/2016	--	--	--
	11/7/2016	354.55	--	43.35
	11/7/2016	--	--	--
	1/23/2017	357.87	--	40.03
	1/24/2017	--	--	--
CUF-93-3	9/25/1993	370.18	53.99	27.55
	1/11/1994	370.15	--	27.65
	1/11/1994	--	53.99	27.62
	1/11/1994	--	--	--
	4/5/1994	372.87	53.99	24.93
	4/5/1994	372.87	--	--
	4/5/1994	--	53.99	24.93
	4/5/1994	--	--	--
	7/19/1994	369.72	55.07	28.08
	7/19/1994	--	55.07	28.08
	1/31/1995	370.77	55.07	27.03
	1/31/1995	--	55.07	27.03
	1/31/1995	--	--	--
	4/6/1995	370.15	55.04	27.65
	7/12/1995	370.74	53.99	27.06
	7/13/1995	--	55.07	27.06
	1/16/1996	--	54.94	28.18
	1/17/1996	369.56	54.94	28.18
	7/23/1996	370.34	55.04	27.39
	7/23/1996	--	55.04	27.39
	7/23/1996	--	--	--
	1/15/1997	370.44	55.04	27.29
	1/16/1997	--	55.04	27.42
	7/22/1997	369.43	55.01	28.31
	7/23/1997	--	55.01	28.31
	1/28/1998	368.77	55.01	28.96
	1/28/1998	368.77	55.01	28.96
	7/14/1998	369.03	55.01	28.70
	7/14/1998	369.03	55.01	28.70
	1/25/1999	373.85	55.01	23.88
	1/25/1999	373.85	55.01	23.88
	3/18/1999	369.23	55.01	28.50
	7/20/1999	368.84	0.00	28.90
	7/21/1999	368.84	55.01	28.90
	7/21/1999	--	--	--
	8/23/1999	368.38	55.01	29.36
	9/24/1999	368.18	55.01	29.55
	10/13/1999	368.54	55.01	29.19
	11/18/1999	367.59	55.01	30.14
	12/17/1999	368.28	55.01	29.45
	1/19/2000	368.41	55.01	29.32
	1/19/2000	368.41	55.01	29.32
	2/25/2000	368.74	55.01	29.00
	3/28/2000	368.87	55.01	28.86
	4/19/2000	368.93	55.01	28.80
	5/18/2000	368.97	55.01	28.77
	6/23/2000	368.87	55.01	28.86
	7/11/2000	368.48	55.01	29.26
	7/12/2000	368.48	55.01	29.26

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-3 cont.	8/30/2000	368.31	55.01	29.42
	9/22/2000	367.82	55.01	29.91
	12/15/2000	367.79	55.01	29.95
	1/29/2001	368.61	55.01	29.13
	1/29/2001	368.61	55.01	29.13
	2/26/2001	368.51	55.01	29.22
	3/26/2001	368.28	55.01	29.45
	4/18/2001	368.38	55.01	29.36
	7/10/2001	368.64	55.01	29.09
	7/10/2001	368.64	55.01	29.09
	7/10/2001	--	--	--
	1/16/2002	368.57	55.01	29.16
	1/16/2002	368.57	55.01	29.16
	7/9/2002	368.38	55.01	29.36
	7/9/2002	368.38	55.01	29.36
	1/29/2003	365.26	55.01	32.47
	1/29/2003	365.26	55.01	32.47
	1/29/2003	--	--	--
	7/23/2003	366.47	55.01	31.26
	7/23/2003	--	55.01	31.26
	1/26/2004	367.62	55.01	30.11
	1/26/2004	--	55.01	30.11
	7/14/2004	367.36	55.01	30.37
	7/14/2004	--	55.01	30.37
	1/19/2005	368.02	55.01	29.72
	1/19/2005	--	55.01	29.72
	1/19/2005	--	--	--
	7/12/2005	367.43	55.01	30.31
	7/12/2005	--	55.01	30.31
	1/25/2006	368.05	55.01	29.68
	1/25/2006	--	55.01	29.68
	7/19/2006	367.20	--	30.54
	7/19/2006	--	--	--
	7/19/2006	--	--	--
	1/23/2007	367.59	55.01	30.14
	1/23/2007	--	--	--
	7/11/2007	367.59	55.01	30.73
	1/23/2008	--	--	--
	1/23/2008	368.54	55.01	29.19
	1/23/2008	--	--	--
	7/16/2008	367.06	55.01	30.67
	7/16/2008	--	--	--
	7/16/2008	--	--	--
	7/16/2008	--	--	--
	1/21/2009	--	--	--
	1/21/2009	368.15	55.01	29.59
	1/21/2009	--	--	--
	4/14/2009	--	--	--
	4/14/2009	369.03	55.01	28.70
	7/22/2009	367.26	55.01	30.47
	10/7/2009	--	--	--
	10/7/2009	--	--	--
	10/7/2009	368.34	55.01	29.39
	10/7/2009	--	--	--
	1/14/2010	--	--	--
	1/14/2010	368.11	55.01	29.62
	1/14/2010	--	--	--
	4/7/2010	--	--	--

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-3 cont.	4/7/2010	--	--	--
	4/7/2010	368.54	55.01	29.19
	7/22/2010	--	--	--
	7/22/2010	--	--	--
	7/22/2010	367.00	55.01	30.73
	7/22/2010	--	--	--
	10/27/2010	--	--	--
	10/27/2010	365.75	55.01	32.18
	1/19/2011	--	--	--
	1/19/2011	366.80	55.01	30.93
	4/5/2011	--	--	--
	4/5/2011	368.05	55.01	29.62
	4/5/2011	--	--	--
	6/7/2011	368.28	55.01	29.45
	7/26/2011	--	--	--
	7/26/2011	367.69	55.01	30.04
	10/4/2011	--	--	--
	10/4/2011	367.98	55.01	29.75
	1/10/2012	--	--	--
	1/10/2012	368.44	55.01	29.29
	4/18/2012	--	--	--
	4/18/2012	366.34	55.01	31.49
	7/19/2012	--	--	--
	7/19/2012	366.18	55.01	31.55
	10/17/2012	--	--	--
	10/17/2012	--	--	--
	10/17/2012	366.24	55.01	31.49
	10/17/2012	--	--	--
	1/14/2013	--	--	--
	1/14/2013	368.97	55.01	28.77
	1/14/2013	--	--	--
	4/3/2013	--	--	--
	4/3/2013	368.51	55.01	29.22
	7/1/2013	--	--	--
	7/1/2013	--	--	--
	7/1/2013	--	--	--
	7/1/2013	--	--	--
	7/1/2013	--	--	--
	7/1/2013	--	--	--
	7/1/2013	368.05	55.01	29.68
	7/1/2013	--	--	--
	10/8/2013	368.64	55.01	29.09
	1/22/2014	368.61	55.01	29.13
	4/8/2014	368.57	55.01	29.16
	7/21/2014	367.13	55.01	30.60
	7/21/2014	--	--	--
	10/9/2014	--	--	--
	1/13/2015	368.44	55.01	29.29
	1/13/2015	--	--	--
	4/14/2015	368.44	0.00	29.29
	7/21/2015	367.92	55.01	29.82
	7/21/2015	--	--	--
	10/21/2015	367.39	55.01	30.34
	1/25/2016	368.28	55.01	29.45
	4/13/2016	368.34	55.01	29.39
	4/13/2016	--	--	--
	7/19/2016	367.52	55.01	30.21
	10/19/2016	366.70	55.07	30.70

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-3 cont.	10/19/2016	--	--	--
	10/19/2016	--	--	--
	10/19/2016	--	--	--
	1/24/2017	367.91	--	29.59
CUF-93-4	9/25/1993	--	36.08	20.53
	1/11/1994	374.22	--	22.30
	1/11/1994	--	36.08	22.27
	4/5/1994	374.61	36.08	21.91
	7/19/1994	377.33	36.87	19.19
	7/19/1994	--	36.87	19.19
	2/13/1995	--	--	--
	4/6/1995	374.54	36.64	22.70
	4/6/1995	374.54	36.64	22.70
	7/13/1995	375.43	36.31	21.81
	1/16/1996	373.43	36.31	23.81
	1/17/1996	373.43	36.31	23.81
	7/23/1996	374.54	36.34	22.70
	7/23/1996	374.54	36.34	22.70
	1/15/1997	371.89	36.34	25.35
	1/16/1997	371.89	36.34	25.35
	7/22/1997	371.98	36.38	25.26
	7/23/1997	371.98	36.38	25.26
	1/28/1998	371.39	36.38	25.85
	1/29/1998	371.39	36.38	25.85
	7/14/1998	372.51	36.38	24.73
	7/15/1998	372.51	36.38	24.73
	1/25/1999	375.40	36.38	21.84
	1/25/1999	375.40	36.38	21.84
	7/20/1999	372.51	0.00	24.73
	7/21/1999	372.51	36.38	24.73
	1/19/2000	370.94	36.38	26.31
	1/19/2000	370.94	36.38	26.31
	7/11/2000	371.98	36.38	25.26
	7/12/2000	371.98	36.38	25.26
	1/29/2001	371.07	36.38	26.17
	1/29/2001	371.07	36.38	26.17
	7/10/2001	373.49	36.38	23.75
	7/10/2001	373.49	36.38	23.75
	1/16/2002	371.36	36.38	25.88
	1/16/2002	371.07	36.38	26.17
	7/9/2002	372.54	36.38	24.70
	7/9/2002	372.54	36.38	24.70
	1/29/2003	370.34	36.38	26.90
	1/29/2003	370.34	36.38	26.90
	7/23/2003	371.59	36.38	25.65
	7/23/2003	--	36.38	25.65
	1/26/2004	372.15	36.38	25.09
	1/26/2004	--	36.38	25.09
	7/14/2004	373.59	36.38	23.65
	7/14/2004	--	36.38	23.65
	1/19/2005	373.13	36.38	24.11
	1/19/2005	--	36.38	24.11
	7/12/2005	372.02	36.38	25.22
	7/12/2005	--	36.38	25.22
	1/25/2006	373.95	36.38	23.29
	1/25/2006	--	36.38	23.29
	7/19/2006	--	--	25.85
	7/19/2006	--	--	--

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-4 cont.	7/19/2006	--	--	--
	1/23/2007	372.90	36.38	24.34
	7/11/2007	372.90	36.38	25.55
	7/11/2007	--	--	--
	1/23/2008	371.69	36.38	25.55
	1/23/2008	--	--	--
	7/16/2008	373.59	36.38	23.65
	7/16/2008	--	--	--
	1/21/2009	370.57	36.38	26.67
	1/21/2009	--	--	--
	4/13/2009	372.31	36.38	24.93
	4/14/2009	--	--	--
	4/14/2009	--	--	--
	7/21/2009	371.39	36.38	26.17
	7/22/2009	--	--	--
	10/6/2009	371.20	36.38	26.04
	10/7/2009	--	--	--
	10/7/2009	--	--	--
	1/14/2010	--	--	--
	1/14/2010	369.46	36.38	27.78
	4/7/2010	--	--	--
	4/7/2010	371.23	36.38	25.85
	4/7/2010	--	--	--
	7/22/2010	--	--	--
	7/22/2010	371.36	36.38	25.88
	10/27/2010	--	--	--
	10/27/2010	370.77	36.38	26.47
	1/18/2011	370.28	36.38	26.96
	1/19/2011	--	--	--
	1/19/2011	--	--	--
	4/4/2011	371.72	36.38	25.52
	4/5/2011	--	--	--
	4/5/2011	--	--	--
	7/26/2011	371.16	36.38	26.08
	7/27/2011	--	--	--
	7/27/2011	--	--	--
	10/4/2011	--	--	--
	10/4/2011	371.36	36.38	25.88
	1/10/2012	--	--	--
	1/10/2012	367.82	36.38	29.42
	4/17/2012	367.52	36.38	29.72
	4/18/2012	--	--	--
	4/18/2012	--	--	--
	7/18/2012	369.30	36.38	27.95
	7/19/2012	--	--	--
	7/19/2012	--	--	--
	10/16/2012	368.28	36.38	28.96
	10/17/2012	--	--	--
	10/17/2012	--	--	--
	1/15/2013	--	--	--
	1/15/2013	372.02	36.38	25.22
	1/15/2013	--	--	--
	4/3/2013	--	--	--
	4/3/2013	369.30	36.38	27.95
	7/2/2013	--	--	--
	7/2/2013	--	--	--
	7/2/2013	--	--	--
	7/2/2013	369.59	36.38	27.65

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-93-4 cont.	10/9/2013	369.75	36.38	27.49
	1/22/2014	369.07	36.38	28.18
	4/9/2014	370.44	36.38	26.80
	7/22/2014	368.70	36.38	28.54
	10/9/2014	--	--	--
	1/14/2015	368.44	36.38	28.80
	4/14/2015	370.31	--	26.93
	7/21/2015	370.61	36.38	26.63
	10/21/2015	369.52	36.38	27.72
	1/25/2016	370.77	36.38	26.47
	1/26/2016	--	--	--
	4/12/2016	370.28	36.38	26.96
	4/13/2016	--	--	--
	7/19/2016	371.69	36.38	25.55
	7/20/2016	--	--	--
	10/18/2016	368.93	36.38	28.27
	10/18/2016	--	--	--
	1/24/2017	372.18	--	25.13
CUF-96-5	7/23/1996	378.97	16.27	7.22
	7/24/1996	378.97	16.27	7.22
	8/5/1996	377.30	0.00	8.89
	8/22/1996	375.99	--	10.20
	9/4/1996	374.84	--	11.35
	9/25/1996	377.63	--	8.56
	1/15/1997	378.38	16.27	7.81
	1/28/1998	379.40	16.27	6.79
	7/14/1998	380.32	16.27	5.90
	1/25/1999	379.92	16.27	6.30
	7/20/1999	380.25	--	5.97
	1/19/2000	376.38	16.27	9.84
CUF-96-6	7/23/1996	375.69	25.62	6.20
	7/24/1996	375.69	25.62	6.20
	1/15/1997	375.92	25.62	5.97
	1/16/1997	375.99	25.62	5.90
	7/22/1997	375.17	25.62	6.72
	7/23/1997	375.13	25.62	6.76
	1/28/1998	375.72	25.62	6.17
	7/14/1998	374.74	25.62	7.15
	1/25/1999	375.86	25.62	6.04
	2/25/1999	--	25.65	11.58
	3/18/1999	375.13	25.62	6.76
	7/20/1999	370.38	--	11.51
	7/21/1999	370.38	25.65	11.51
	8/23/1999	370.21	25.62	11.68
	9/24/1999	370.54	25.62	11.35
	10/13/1999	373.62	25.62	8.27
	11/18/1999	370.08	25.62	11.81
	12/17/1999	374.81	25.62	7.08
	1/19/2000	370.25	25.62	11.64
	2/25/2000	370.38	25.62	11.51
	3/28/2000	370.44	25.62	11.45
	4/19/2000	376.31	25.62	5.58
	5/18/2000	370.54	25.62	11.35
	6/23/2000	371.82	25.62	10.07
	7/11/2000	373.79	25.62	8.10
	7/11/2000	373.79	25.62	8.10
	8/30/2000	375.56	25.62	6.33
	9/22/2000	374.12	25.62	7.77

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-96-6 cont.	12/15/2000	375.43	25.62	6.46
	1/29/2001	360.21	25.62	21.68
	2/26/2001	377.82	25.62	4.07
	3/26/2001	377.72	25.62	4.17
	4/18/2001	375.95	25.62	5.94
CUF-96-7	7/23/1996	378.77	18.83	6.89
	7/24/1996	378.77	18.83	6.89
	1/15/1997	378.94	18.79	6.72
	1/16/1997	378.71	18.79	6.95
	1/16/1997	--	--	--
	7/22/1997	378.18	18.86	7.48
	7/23/1997	378.25	18.86	7.41
	1/28/1998	378.35	18.86	7.31
	7/14/1998	378.28	18.86	7.38
	1/25/1999	378.41	18.86	7.25
	7/20/1999	377.99	--	7.68
	1/19/2000	378.18	18.86	7.48
	7/11/2000	377.92	18.86	7.74
	7/11/2000	377.92	18.86	7.74
CUF-96-8	7/23/1996	365.49	36.60	7.18
	7/25/1996	--	36.60	7.18
	1/15/1997	365.26	36.64	7.41
	1/16/1997	365.26	36.64	7.41
	7/22/1997	363.29	36.60	9.38
	7/23/1997	363.29	36.60	9.38
	1/28/1998	364.87	36.60	7.81
	7/14/1998	363.95	36.60	8.72
	1/25/1999	369.85	36.67	2.82
	2/25/1999	--	36.67	11.58
	3/18/1999	367.69	36.67	4.99
	7/20/1999	363.00	--	9.68
	7/21/1999	363.00	36.67	9.68
	8/23/1999	361.62	36.67	11.05
	9/24/1999	361.46	36.67	11.22
	10/13/1999	363.69	36.67	8.99
	11/18/1999	361.23	36.67	11.45
	12/17/1999	367.03	36.67	5.64
	1/19/2000	362.90	36.67	9.77
	2/25/2000	364.47	36.67	8.20
	3/28/2000	365.03	36.67	7.64
	4/19/2000	366.80	36.67	5.87
	5/18/2000	364.77	36.67	7.90
	6/23/2000	363.10	36.67	9.58
	7/11/2000	362.24	36.67	10.43
	7/11/2000	362.24	36.60	10.43
	8/30/2000	363.39	36.67	9.28
	9/22/2000	361.95	36.67	10.73
	12/15/2000	362.70	36.67	9.97
	1/29/2001	364.28	36.67	8.40
	2/26/2001	368.25	36.67	4.43
CUF-96-9	7/23/1996	369.95	31.32	22.89
	7/25/1996	369.95	31.32	22.89
	1/15/1997	370.84	31.32	22.01
	1/16/1997	370.84	31.32	22.01
	7/22/1997	369.89	31.32	22.96
	7/23/1997	369.89	31.32	22.96
	1/28/1998	371.03	31.32	21.81
	7/14/1998	370.54	31.32	22.30

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-96-9 cont.	1/25/1999	371.59	31.32	21.25
	2/25/1999	--	31.36	21.68
	3/18/1999	371.53	31.32	21.32
	7/20/1999	370.34	--	22.50
	7/21/1999	370.34	31.36	22.50
	8/23/1999	369.59	31.32	23.26
	9/24/1999	369.16	31.32	23.68
	10/13/1999	369.43	31.32	23.42
	11/18/1999	369.62	31.32	23.22
	12/17/1999	370.34	31.32	22.50
	1/19/2000	370.38	31.32	22.47
	2/25/2000	371.13	31.32	21.71
	3/28/2000	371.43	31.32	21.42
	4/19/2000	371.39	31.32	21.45
	5/18/2000	371.26	31.32	21.58
	6/23/2000	370.28	31.32	22.57
	7/11/2000	369.92	31.32	22.93
	7/12/2000	369.92	31.32	22.93
	8/30/2000	370.21	31.32	22.63
	9/22/2000	370.31	31.32	22.53
	12/15/2000	370.48	31.32	22.37
	1/29/2001	386.94	31.32	5.90
	2/26/2001	371.66	31.32	21.19
	1/23/2017	373.80	--	18.80
CUF-B103	1/16/1996	375.95	79.61	--
	7/23/1996	375.53	81.02	20.63
	1/15/1997	375.66	81.02	20.50
	7/22/1997	375.53	81.02	20.63
	1/28/1998	374.08	81.02	22.07
	7/14/1998	375.17	81.02	20.99
	1/25/1999	377.30	81.02	18.86
	7/20/1999	374.25	0.00	21.91
	1/19/2000	372.80	81.02	23.35
	7/11/2000	373.66	81.02	22.50
CUF-B106	4/6/1995	361.16	--	37.06
	5/2/1995	396.55	--	1.67
	1/16/1996	361.26	--	0.00
	7/23/1996	363.03	102.99	35.19
	1/15/1997	361.16	102.99	37.06
	7/22/1997	362.24	102.99	35.98
	1/28/1998	360.11	102.99	38.11
	7/14/1998	362.83	102.99	35.39
	1/25/1999	370.48	102.99	27.75
	7/20/1999	361.88	--	36.34
	11/18/1999	359.23	102.99	39.00
	12/17/1999	359.55	102.99	38.67
	1/19/2000	359.62	102.99	38.61
	2/25/2000	359.82	102.99	38.41
	3/28/2000	360.93	102.99	37.29
	4/19/2000	362.37	102.99	35.85
	5/18/2000	363.42	102.99	34.80
	6/23/2000	363.62	102.99	34.60
	7/11/2000	362.44	102.99	35.78
	8/30/2000	360.47	102.99	37.75
	9/22/2000	359.78	102.99	38.44
	12/15/2000	359.75	102.99	38.47
	1/29/2001	359.65	102.99	38.57
	2/26/2001	362.70	102.99	35.52

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF B106 cont.	3/26/2001	359.95	102.99	38.28
	4/18/2001	362.93	102.99	35.29
CUF-B110	2/15/1995	396.98	--	1.44
	4/6/1995	377.56	51.33	20.86
	1/16/1996	373.00	49.56	0.00
	7/23/1996	377.17	49.63	21.25
	1/15/1997	376.87	49.63	21.55
	7/22/1997	375.56	49.63	22.86
	1/28/1998	375.69	49.63	22.73
	7/14/1998	376.25	49.63	22.17
	1/25/1999	377.36	49.63	21.06
	3/18/1999	376.02	49.63	22.40
	7/20/1999	375.95	--	22.47
	8/23/1999	375.49	49.63	22.93
	9/24/1999	375.36	49.63	23.06
	10/13/1999	375.76	49.63	22.66
	11/18/1999	375.04	49.63	23.39
	12/17/1999	375.46	49.63	22.96
	1/19/2000	375.66	49.63	22.76
	2/25/2000	375.92	49.63	22.50
	3/28/2000	376.05	49.63	22.37
	4/19/2000	375.95	49.63	22.47
	5/18/2000	376.05	49.63	22.37
	6/23/2000	376.12	49.63	22.30
	7/11/2000	375.89	49.63	22.53
	8/30/2000	375.66	49.63	22.76
	9/22/2000	375.56	49.63	22.86
	12/15/2000	375.89	49.63	22.53
	1/29/2001	376.08	49.63	22.34
	2/26/2001	376.28	49.63	22.14
	3/26/2001	376.25	49.63	22.17
	4/18/2001	376.35	49.63	22.07
CUF-B116	7/23/1996	397.73	19.94	13.78
	1/15/1997	397.93	19.94	13.58
	1/28/1998	397.04	19.91	14.46
	7/14/1998	397.54	19.91	13.97
	1/25/1999	397.47	19.91	14.04
	3/18/1999	397.83	19.91	13.68
	7/20/1999	397.31	--	14.20
	8/23/1999	397.60	19.91	13.91
	9/24/1999	397.54	19.91	13.97
	10/13/1999	397.40	19.91	14.10
	11/18/1999	396.49	19.91	15.02
	12/17/1999	397.40	19.91	14.10
	1/19/2000	397.01	19.88	14.50
	2/25/2000	397.44	19.91	14.07
	3/28/2000	397.34	19.91	14.17
	4/19/2000	397.14	19.91	14.37
	5/18/2000	397.14	19.91	14.37
	6/23/2000	397.63	19.91	13.87
	7/11/2000	397.31	19.88	14.20
	8/30/2000	396.95	19.91	14.56
	9/22/2000	396.68	19.91	14.83
	12/15/2000	397.70	19.91	13.81
	1/29/2001	397.83	19.91	13.68
	2/26/2001	398.29	19.91	13.22
	3/26/2001	397.73	19.91	13.78
	4/18/2001	397.70	19.91	13.81

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-GP1	10/13/1999	392.22	20.07	3.74
	11/18/1999	388.61	20.07	7.35
	12/17/1999	392.55	20.07	3.41
	1/19/2000	390.88	20.07	5.08
	2/25/2000	392.29	20.07	3.67
	3/28/2000	390.16	20.07	5.81
	4/19/2000	391.76	20.07	4.20
	5/18/2000	388.48	20.07	7.48
	6/23/2000	389.30	20.07	6.66
	8/30/2000	395.96	--	--
	9/22/2000	395.96	--	--
CUF-GP10	10/13/1999	391.14	23.26	7.68
	11/18/1999	390.58	23.26	8.23
	12/17/1999	390.45	23.26	8.36
	1/19/2000	390.81	23.26	8.00
	2/25/2000	390.48	23.26	8.33
	3/28/2000	390.22	23.26	8.59
	4/19/2000	390.39	23.26	8.43
	5/18/2000	390.16	23.26	8.66
	6/23/2000	390.58	23.26	8.23
	7/11/2000	390.45	23.26	8.36
	8/30/2000	390.19	23.26	8.63
	9/22/2000	390.45	23.26	8.36
	11/15/2000	391.34	23.26	7.48
	1/29/2001	391.53	23.26	7.28
	2/26/2001	391.40	23.26	7.41
	3/26/2001	391.34	23.26	7.48
	4/18/2001	391.53	23.26	7.28
CUF-GP2	10/13/1999	388.61	28.70	10.07
	11/18/1999	388.02	28.70	10.66
	12/17/1999	388.12	28.70	10.56
	1/19/2000	388.48	28.70	10.20
	2/25/2000	388.16	28.70	10.53
	3/28/2000	388.38	28.70	10.30
	4/19/2000	388.35	28.70	10.33
	5/18/2000	388.16	28.70	10.53
	6/23/2000	388.02	28.70	10.66
	7/11/2000	388.06	28.70	10.63
	8/30/2000	387.86	28.70	10.82
	9/22/2000	387.89	28.70	10.79
	11/15/2000	388.29	28.70	10.40
	1/29/2001	388.81	28.70	9.87
	2/26/2001	388.71	28.70	9.97
	3/26/2001	388.52	28.70	10.17
	4/18/2001	388.71	28.70	9.97
CUF-GP3	10/13/1999	389.43	20.11	8.56
	11/18/1999	388.78	20.11	9.22
	12/17/1999	389.14	20.11	8.86
	1/19/2000	387.99	20.11	10.00
	2/25/2000	388.75	20.11	9.25
	3/28/2000	388.75	20.11	9.25
	4/19/2000	389.04	20.11	8.95
	5/18/2000	388.81	20.11	9.18
	6/23/2000	388.98	20.11	9.02
	7/11/2000	389.43	20.11	8.56
	8/30/2000	389.99	20.11	8.00
	9/22/2000	389.80	20.11	8.20
	11/15/2000	390.62	20.11	7.38

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-GP-3 cont.	1/29/2001	388.35	20.11	9.64
	2/26/2001	392.32	20.11	5.67
	3/26/2001	388.84	20.11	9.15
	4/18/2001	389.30	20.11	8.69
CUF-GP4	10/13/1999	392.06	23.29	6.63
	11/18/1999	391.57	23.29	7.12
	12/17/1999	391.30	23.29	7.38
	1/19/2000	391.66	23.29	7.02
	2/25/2000	391.30	23.29	7.38
	3/28/2000	391.01	23.29	7.68
	4/19/2000	391.21	23.29	7.48
	5/18/2000	390.94	23.29	7.74
	6/23/2000	391.24	23.29	7.45
	7/11/2000	391.21	23.29	7.48
	8/30/2000	391.11	23.29	7.58
	9/22/2000	391.47	23.29	7.22
	11/15/2000	392.35	23.29	6.33
	1/29/2001	392.45	23.29	6.23
	2/26/2001	392.42	23.29	6.26
	3/26/2001	392.39	23.29	6.30
	4/18/2001	392.45	23.29	6.23
CUF-GP5	10/13/1999	391.86	21.98	6.04
	11/18/1999	391.40	21.98	6.49
	12/17/1999	391.11	21.98	6.79
	1/19/2000	391.50	21.98	6.40
	2/25/2000	391.11	21.98	6.79
	3/28/2000	390.88	21.98	7.02
	4/19/2000	391.04	21.98	6.86
	5/18/2000	390.78	21.98	7.12
	6/23/2000	391.07	21.98	6.82
	7/11/2000	391.07	21.98	6.82
	8/30/2000	390.91	21.98	6.99
	9/22/2000	391.27	21.98	6.63
	11/15/2000	392.16	21.98	5.74
	1/29/2001	392.26	21.98	5.64
	2/26/2001	392.19	21.98	5.71
	3/26/2001	392.09	21.98	5.81
	4/18/2001	392.26	21.98	5.64
CUF-GP6	10/13/1999	387.70	18.53	10.66
	11/18/1999	387.93	18.53	10.43
	12/17/1999	388.35	18.53	10.00
	1/19/2000	388.52	18.53	9.84
	2/25/2000	388.58	18.53	9.77
	3/28/2000	388.71	18.53	9.64
	4/19/2000	389.14	18.53	9.22
	5/18/2000	388.68	18.53	9.68
	6/23/2000	388.52	18.53	9.84
	7/11/2000	388.42	18.53	9.94
	8/30/2000	388.29	18.53	10.07
	9/22/2000	388.06	18.53	10.30
	11/15/2000	388.61	18.53	9.74
	1/29/2001	388.45	18.53	9.91
	2/26/2001	389.11	18.53	9.25
	3/26/2001	388.29	18.53	10.07
	4/18/2001	388.12	18.53	10.23

Well ID	Date	GW Elevation (ft abv s/l)	Well Depth (ft)	Water Level Depth (ft)
CUF-GP7	2/25/2000	397.93	0.00	0.00
	8/30/2000	397.93	0.00	0.00
	9/22/2000	397.93	0.00	0.00
CUF-GP8	10/13/1999	400.13	17.97	13.12
	11/18/1999	399.67	17.97	13.58
	12/17/1999	399.27	17.97	13.97
	1/19/2000	399.54	17.97	13.71
	2/25/2000	399.24	17.97	14.01
	3/28/2000	399.37	17.97	13.87
	4/19/2000	399.41	17.97	13.84
	5/18/2000	399.34	17.97	13.91
	6/23/2000	399.37	17.97	13.87
	7/11/2000	399.34	17.97	13.91
	8/30/2000	399.34	17.97	13.91
	9/22/2000	399.31	17.97	13.94
	11/15/2000	400.36	17.97	12.89
	1/29/2001	400.23	17.97	13.02
	2/26/2001	400.13	17.97	13.12
	3/26/2001	400.19	17.97	13.05
	4/18/2001	400.13	17.97	13.12
CUF-GP9	10/13/1999	398.22	22.99	14.89
	11/18/1999	397.70	22.99	15.42
	12/17/1999	398.06	22.99	15.06
	1/19/2000	398.00	22.99	15.12
	2/25/2000	398.00	22.99	15.12
	3/28/2000	398.09	22.99	15.02
	4/19/2000	397.86	22.99	15.25
	5/18/2000	397.73	22.99	15.38
	6/23/2000	398.09	22.99	15.02
	7/11/2000	397.96	22.99	15.15
	8/30/2000	397.83	22.99	15.28
	9/22/2000	397.70	22.99	15.42
	11/15/2000	398.39	22.99	14.73
	1/29/2001	398.49	22.99	14.63
	2/26/2001	398.19	22.99	14.92
	3/26/2001	398.19	22.99	14.92
	4/18/2001	398.49	22.99	14.63
CUF-RS	1/18/2010	364.70	49.59	18.56

ft abv s/l = feet above sea level
ft = feet
cont. - continued
-- no data

Well ID	Program	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
CUF-93-2R	TDEC and CCR	Jan-06	--	94	--	93	0.2	6.6	5001	18.8	4800	53
		Jul-06	--	84	--	163	0.2	6.6	4556	22.2	5300	5
		Jan-07	--	92	--	60	0.2	6.7	4580	18.8	4400	64
		Jul-07	--	80	--	195	0.2	6.4	4781	20.8	4200	12
		Jan-08	--	92	--	161	0.3	6.6	4755	19.1	4200	12
		Jul-08	--	76	--	81	0.2	6.3	4755	21.7	4500	62
		Jan-09	--	80	--	254	0.2	6.5	4902	18.9	3900	20
		Apr-09	--	88	--	5	0.2	6.6	4878	21.2	--	--
		Jul-09	--	68	--	176	0.2	6.3	4920	21.2	4400	9.8
		Oct-09	--	72	--	208	0.4	6.5	5075	20.6	4800	11
		Jan-10	--	68	--	230	0.3	6.4	4972	18.8	3900	8.9
		Apr-10	--	70	--	224	0.2	6.4	4868	21.2	4500	6.4
		Jul-10	--	68	--	101	0.1	6.3	4886	23.5	4700	7
		Oct-10	--	72	--	250	0.3	6.3	5125	20.4	4700	27
		Jan-11	--	64	--	221	0.2	6.3	4997	18.6	3900	13
		Apr-11	--	66	--	275	0.2	6.5	5032	19.2	4300	6.5
		Jul-11	--	64	--	137	0.1	6.3	5125	25.6	4300	12
		Oct-11	--	60	--	108	0.1	6.3	5137	22.2	4800	9.2
		Jan-12	--	60	--	316	0.3	6.3	5260	19.3	4000	5.2
		Apr-12	--	68	--	217	7.4	6.3	5339	20.4	--	16
		Jul-12	--	56	--	254	0.2	6.2	5370	22.2	--	8.3
		Oct-12	--	68	--	244	0.2	6.3	5318	20.4	5100	3.8
		Jan-13	--	64	--	242	0.2	6.3	5340	15.4	--	2.3
		Apr-13	--	72	--	248	0.2	6.5	5395	17.6	2800	5.4
		Jul-13	--	76	--	217	0.2	6.4	5380	21.7	--	2.7
		Oct-13	--	68	--	150	0.1	6.4	5275	19.3	4400	3.1
		Jan-14	--	72	--	240	0.2	6.3	5406	11.7	--	4.8
		Apr-14	--	68	--	220	0.1	6.3	5366	19.2	--	5.3
		Jul-14	--	68	--	214	0.2	6.2	5337	24.8	--	6.7
		Oct-14	--	--	--	--	--	--	--	--	--	6.8
		Jan-15	--	68	--	197	0.1	6.3	5353	17.6	--	<2.5
		Apr-15	--	68	--	195	0.1	6.5	5256	19.3	--	<2.5
		Jul-15	--	64	--	188	0.1	6.2	5241	21.9	--	<2.5
		Oct-15	--	58	--	153	0.1	6.5	5213	20.4	--	<2.5
		Jan-16	--	64	--	151	0.1	6.3	5226	19.1	--	<2.5
		Apr-16	--	84	--	162	0.9	6.6	5239	19.6	--	2.9
		Jul-16	--	72	--	207	0.9	6.2	5082	22.1	--	<2.5
		Oct-16	--	80	--	230	1.2	6.4	5062	21.5	4690	10.9
		Nov-16	<5	--	97.5	25.5	0.96	6.44	5050	18.5	4100	3.8
		Nov-16	<5	--	95.5	--	--	--	--	--	4200	4.5
		Jan-17	<5	--	86.9	-5.6	0.21	6.44	4760	17.5	4390	2.9
CUF-96-9	TDEC and CCR	Jul-96	--	648	--	390	3.8	6.45	2507	17.2	1500	150
		Jan-97	--	726	--	194	3.6	6.7	2988	15	1800	400
		Jul-97	--	868	--	330		6.56	3255	17.7	2000	220
		Feb-99	--	796	--	129	1.6	6.65	3500	16.17	1900	400
		Jul-99	--	792	--	124	1.77	6.57	3511	17.91	2300	220
		Jul-00	--	--	--	118	1.07	6.64	3670	17.36	--	--

Well ID	Program	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
CUF-201	CCR	Nov-16	<5	--	130	-127.7	0.3	7.12	191	18.8	119	0.8
		Jan-17	<5	--	109	-127.7	0.3	7.12	191	18.8	103	2.3
CUF-202	CCR	Nov-16	<5	--	306	-28.8	0.3	7.36	376	17.9	230	<0.5
		Jan-17	<5	--	218	-28.8	0.3	7.36	376	17.9	221	<0.526
CUF-204	CCR	Oct-16	--	276	--	139	1.7	6.9	525	14.32	310	<2.5
		Nov-16	<5	--	324	-28.9	0.74	7.04	529	15.5	322	<0.5
		Jan-17	<5	0	349	-38.8	2.46	7.08	4800	14.9	284	<0.5
CUF-205	CCR	Nov-16	<5	--	292	68	0.75	6.96	750	18.8	513	<0.5
		Jan-17	<5	--	259	68	0.75	6.96	750	18.8	435	<0.5
CUF-206	CCR	Nov-16	<5	--	114	-116	0.31	6.58	3740	15.9	3190	85.6
		Jan-17	<5	--	115	-116	0.31	6.58	3740	15.9	2640	78.4
CUF-207	CCR	Nov-16	<5	--	322	-118	0.3	6.75	3920	16.7	2840	49.4
		Jan-17	<5	--	281	-118	0.3	6.75	3920	16.7	2860	78
CUF-208	CCR	Nov-16	<5	--	247	-21.4	0.61	6.73	4060	17.3	3380	1.6
		Jan-17	<5	--	234	-21.4	0.61	6.73	4060	17.3	3100	3.4
CUF-209	CCR	Nov-16	<5	--	302	-104.7	0.36	7.06	1380	17.4	770	7.3
		Jan-17	<5	--	305	-104.7	0.36	7.06	1380	17.4	613	10.6
CUF-210	CCR	Nov-16	<5	--	306	-40	1.37	7.06	562	17.7	319	<0.5
		Jan-17	<5	--	394	-40	1.37	7.06	562	17.7	380	2.9
CUF-211	CCR	Nov-16	<5	--	310	-68.7	3.91	6.63	1520	18.7	949	35.4
		Jan-17	<5	--	307	-68.7	3.91	6.63	1520	18.7	908	36
CUF-212	CCR	Nov-16	<5	--	93.5	-100.4	1.94	7.33	4210	19.3	3790	15.5
		Jan-17	<5	--	60.6	-100.4	1.94	7.33	4210	19.3	3720	12.8
CUF-213	CCR	Nov-16	111	--	<5	-88	1.31	9.77	4140	18.9	3260	<0.505
		Jan-17	178	--	<5	-88	1.31	9.77	4140	18.9	3120	0.8
CUF-93-1	TDEC	Sep-93	--	10057	--	127	4.3	9.98	510	27.1	270	7100
		Jan-94	--	416	--	43	1.2	11.73	1188	15	180	9300
		Apr-94	--	832	--	43	--	9.96	732	15.9	450	2300
		Jul-94	--	370	--	337	1.3	7.05	759	20.3	460	150
		Jan-95	--	345	--	358	--	7.08	595	14.9	400	45
		Jul-95	--	325	--	387	--	7.32	676	17.8	390	64
		Jan-96	--	308	--	188	--	6.99	728	16.1	260	120
		Jul-96	--	164	--	429	2.1	8.51	480	17.8	300	100
		Jan-97	--	386	--	304	3.7	7	762	15.1	300	75
		Jul-97	--	358	--	439	--	7.36	736	17.7	390	18
		Jan-98	--	354	--	220	--	6.9	759	14.7	390	14
		Jul-98	--	246	--	471	--	7.79	508	17.1	260	110
		Jan-99	--	358	--	176	1.57	6.86	7.62	15.53	510	40
		Jul-99	--	360	--	194	2.96	6.94	764	19.47	440	97
		Jan-00	--	356	--	228	2.29	6.78	769	15.15	<10	78
		Jul-00	--	344	--	171	1.61	6.71	787	27.94	490	86
		Jan-01	--	356	--	266	2.03	6.89	751	17.32	510	--
		Jul-01	--	296	--	254	2.21	6.8	790	18.62	490	200
		Jan-02	--	300	--	423	2.68	6.8	802	16.95	500	50
		Jul-02	--	132	--	292	2.72	7.04	824	19.3	520	86
		Jan-03	--	324	--	306	1.67	6.86	880	16.67	530	100
		Jul-03	--	128	--	164	2.08	6.82	888	18.61	510	130

Well ID	Program	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
CUF-93-1 cont.		Jan-04	--	320	--	167	2.2	6.8	940	17.2	650	170
		Jul-04	--	284	--	198	2.41	6.4	984	19.86	650	100
		Jan-05	--	328	--	374	2.8	6.9	1025	16.85	650	160
		Jul-05	--	332	--	419	2.98	7	1101	17.7	810	39
		Jan-06	--	312	--	157	1.6	6.7	1225	16.6	810	46
		Jul-06	--	304	--	159	2.5	6.7	1275	19.5	950	58
		Jan-07	--	316	--	141	3.2	6.9	1308	14.7	970	58
		Jul-07	--	300	--	186	2.8	6.7	1429	18.7	1100	70
		Jan-08	--	320	--	121	1.9	7	1663	16.07	1300	73
		Jul-08	--	308	--	80	2.7	6.8	1530	20.2	1200	49
		Jan-09	--	312	--	112	2.4	6.8	1633	12.9	1000	80
		Mar-09	--	324	--	118	1.8	7.4	1670	17.4	--	--
		Apr-09	--	324	--	138	4.6	7.2	1670	16.9	--	--
		Jul-09	--	220	--	210	2.2	6.7	1755	19.3	1400	38
		Oct-09	--	120	--	209	2.3	6.9	1834	16.8	1500	38
		Jan-10	--	124	--	173	1.4	6.9	1835	15.6	1200	29
		Apr-10	--	224	--	279	1.4	6.8	1800	18.8	1400	58
		Jul-10	--	208	--	169	1.9	6.8	1948	22.1	1700	53
		Oct-10	--	184	--	276	3.3	7.2	1998	16.4	1700	55
		Jan-11	--	200	--	233	3.3	6.9	2127	14.1	1400	51
		Apr-11	--	36	--	272	4.5	10.9	300	14.4	1400	43
		Jul-11	--	108	--	207	2.6	7.1	2016	20.5	1900	27
		Oct-11	--	184	--	171	2.4	6.7	2042	20.8	1600	45
		Jan-12	--	60	--	151	4.4	9.3	1977	16.9	1200	97
		Apr-12	--	168	--	375	3.9	7.8	2062	16.7	--	51
		Jul-12	--	148	--	219	1.6	7.2	2172	21.1	--	11
		Oct-12	--	208	--	176	1.5	6.8	2294	17.8	2000	26
		Jan-13	--	104	--	151	3.4	6.9	2293	14.3	--	26
		Apr-13	--	60	--	264	2.6	7.8	2211	14.5	1200	44
		Jul-13	--	40	--	288	2.9	9.2	1992	18.8	--	60
		Oct-13	--	184	--	187	2	7.2	2451	16.8	1670	36.9
		Jan-14	--	200	--	164	3.1	6.8	2584	14.5	--	69.2
		Apr-14	--	96	--	308	3.8	8.3	2017	13.3	--	52.4
		Jul-14	--	60	--	327	2.8	8.9	2282	20.2	--	48.4
		Oct-14	--	--	--	--	--	--	--	--	--	66
		Jan-15	--	116	--	321	3.5	7.9	2635	13.1	--	33
		Apr-15	--	64	--	191	3.7	10.5	2359	16.7	--	72
		Jul-15	--	102	--	228	3.4	7.4	2363	22.1	--	65.6
		Oct-15	--	144	--	165	2.3	7.5	2823	15.9	--	30.7
		Jan-16	--	56	--	136	3.8	7.3	2857	14.8	--	18.3
		Apr-16	--	100	--	308	3.2	8.7	2718	16.1	--	44
		Jul-16	--	196	--	155	3.3	6.8	2791	20.9	--	18.7
		Oct-16	--	192	--	157	1.7	6.4	3167	27.9	2770	32.2
		Jan-17	--	202	--	149	0.9	6.4	3076	16.5	2090	17.8

Well ID	Program	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
CUF-93-3	TDEC	Sep-93	--	250	--	130	0.4	6.79	912	18.4	780	1000
		Jan-94	--	323	--	86	0.6	7.02	1101	15.6	540	150
		Apr-94	--	329	--	29	0.4	6.89	1212	16.2	640	60
		Jul-94	--	316	--	159	0.2	6.91	1170	19.2	810	41
		Jan-95	--	311	--	244	0.8	6.96	1137	15	780	22
		Jul-95	--	325	--	128	0.4	6.97	1130	19.4	800	95
		Jan-96	--	340	--	107	0.5	6.92	1157	16.4	680	18
		Jul-96	--	324	--	355	0.6	6.92	1146	20.4	810	16
		Jan-97	--	450	--	134	0.3	7.03	1139	15.8	810	8
		Jul-97	--	332	--	87	0.2	7.08	1081	20.6	720	9
		Jan-98	--	330	--	57	0.4	6.97	1108	17.7	710	20
		Jul-98	--	316	--	97	0.4	7.15	1049	18.8	770	24
		Jan-99	--	316	--	24	0.33	6.98	1096	16.88	770	14
		Jul-99	--	326	--	4	0.35	6.82	1093	19.4	770	30
		Jan-00	--	320	--	169	2.55	6.99	1070	15.29	730	260
		Jul-00	--	316	--	23	0.21	6.95	1093	18.08	740	9
		Jan-01	--	320	--	153	0.55	7.03	1000	18	770	--
		Jul-01	--	310	--	106	0.36	6.91	1062	20.14	760	15
		Jan-02	--	268	--	145	0.29	6.87	1123	18.4	680	38
		Jul-02	--	244	--	104	0.26	7	1053	20.91	730	58
		Jan-03	--	272	--	127	0.33	6.97	1148	16.81	780	17
		Jul-03	--	240	--	62	0.22	6.9	1085	19.15	780	61
		Jan-04	--	264	--	104	0.3	6.9	1094	18.2	720	26
		Jul-04	--	304	--	101	0.2	6.7	1059	19.1	790	16
		Jan-05	--	268	--	165	0.5	6.9	1065	16.6	750	22
		Jul-05	--	240	--	164	0.3	6.9	1081	18.3	790	12
		Jan-06	--	268	--	-27	0.2	6.7	1123	16.9	770	14
		Jul-06	--	310	--	70	0.2	6.9	1144	20.3	760	11
		Jan-07	--	274	--	24	0.2	7	1126	16.5	760	7
		Jul-07	--	308	--	108	0.2	6.8	1150	19.4	770	19
		Jan-08	--	272	--	90	0.3	7	1143	16.9	770	15
		Jul-08	--	308	--	-53	0.2	6.8	1145	19.6	780	24
		Jan-09	--	308	--	15	0.2	6.9	1173	16.6	760	89
		Apr-09	--	268	--	-9	0.3	7	1167	17.7	--	--
		Jul-09	--	336	--	50	0.2	6.7	1183	20.8	820	81
		Oct-09	--	360	--	96	0.3	6.9	1181	18.7	810	67
		Jan-10	--	356	--	104	0.3	6.8	1190	17	800	94
		Apr-10	--	--	--	--	--	--	--	--	800	65
		Jul-10	--	390	--	-38	0.1	6.7	1167	22.2	830	80
		Oct-10	--	400	--	11	0.2	6.7	1168	20	800	84
		Jan-11	--	400	--	60	0.2	6.8	1168	15.7	770	20
		Apr-11	--	368	--	20	0.1	6.7	1175	17.9	840	150
		Jun-11	--	372	--	73	0.3	6.7	1208	22.3	--	--
		Jul-11	--	404	--	53	0.3	6.7	1208	27.5	830	9.8
		Oct-11	--	400	--	9	0.2	6.8	1181	17.3	830	9.8
		Jan-12	--	412	--	45	0.2	6.8	1209	16.2	830	8
		Apr-12	--	444	--	75	5.9	6.8	1245	18.8	--	13

Well ID	Program	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
CUR-93-3 cont.		Jul-12	--	444	--	110	0.2	6.7	1287	23.4	--	9.6
		Oct-12	--	448	--	98	0.2	6.8	1270	18.7	850	15
		Oct-12	--	--	--	--	--	--	--	--	860	14
		Jan-13	--	264	--	115	0.1	6.8	1260	10.4	--	13
		Apr-13	--	452	--	120	0.9	6.8	1276	15.1	1700	12
		Jul-13	--	466	--	89	0.1	6.8	1280	19.7	--	9
		Oct-13	--	540	--	40	0.3	7	1315	17.4	818	11.2
		Jan-14	--	476	--	128	0.2	6.8	1281	11.6	--	12.5
		Apr-14	--	432	--	104	0.3	6.7	1249	17.6	--	16.5
		Jul-14	--	468	--	75	0.1	6.7	1259	22	--	16.4
		Oct-14	--	--	--	--	--	--	--	--	--	59
		Jan-15	--	436	--	75	0.1	6.8	1273	12	--	9.8
		Apr-15	--	456	--	101	0.2	6.7	1272	17.6	--	9.8
		Jul-15	--	448	--	98	0.3	6.6	1339	25.7	--	11.1
		Oct-15	--	476	--	10	0.2	7	1315	19.8	--	10.2
		Jan-16	--	72	--	31	0.1	6.7	1306	15.9	--	9.7
		Apr-16	--	504	--	48	0.9	7	1329	16.8	--	9.3
		Jul-16	--	456	--	116	1.5	6.7	1361	25.4	--	9.1
		Oct-16	--	492	--	97	1.3	6.7	1486	23.4	922	8.4
		Jan-17	--	528	--	118	2	6.6	1389	16.3	875	8.3
CUF-93-4	TDEC	Sep-93	--	337	--	490	7.5	7.04	647	19.5	400	2000
		Jan-94	--	410	--	307	--	7.32	617	15.2	190	7100
		Apr-94	--	352	--	266	1.7	6.97	722	16.8	400	310
		Jul-94	--	386	--	466	1.8	6.91	707	19.6	450	1600
		Feb-95	--	149	--	324	--	7.37	1355	--	1400	3300
		Apr-95	--	140	--	301	--	7.75	563	17.5	--	93
		Jul-95	--	300	--	373	--	8.37	460	18.1	280	620
		Jan-96	--	310	--	402	--	7.6	627	17.7	250	900
		Jul-96	--	162	--	472	2.6	7.53	578	23	400	96
		Jan-97	--	106	--	374	--	8.04	338	15.1	230	400
		Jul-97	--	296	--	470	--	7.12	742	18.3	450	350
		Jan-98	--	400	--	343	--	7.25	758	14.9	440	390
		Jul-98	--	312	--	467	--	7.22	828	18.3	580	69
		Jan-99	--	322	--	337	2.93	7.1	8.33	16.77	520	42
		Jan-99	--	--	--	--	--	--	--	--	--	--
		Jul-99	--	324	--	417	3.52	6.9	878	20.47	570	130
		Jan-00	--	324	--	489	5.2	6.92	859	15.84	570	120
		Jul-00	--	324	--	322	2.73	7.03	855	18.16	540	17
		Jan-01	--	324	--	450	2.62	7.1	820	18.3	550	--
		Jul-01	--	308	--	393	--	6.99	847	18.5	600	160
		Jan-02	--	320	--	447	2.92	6.97	870	17.69	570	150
		Jul-02	--	0.308	--	316	2.83	7.04	890	18.75	670	100
		Jan-03	--	324	--	357	2.66	6.95	973	16.72	770	360
		Jul-03	--	304	--	289	4.6	7.12	1157	18.02	820	180
		Jan-04	--	308	--	281	3.2	7.1	1208	18.2	850	41
		Jul-04	--	316	--	393	2.8	6.5	1303	19	1200	99
		Jan-05	--	328	--	440	2.88	6.9	1400	16.98	1000	120

Well ID	Program	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
CUF-93-4 cont		Jul-05	--	304	--	481	4.7	7.1	1492	17.2	1400	48
		Jan-06	--	316	--	296	4.5	6.8	1627	16.4	1300	110
		Jul-06	--	308	--	332	3.6	6.9	1702	18.4	1600	32
		Jan-07	--	316	--	215	3.6	6.9	1724	14.9	1400	140
		Jul-07	--	308	--	387	4.4	6.8	1708	17.7	1600	36
		Jan-08	--	320	--	249	3.3	6.9	1839	16.02	1200	120
		Jul-08	--	304	--	114	3.5	6.8	1870	19.4	1700	77
		Jan-09	--	308	--	133	3.8	6.8	2044	15.2	1400	79
		Apr-09	--	324	--	165	5.9	7	2259	16.2	--	--
		Jul-09	--	260	--	228	3.3	6.6	2257	18.8	2100	65
		Oct-09	--	276	--	415	6.8	6.9	2482	16.7	2300	78
		Jan-10	--	276	--	329	3.4	6.8	2914	15.7	2400	140
		Apr-10	--	280	--	323	3.5	6.7	2819	19.1	2400	110
		Jul-10	--	280	--	247	3.2	6.6	2657	20.1	2700	64
		Oct-10	--	292	--	328	5.4	6.7	2942	15.8	2800	42
		Jan-11	--	296	--	265	4.7	6.5	2922	13.9	2500	56
		Apr-11	--	296	--	340	6.7	6.9	2800	14.6	2500	37
		Jul-11	--	300	--	223	3.2	6.9	2586	20.8	2500	60
		Oct-11	--	284	--	212	2.8	6.6	2615	20.7	2500	120
		Jan-12	--	292	--	189	3.7	7.4	3350	16.7	2800	68
		Apr-12	--	300	--	427	3.2	6.8	3341	15.9	--	24
		Jul-12	--	284	--	410	2.7	6.5	3168	20.4	--	26
		Oct-12	--	284	--	468	3.9	6.8	3108	17.3	2900	33
		Jan-13	--	176	--	240	4.1	6.7	3090	12.6	--	54
		Apr-13	--	308	--	479	3.4	6.9	3336	10.7	1700	38
		Jul-13	--	300	--	329	2.2	6.6	3499	18.3	--	47
		Oct-13	--	288	--	328	3	6.9	3509	15.7	3000	61.7
		Jan-14	--	288	--	288	3	6.7	3609	14.3	--	47.3
		Apr-14	--	300	--	349	2.3	6.7	3672	14.5	--	42.7
		Jul-14	--	300	--	349	2.3	6.4	3702	19	--	38.5
		Oct-14	--	--	--	--	--	--	--	--	--	6.9
		Jan-15	--	288	--	327	5.1	6.7	3667	12.8	--	16
		Apr-15	--	296	--	336	2.5	6.7	3526	16.1	--	14
		Jul-15	--	320	--	386	2	6.4	3409	20.7	--	8.44
		Oct-15	--	294	--	299	3.6	6.9	3549	14.8	--	14.5
		Jan-16	--	64	--	350	3.9	6.3	3300	14.2	--	6.2
		Apr-16	--	288	--	323	3.7	7	3440	13	--	14
		Jul-16	--	292	--	275	4.5	6.6	3495	19.4	--	73.4
		Oct-16	--	296	--	153	1.9	6.5	3470	23.7	2740	--
		Jan-17	--	304	--	190	1.2	6.5	3380	14	2710	4.4
CUF-10-1	N/A	Jan-11	--	--	--	--	--	--	--	--	290	9.4
		Jul-11	--	148	--	219	2.5	6.5	520	20.2	330	10
		Jan-12	--	144	--	244	1.9	6	471	17.4	310	31
		Jul-12	--	140	--	283	3.2	6	496	20.6	--	14
		Jan-13	--	140	--	285	3.8	6.9	579	14.21	--	16
		Jul-13	--	128	--	259	2.9	6.4	460	17.7	--	11
		Jan-14	--	108	--	313	3.5	6.7	393	12.4	--	16.1

Well ID	Program	Date	General Chemistry: Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
CUF-10-1 cont.		Jul-14	--	120	--	24.5	3.7	6.2	433	19.3	--	10.3
		Oct-15	--	136	--	257	2.2	6.2	423	15	--	9.2
		Apr-16	--	112	--	325	4	6.3	385	13.9	--	10.5
CUF-10-2	N/A	Jan-11	--	64	--	200	0.4	5.4	488	16.8	290	3.1
		Jul-11	--	60	--	192	0.3	5.3	476	22	320	4.2
		Jan-12	--	40	--	192	0.3	5.3	462	18.3	310	5.7
		Jul-12	--	52	--	276	0.2	5.3	500	22.8	--	7.8
		Jan-13	--	40	--	299	0.2	5.3	504	16.2	300	1.1
		Jul-13	--	52	--	273	0.2	5.4	483	18.8	--	3.4
		Jan-14	--	40	--	258	0.2	5.5	501	15.6	--	2.1
		Jul-14	--	52	--	263	0.2	5.2	458	21.7	--	2.9
		Oct-15	--	60	--	170	0.3	5.6	465	21.3	--	4
		Apr-16	--	62	--	235	1	5.5	457	19.5	--	<2.5
CUF-93-2	N/A	Sep-93	--	42	--	47	0.3	7.62	842	18.1	100	650
		Jan-94	--	35	--	61	0.6	7.65	989	16.2	630	88
		Apr-94	--	46	--	2	0.4	7.55	1296	17	760	120
		Jul-94	--	55	--	70	0.1	7.55	1027	18.9	780	26
		Jan-95	--	35	--	199	0.4	7.56	1328	16.2	1100	16
		Jul-95	--	62	--	200	0.6	7.02	1659	19.4	1400	15
		Jan-96	--	31	--	140	0.6	7.11	2952	17.3	1700	8
		Jul-96	--	42	--	300	0.1	6.97	3611	19.9	3300	19
		Jan-97	--	50	--	126	0.2	7.01	3994	17.6	3700	6
		Jul-97	--	6	--	165	0.2	6.72	3946	22.8	3600	16
		Jan-98	--	40	--	104	0.3	7.36	4213	19.1	3800	11
		Jul-98	--	36	--	87	0.2	7.88	4193	20.3	4300	7
		Jan-99	--	33	--	-1	0.3	8.19	4488	18.36	4200	7
		Jul-99	--	44	--	89	0.18	7.36	4679	20.58	4500	12
		Jan-00	--	40	--	187	2.26	7.04	4616	16.83	3600	180
		Jul-00	--	64	--	77	0.2	7.01	4946	20.32	4700	4
		Jan-01	--	0	--	4	0.28	8.1	4664	20.28	6400	
		Jul-01	--	28	--	113	0.51	7.46	5243	23.01	5800	6
		Jan-02	--	44	--	95	0.28	7.86	5316	20.09	6000	6
		Jul-02	--	38	--	60	0.21	7.82	5888	22	5900	9
		Jan-03	--	40	--	73	0.48	7.9	5948	19.78	5700	10
		Jul-03	--	52	--	-49	0.21	8.29	5451	21.66	7100	11
		Jan-04	--	48	--	-29	0.3	8.2	5681	19.2	5100	19
		Jul-04	--	34	--	-24	0.2	7.8	5495	20.5	7800	12
		Jan-05	--	36	--	-1	0.4	7.8	5853	18.3	6100	21
		Mar-05	--	60	--	-22	0.3	8.1	6476	18.9	--	--
		Jul-05	--	28	--	52	0.3	7.6	5463	20.4	7000	12
		Jan-06	--	48	--	11	0.2	7.7	6705	20.2	6800	10
		Jul-06	--	52	--	-29000	0.1	7.9	6663	21.4	7500	13
		Jan-07	--	44	--	61	0.2	7.4	6669	20.3	6300	18
		Jul-07	--	48	--	15	0.1	7.5	6652	22.3	6000	12
		Jan-08	--	52	--	37	0.3	7.7	6840	20.9	6400	11
		Mar-08	--	56	--	25	0.3	7.9	6970	21.7	--	--
		Jul-08	--	44	--	98	0.1	7.3	6569	23	6100	14

Well ID	Program	Date	General Chemistry: Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
CUF-93-2 cont.		Jan-09	--	52	--	157	0.2	7.6	6699	20.6	5500	12
		Mar-09	--	52	--	10	0.2	7.7	7084	21.2	--	--
		Apr-09	--	56	--	24	0.1	7.9	6833	22.1	--	--
		Jul-09	--	48	--	82	0.1	7.3	6643	21.4	6300	10
		Oct-09	--	48	--	27	0.2	7.7	6733	20.5	6600	12
		Jan-10	--	46	--	68	0.3	7.3	6626	19.6	6100	9.6
		Apr-10	--	80	--	179	0.3	6.7	6337	21.6	6200	10
		Jul-10	--	80	--	131	0.2	6.7	6287	23.5	6200	13
		Oct-10	--	76	--	190	0.1	6.6	6198	20.7	5900	6.8
		Jan-11	--	58	--	202	0.2	6.8	6036	17.9	4800	39
		Apr-11	--	60	--	117	0.2	7	6043	18.8	5400	20
		Jun-11	--	44	--	56	0.2	7.1	5881	25.2	--	--
CUF-96-6	N/A	Jul-96	--	368	--	208	4.5	11.62	2617	26.7	1400	36
		Jan-97	--	140	--	202	0.9	11.56	2266	14.2	1800	200
		Jul-97	--	116	--	207	0.8	11.32	2143	25	1500	17
		Feb-99	--	28	--	156	2.59	9.43	1595	18.83	1400	640
		Jul-99	--	176	--	284	2.31	7.54	1836	28.68	1500	100
CUF-96-7	N/A	Jul-96	--	386	--	297	0.3	6.92	993	20	660	21
		Jan-97	--	480	--	111	0.3	6.82	1094	14.6	640	15
		Jul-97	--	530	--	122	0.2	6.75	1030	19.9	560	21
		Jul-00	--	--	--	35	0.39	6.93	918	19.1	--	--
CUF-96-8	N/A	Jul-96	--	36	--	498	2.7	6.6	136	17	--	1100
		Jan-97	--	56	--	419	4.6	6.41	180	13.8	120	50
		Jul-97	--	18	--	449	--	6.88	82	17.8	60	44
		Feb-99	--	160	--	302	2.03	6.12	402	21.97	300	30
		Jul-99	--	96	--	386	3.62	6.42	351	29.31	280	96
		Jul-00	--	152	--	435	5.1	6.62	600	25.3	440	62
CUF-RS	N/A	Jan-94	--	271	--	320	--	7.18	578	9.1	210	28
		Apr-94	--	252	--	270	--	7.27	529	11.6	300	75
		Jul-94	--	270	--	384	--	7.05	540	20.6	340	13
		Jan-95	--	240	--	369	3.5	7.19	583	10.1	320	12
		Jul-95	--	213	--	333	2.3	6.96	557	18.4	330	160
		Jan-96	--	244	--	419	4.8	7.19	564	12	250	4
		Jul-96	--	242	--	487	3.7	--	549	19.2	380	45
		Jan-97	--	210	--	436	6.5	7.3	541	11.7	340	38
		Jul-97	--	236	--	400	3.9	7.65	539	20.2	310	6
		Jan-98	--	247	--	346	--	7.25	544	11.5	320	2
		Jul-98	--	240	--	495	2.6	7.23	526	19.2	340	4
		Jan-99	--	220	--	318	--	7.29	538	12.36	340	1
		Jul-99	--	228	--	409	1.84	7.07	562	20.49	350	19
		Jan-00	--	220	--	394	7.34	7.51	561	8.1	350	64
		Jan-01	--	224	--	462	7.84	7.82	547	11.54	390	--
		Jul-01	--	240	--	403	4.83	7.48	574	24.33	380	63
		Jan-02	--	220	--	462	7.24	7.57	541	11.75	300	23
		Jul-02	--	140	--	299	10.58	8.83	477	30.12	340	290
		Jan-03	--	224	--	407	8.54	8	533	9.73	330	9
		Jul-03	--	140	--	268	11.3	8.74	394	27.02	240	240

Well ID	Program	Date	Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	ORP (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (uohm/cm)	Temperature (°C)	TDS (mg/L)	TSS (mg/L)
			General Chemistry									
CUF-RS cont.		Jan-04	--	220	--	311	5.8	7.5	593	14.7	360	35
		Jul-04	--	236	--	399	5.62	7.3	598	22.4	380	330
		Jan-05	--	220	--	472	7.6	7.6	577	12.1	370	7
		Jul-05	--	224	--	472	4.8	7.6	577	20.2	370	82
		Jan-06	--	220	--	308	8.6	7.4	614	12.5	370	56
		Jul-06	--	228	--	291	5.3	--	642	23.9	400	160
		Jan-07	--	236	--	216	8.7	7.8	606	10.4	350	12
		Jul-07	--	224	--	430	5.8	7.5	624	23.6	380	47
		Jan-08	--	228	--	266	10.8	7.7	2	10.5	350	27
		Jan-09	--	216	--	154	7.6	7.4	651	10.01	360	10
		Apr-09	--	220	--	153	7.2	7.4	632	18.1	--	--
		Jul-09	--	216	--	209	5.4	7.3	580	22.1	340	75
		Oct-09	--	228	--	265	5.3	7.4	611	17.8	400	66
		Jan-10	--	236	--	206	6.8	7.6	652	11.6	400	94
		Apr-10	--	280	--	191	5.3	7.2	627	18.5	400	490
		Jan-11	--	184	--	175	9.8	7.3	651	8.4	400	7.4
		Apr-11	--	220	--	279	6	7.1	581	16	380	27
		Jul-11	--	228	--	217	5.5	7.2	625	25.7	380	8.6
		Oct-11	--	228	--	224	5.8	7.4	627	21.4	370	13
		Jan-12	--	228	--	215	6.4	7.5	600	13.7	360	25
		Apr-12	--	232	--	344	2.3	7.3	602	14.8	--	22
		Jul-12	--	240	--	362	5.6	7.4	611	24.21	--	11
		Oct-12	--	228	--	330	5.8	7.6	630	20.1	380	69
		Jan-13	--	208	--	314	8.5	7.4	609	10.5		19
		Apr-13	--	240	--	317	7.4	7.7	599	13.7	1400	4.9
		Jul-13	--	240	--	323	7.2	8	738	19.7	--	53
		Oct-13	--	240	--	262	6.8	7.7	650	18.7	332	18.8
		Jan-14	--	248	--	253	8.1	7.3	597	7.4	--	37.1
		Apr-14	--	240	--	280	6.9	7.7	600	15	--	11.1
		Jul-14	--	232	--	309	5.7	7.2	607	21.7	--	28.3
		Oct-14	--	--	--	--	--	--	--	--	--	24
		Jan-15	--	248	--	285	7.3	7.3	597	7.1	--	<2.5
		Apr-15	--	240	--	282	5.9	7.1	564	16.1	--	<2.5
		Jul-15	--	284	--	285	5.1	7	616	28.3	--	7.7
		Oct-15	--	248	--	260	9.4	7.7	575	21.5	--	<2.5
		Jan-16	--	44	--	213	9.2	7.4	674	10.5	--	10.6
		Apr-16	--	252	--	281	7.9	7.6	579	15.6	--	14.8

mg/L - milligrams per liter
ORP - Oxygen Reduction Potential
mv - millivolt
°C - Degrees Celcius
uhom/cm - micro ohms per centimeter
-- no data
N/A - not available

APPENDIX N
WELL ABANDONMENT RECORDS

Geotechnical Field Services for Well Installations and Closures

Groundwater Monitoring Optimization – Phase 3
Cumberland Fossil Plant
Cumberland City,
Stewart County, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

February 10, 2017

February 10, 2017
File: rpt_003_CUF_175565299

Attention: Ms. Shannon Bennett
Senior Program Manager-Civil Engineering
Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

Reference: Geotechnical Field Services for Well Installations and Closures
Groundwater Monitoring Optimization – Phase 3
Cumberland Fossil Plant
Cumberland City, Stewart County, Tennessee

Dear Ms. Bennett,

Stantec Consulting Services Inc. (Stantec) has prepared the enclosed Geotechnical Field Services report for the installation and closure of monitoring wells at the Cumberland Fossil Plant (CUF) in accordance with our proposal dated April 8, 2015 and TVA Purchase Orders 1082306 and 1082345. The services performed were in accordance with our Work Plan dated April 4, 2016.

Stantec appreciates the opportunity to provide these services to the TVA. If you have any questions or need additional information, please call.

Sincerely,

STANTEC CONSULTING SERVICES INC.

John Banton, PE
Senior Project Engineer

Barry L. Bryant, PE
Senior Principal

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1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) has prepared this Geotechnical Field Services Report for the implementation (Phase 3) of AECOM's Groundwater Monitoring Optimization (May 2, 2016) for coal combustion residual (CCR) units at the Cumberland Fossil Plant (CUF). Phase 3 includes, in part, the installation of new groundwater monitoring wells and closure of existing wells no longer of use in establishing the groundwater monitoring networks for the CCR units. Stantec's Phase 3 Work Plan was previously submitted to the Tennessee Valley Authority (TVA) on April 4, 2016.

CUF contains four CCR units: Stilling and Retention Ponds, Bottom Ash Pond, Dry Ash Stack, and the Gypsum Storage Area. The Stilling, Retention and Bottom Ash Ponds are active impoundments. Currently, these units are not subject to groundwater monitoring by the Tennessee Department of Environment and Conservation (TDEC). However, it is anticipated that TDEC will require groundwater monitoring as part of unit closure projects. The Dry Ash Stack and Gypsum Storage Area are both active landfills (former impoundments) with active TDEC compliance monitoring. All four CCR units are subject to the new CCR Rule. Figure 1, as developed by AECOM, shows the four CCR units as well as the groundwater monitoring networks.

This Geotechnical Field Services Report provides the results of new well installations and the closure of wells no longer of use. Also included are discussions of well redevelopment, downhole video logging of wells, dedicated sampling pump installations, and field survey of wells remaining in-service. Supporting documentation gathered during this project is provided in the accompanying appendices.

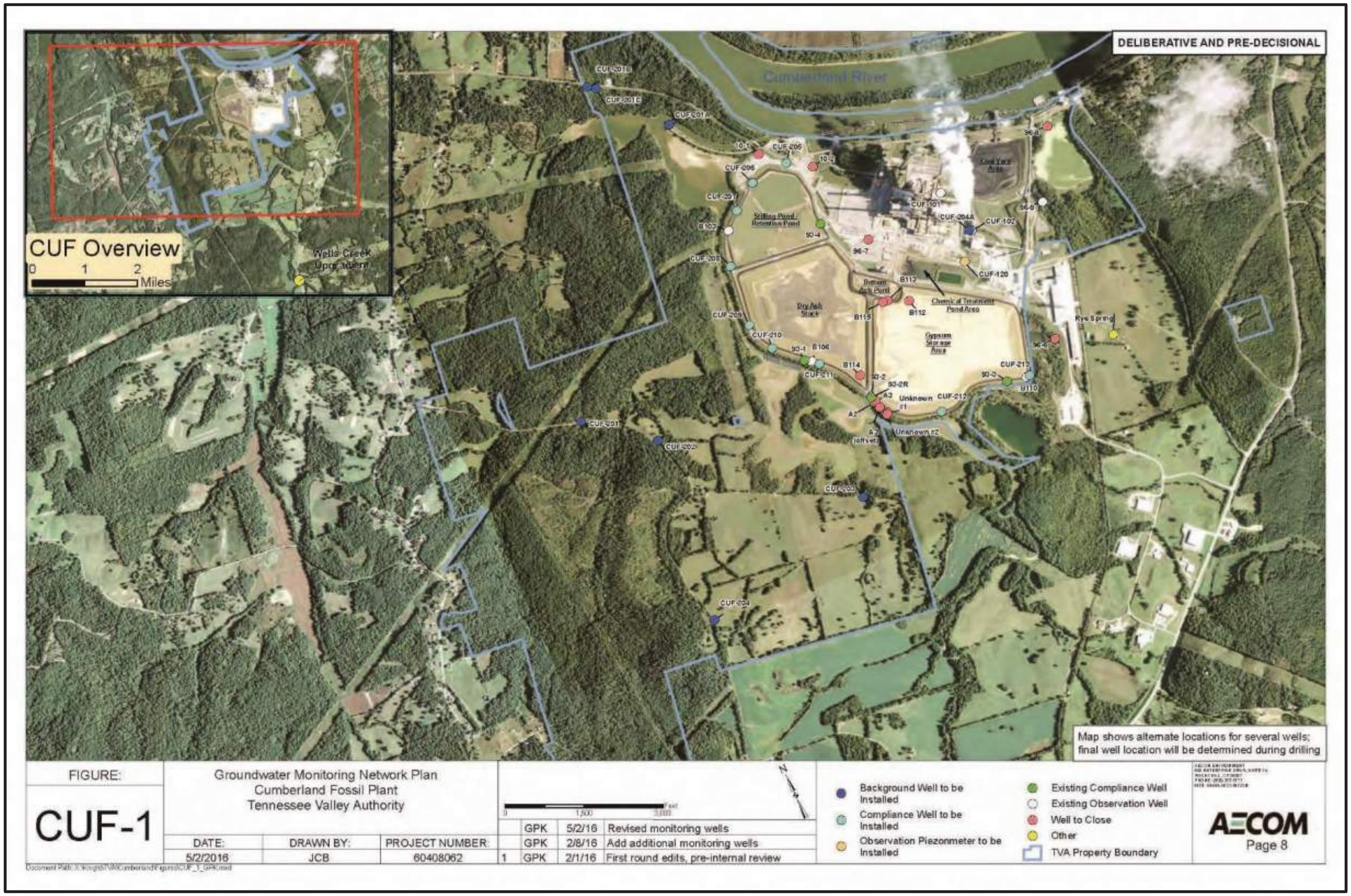


Figure 1. CCR Units and Groundwater Monitoring Network

2.0 PHASE 3 FIELD WORK

Phase 3 recommendations provided by AECOM include twelve (12) new monitoring wells, one (1) new observation well, fifteen (15) well closures, and the redevelopment of eight (8) existing wells. The work was performed by qualified Stantec and subcontractor drill crews using rotary and sonic drill units working under the direction of a licensed Tennessee driller (#949). Additionally, Stantec field supervision was provided by a professional geologist and engineer, both licensed in the State of Tennessee. TVA personnel assisted Stantec by providing excavation (drill) permitting, utility clearances, and access to locations along with other site coordination. The well locations were surveyed by a Stantec survey crew at the conclusion of the installation activities. The groundwater monitoring network is shown on the drawing in Appendix A.

2.1 NEW MONITORING WELLS

Twelve (12) new monitoring wells, designated as CUF-201, CUF-202 and CUF-204 through CUF-213, along with one new observation well (CUF-120) were installed in accordance with AECOM's Groundwater Optimization for CUF and Stantec's Monitoring Well Installation, Standard Procedure SCSI-TI-MW-01 (April 6, 2016). Each well was screened within the appropriate aquifer as designated by AECOM during the field work.

The monitoring wells were installed using current industry and regulatory protocols to prevent introducing contaminants during the drilling and installation process. These procedures include, in part, decontamination of the drilling equipment and tools before and after each well by washing with hot, potable water delivered under high pressure, using new well screen and riser that have been cleaned and sealed in plastic at the factory, and placing washed filter pack sand that is approved by the National Science Foundation (NSF). Other steps employed during the installations include the workers donning clean, nitrile gloves during the handling of downhole equipment and well materials, and using potable water for grouting purposes. The drilling and well installation fieldwork was performed and documented under the direct supervision of a Stantec project engineer and/or geologist.

2.1.1 Drilling and Installation Methodologies

The wells were installed using truck- and track-mounted rotary drill rigs equipped with hollow-stem augers and a track-mounted sonic unit. Wells with screened intervals in soil overburden were typically installed by first advancing 4¼-inch inside diameter (ID) hollow-stem augers through the soil overburden. Standard Penetration Tests (SPTs) were conducted at 2½-foot depth intervals through the soil overburden to assist in characterizing the subsurface soils. Wells drilled into bedrock were accomplished with a sonic drill unit equipped with nine-inch casing. The subsurface materials were logged with particular attention given to the material type, color, moisture content, consistency, and other notable composition characteristics. The recovered soil samples were placed in pint-size glass jars with lids and transported to Stantec's Lexington, Kentucky laboratory. Additionally, representative soil samples from the screened intervals of two background wells (CUF-201 and CUF-202) were separately containerized for analytical testing by Environmental Science Corporation (ESC) located in Mt. Juliet, Tennessee. Further discussion of these analytical samples is provided in Section 3.

New wells were installed through 8¼-inch ID hollow-stem augers or nine-inch diameter sonic casing. The new well consists of a four-inch diameter by ten-foot long Schedule 40 PVC pre-packed well screen (0.010-inch slots) and riser. The screen and riser consisted of flush-joint, threaded PVC pipe. A four-inch diameter Schedule 40 PVC bottom well plug measuring approximately six inches in length was threaded onto the bottom of the screen. The PVC riser extended approximately 45 inches above the ground surface and was capped with a temporary plug or slip cap. The annular space was backfilled with a sand filter pack (20/40 mesh – Global No. 7 sand) extending from the bottom of the borehole to an elevation corresponding to approximately two to three feet above the well screen. A minimum two-foot thick bentonite pellet seal was then placed on top of the sand filter pack. After the bentonite pellet seal sufficiently hydrated, the remaining annular space was backfilled with a bentonite grout (containing 30% pure bentonite solids).

Subsequent wellhead construction consisted of an above-grade, eight-inch square steel locking protective cover anchored to a five-foot square by twelve-inch thick pre-cast concrete surface pad. The protective cover extends approximately four-feet above the precast concrete pad and the annular space was filled with pea gravel to about six-inches below the top of PVC casing. Four four-inch diameter steel protective bollards filled with concrete are installed near each corner of the concrete pad.

During the field work, several new well installations were modified from the recommendations provided in AECOM's Groundwater Optimization for CUF due to encountered subsurface conditions. Stantec issued Requests for Information (RFIs) to document those modifications that included such items as dry boreholes, relocated well locations, and screened interval depths. A total of thirteen RFIs (609389-001 through 609389-011, 609389-015 and 609389-018 were submitted for the new well installations. These RFIs are included at the end of this report in Appendix L.

Well construction diagrams and boring logs for the new monitoring wells are provided in Appendices B and C, respectively. A plan view showing the boring locations including the dry boreholes is also included in Appendix C. A summary of the new well installations is presented in the following tables (all measurements are expressed in feet).

Table 1. Summary of New Well Survey Data

Well ID	TN State Plane Northing (ft NAD27)	TN State Plane Easting (ft NAD27)	Latitude NAD83 (D M S)	Longitude NAD83 (D M S)	Top of Protective Cover Elevation (ft NGVD29)	Top of Well Casing Elevation (ft NGVD29)	Top of Concrete Pad Elevation (ft NGVD29)	Ground Surface Elevation (ft NGV29)
CUF-120	730,384.17	1,513,540.26	N36°23'14.19"	W87°39'09.61"	394.27	393.19	390.26	389.4
CUF-201	730,765.35	1,505,625.26	N36°23'16.63"	W87°40'46.48"	401.27	400.41	397.18	396.7
CUF-202	730,347.74	1,506,636.70	N36°23'12.67"	W87°40'34.02"	384.17	383.28	380.09	379.5
CUF-204	726,557.28	1,506,364.04	N36°22'35.15"	W87°40'36.56"	440.91	439.66	436.84	435.9
CUF-205	733,581.23	1,511,258.33	N36°23'45.42"	W87°39'38.18"	385.46	384.51	381.36	380.8
CUF-206	733,499.10	1,510,518.16	N36°23'44.48"	W87°39'47.21"	399.68	398.67	395.57	394.9
CUF-207	733,146.70	1,510,018.97	N36°23'40.91"	W87°39'53.24"	399.03	398.19	394.94	394.4
CUF-208	732,242.48	1,509,462.75	N36°23'31.88"	W87°39'59.86"	399.48	398.38	395.38	394.6
CUF-209	731,074.78	1,509,317.09	N36°23'20.31"	W87°40'01.40"	399.19	398.23	395.11	394.5
CUF-210	730,478.75	1,509,519.11	N36°23'14.45"	W87°39'58.80"	399.23	398.20	395.12	394.5
CUF-211	729,830.15	1,510,203.78	N36°23'08.15"	W87°39'50.30"	399.77	398.76	395.72	395.0
CUF-212	728,016.94	1,511,935.77	N36°22'50.52"	W87°39'28.74"	399.61	398.71	395.58	395.0
CUF-213	727,951.80	1,513,737.18	N36°22'50.17"	W87°39'06.70"	400.09	399.05	396.04	395.3

NAD27 – North American Datum of 1927.
NAD83 – North American Datum of 1983.
D M S – Degrees, Minutes, Seconds.
ft NGVD29 – feet National Geodetic Vertical Datum of 1929.
Survey data provided by Stantec (August 30, 2016 and November 18, 2016).

Table 2. Summary of New Well Construction Details

Well ID	Top of Casing Elevation (ft NGVD29)	Bottom of Well*		Screened Interval*		Bottom of Borehole	
		Depth (ft btoc)	Elevation (ft NGVD29)	Depth (ft btoc)	Elevation (ft NGVD29)	Depth (ft btoc)	Elevation (ft NGVD29)
CUF-120	393.19	14.7	378.5	9.3 - 14.3	383.8 – 378.9	14.5	374.9
CUF-201	400.41	28.1	372.3	17.6 – 27.7	382.8 – 372.7	25.1	371.6
CUF-202	383.28	19.9	363.4	14.3 – 19.6	369.0 – 363.7	18.5	361.0
CUF-204	439.66	48.8	390.8	38.2 – 48.4	401.5 – 391.3	46.0	389.9
CUF-205	384.51	27.5	357.0	16.9 – 27.1	367.6 – 357.4	25.2	355.6
CUF-206	398.67	93.6	305.1	82.7 – 92.9	316.0 – 305.8	91.5	303.4
CUF-207	398.19	85.7	312.5	75.0 – 85.1	323.2 – 313.1	84.3	310.1
CUF-208	398.38	58.6	339.8	47.9 – 58.0	350.5 – 340.4	60.0	334.6
CUF-209	398.23	63.8	334.4	53.1 – 63.3	345.1 – 334.9	61.4	333.1
CUF-210	398.20	69.0	329.2	63.5 – 68.5	334.7 – 329.7	72.0	322.5
CUF-211	398.76	68.6	330.2	57.7 – 67.9	341.1 – 330.9	71.5	323.5
CUF-212	398.71	73.2	325.5	62.6 – 72.8	336.1 – 325.9	70.0	325.0
CUF-213	399.05	45.7	353.4	40.0 – 45.2	359.1 – 353.9	45.9	349.4

* Based on downhole video performed by Stantec in October, 2016.
ft NGVD29 – feet National Geodetic Vertical Datum of 1929.
ft btoc – feet below top of casing.
ft bgs - feet below ground surface.

2.1.2 Boring CUF-120A and Well CUF-120

Well CUF-120, situated north of the gypsum storage area, was installed as an observation well within the soil overburden. Initially, this well was planned to be screened entirely within the upper bedrock zone. However, groundwater was not encountered in boring CUF-120A after advancing 17.0 feet into bedrock and the borehole was subsequently backfilled with high solids (30%) bentonite grout. Water was encountered during drilling within the soil overburden and Stantec was directed by AECOM to install one-inch diameter PVC riser and slotted well screen (five-foot length) for this saturated zone. The soil overburden is visually described as lean clay, brown in color, moist, stiff in consistency, with sand and gravels with depth.

Groundwater was initially noted at a depth of 8.6 feet below ground surface (bgs) (elevation 380.8 feet) during the drilling process. The bottom of well CUF-120 was positioned at approximately eleven (11) feet bgs (elevation 378.5 feet).

2.1.3 Well CUF-201

Well CUF-201 was installed as a background monitoring well in alluvial sand and gravel deposits that is similar to the overburden geology beneath the Stilling/Retention Pond, Dry Ash Stack, and Gypsum Storage Area. The near-surface conditions at CUF-201 consist of approximately one-foot of topsoil underlain by lean clay, reddish brown and gray in color, moist, soft to medium stiff, and containing chert gravel. Underlying the lean clay at a depth of 11.5 feet bgs, gray and brown silt, moist to wet, loose, with silty sand and chert gravel was present to the bottom of the hole at 25.1 feet bgs (elevation 371.6 feet).

Groundwater was encountered at 15.1 feet bgs (elevation 381.6 feet) during drilling within silt strata and rose to a level of 9.8 feet bgs (elevation 386.9 feet) after drilling. A ten-foot screen was positioned approximately nine feet below the encountered groundwater table by establishing the well bottom at 24.4 feet bgs (elevation 372.3 feet). The top of the screened interval is 13.9 feet bgs (elevation 382.8 feet). A subsequent measurement within the well casing on September 8, 2016 revealed the water surface to be 12.1 feet below top of casing (btoc) (elevation 388.3 feet), which corresponds to a 16-foot water column within the well.

Analytical testing was performed on one composite soil sample from the recovered SPT sampling within the screened interval of CUF-201. Soil samples were placed in coolers and packed in ice for shipment to ESC Lab Science, Mt. Juliet, Tennessee. Sample results are discussed in Section 3.

2.1.4 Well CUF-202

Well CUF-202 was installed as a background monitoring well in alluvial sand and gravel with geology similar to the overburden geology beneath the Stilling/Retention Pond, Dry Ash Stack, and Gypsum Storage Area. The near-surface conditions at CUF-202 consist of a six-inch thick topsoil mantle underlain by light brown to brown gravelly silt with chert, moist, and stiff to very stiff. Underlying the silt at a depth of 10.5 feet bgs (elevation 369.0 feet), light brown sandy silt with gravel, moist and stiff was encountered and extended to the bottom of borehole at 18.5 feet bgs (elevation 361.0 feet).

During the drilling process, groundwater was measured at 8.3 feet bgs (elevation 371.2 feet) and rose to 5.9 feet bgs (elevation 373.6 feet) after drilling. The screened interval was positioned between the depths of 10.5 and 15.8 feet bgs (elevations 369.0 and 363.7 feet). The bottom of the well was positioned at a depth of 16.1 feet bgs (elevation 363.4 feet). A subsequent measurement within the well casing on September 8, 2016 revealed the water surface to be 5.9 feet btoc (elevation 377.4 feet), which corresponds to a 14-foot water column within the well.

Analytical testing was performed on one composite soil sample from the recovered SPT sampling within the screened interval of CUF-202. Soil samples were placed in coolers and packed in ice for shipment to ESC Lab Science, Mt. Juliet, Tennessee. Analytical results are discussed in Section 3.

2.1.5 Borings CUF-202A and CUF-202B

Prior to the successful well installation at boring CUF-202, two other borings were drilled (CUF-202A and CUF-202B). Sufficient groundwater for monitoring purposes was not encountered at these boring locations and the lithology was predominantly clay. These boreholes were subsequently tremmie-backfilled with high-solids (30%) bentonite grout. See Appendix C for these boring logs and locations.

2.1.6 Borings CUF-203A and CUF-203B

Two boring attempts (CUF-203A and CUF-203B) were made for installing a background bedrock monitoring well as recommended in AECOM's Groundwater Optimization for CUF. Both borings did not encounter sufficient groundwater for monitoring purposes within the depth drilled (50 feet bgs for each boring). These boreholes were subsequently grouted with high-solids (30%) bentonite grout after consultation with AECOM and TVA. The boring logs and locations for CUF-203A and CUF-203B are provided in Appendix C.

2.1.7 Well CUF-204

Well CUF-204 was installed as a bedrock background monitoring well. The near-surface conditions at CUF-204 consist of approximately six inches of topsoil underlain by brown lean clay, moist, medium to stiff, with crumbly silt material and trace fine roots to 7.5 feet bgs (elevation 428.4 feet). Underlying the lean clay, red-brown and tan mottled fat clay, moist to wet, very stiff, with silty zones and trace manganese staining and gravels was present to a depth of 21.5 feet bgs (elevation 414.4 feet). Underlying the fat clay, limestone was encountered and is described as gray with red banding, thin bedded to finely crystalline grained, and soft to hard. The upper 6.5 feet of limestone was found to be weathered. The limestone continued to the bottom of the hole at 46.0 feet bgs (elevation 389.9 feet).

At the completion of drilling, groundwater was measured at 29.7 feet bgs (elevation 406.2 feet). The screened interval was positioned between the depths of 34.4 and 44.6 feet bgs (elevations 401.5 and 391.3 feet). The bottom of the well was positioned at a depth of 45.1 feet bgs (elevation 390.8 feet). A subsequent measurement within the well casing on September 8, 2016 revealed the water surface to be 29.1 feet btoc (elevation 410.6 feet), which corresponds to a 19.9-foot water column within the well.

2.1.8 Boring CUF-204A

An initial boring (CUF-204A) was advanced at the proposed location shown in AECOM's Groundwater Optimization for CUF. However, sufficient groundwater for monitoring purposes was not encountered within the depth drilled (45.0 feet bgs; elevation 413.3 feet), which includes 31.5 feet within limestone bedrock. No well was installed and the borehole was tremmie-backfilled with high solids (30%) bentonite grout. The location and boring log is provided in Appendix C.

2.1.9 Well CUF-205

Well CUF-205 was installed for downgradient monitoring for the Stilling Pond/Retention Pond. The near-surface conditions at CUF-205 consist of approximately two feet of red-brown lean clay that appeared to be fill material followed by 4.5 feet of light brown silt with limestone gravels. Underlying these layers, red-brown fat clay, moist, soft, with traces of gravel and sand was present to a depth of 11.5 feet bgs (elevation 369.3 feet). Underlying the fat clay, light brown silt was present and was found to be moist to wet and stiff to very stiff. This silt layer extended to a depth of 18.0 feet bgs (elevation 362.8 feet) and then transitioned into light brown silty gravel to auger refusal and the bottom of the hole at 25.2 feet bgs (elevation 355.6 feet).

Groundwater was encountered at a depth of 14.4 feet bgs (elevation 366.4 feet) during drilling and rose to 11.8 feet bgs (elevation 369.0 feet) after drilling. The bottom of well was positioned at a depth of 23.8 feet bgs (elevation 357.0 feet) and the top of screen at 13.2 feet bgs (elevation 367.6 feet). A measurement within the well casing on September 7, 2016 revealed the water surface to be 18.2 feet btoc (elevation 366.3 feet), which corresponds to a 9.3-foot water column within the well.

2.1.10 Well CUF-206

Well CUF-206 was installed as a downgradient monitoring well in alluvial sand and gravel deposits for the Stilling Pond/Retention Pond. Underlying a thin surface layer of crushed stone, the subsurface conditions at CUF-206 consist predominately of lean clay with varying amounts of chert gravels. The lean clay is described as reddish brown, brown-gray or gray in color, moist in natural moisture content, and medium stiff to stiff. At a depth of 76.0 feet bgs (elevation 318.9

feet), the gravel content increased within the lean clay and transitioned into sand with gravel at a depth of 79.5 feet bgs (elevation 315.4 feet) and extended to bedrock at 90.0 feet bgs (elevation 304.9 feet). The borehole was terminated at 91.5 feet bgs (elevation 303.4 feet) in limestone bedrock.

At the completion of drilling, groundwater was measured at 33.7 feet bgs (elevation 361.2 feet). The screened interval was positioned between the depths of 78.9 and 89.1 feet bgs (elevations 316.0 and 305.8 feet) with the well bottom at 89.8 feet bgs (elevation 305.1 feet). A subsequent measurement within the well casing on September 7, 2016 revealed the water surface to be 35.1 feet btoc (elevation 363.6 feet), which corresponds to a 58.5-foot water column within the well.

2.1.11 Well CUF-207

Well CUF-207 was installed as a downgradient monitoring well in alluvial sands and gravels for the Stilling Pond/Retention Pond. The near-surface conditions at CUF-207 consist of approximately 16.0 feet of red-brown gravelly fat clay, moist, medium stiff, with limestone fragments. The fat clay transitioned into gravelly lean clay to lean clay described as brown to red-brown and gray-brown in color, moist to wet, and soft to medium stiff. The lean clay material extended to a depth of 58.0 feet bgs (elevation 336.4 feet) and was underlain by sandy silt, brown to gray in color, wet in natural moisture content and soft to very soft. The sandy silt extended to 72.5 feet bgs (elevation 321.9 feet) and transitioned into gravel with sand, gray in color, wet and loose, to the bedrock surface at 82.5 feet bgs (elevation 311.9 feet). The bedrock consists of shale, gray in color and weathered. The borehole was terminated at a depth of 84.3 feet bgs (elevation 310.1 feet).

At the completion of drilling, groundwater was measured at 31.9 feet bgs (elevation 362.5 feet). The screened interval was positioned between the depths of 71.2 and 81.3 feet bgs (elevations 323.2 and 313.1 feet) with the well depth at 81.9 feet bgs (elevation 312.5 feet). A subsequent measurement within the well casing on September 7, 2016 revealed the water surface to be 33.7 feet btoc (elevation 364.5 feet), which corresponds to a 52.0-foot water column within the well.

2.1.12 Well CUF-208

Well CUF-208 was installed as a downgradient monitoring well in the alluvial sands and gravels between the Stilling Pond/Retention Pond and Dry Ash Stack. The near-surface conditions at CUF-208 consist of gravelly fat to lean clay extending to 22.5 feet bgs (elevation 372.1 feet). These soils are described as red-brown and brown to light brown in color, moist, and medium stiff to stiff. Underlying these soils, gravelly silt described as light brown to brown with gray mottling in color, moist to wet and soft to medium stiff was present extended to bottom of the borehole at 60.0 feet bgs (elevation 334.6 feet).

Groundwater was encountered during drilling at 30.0 feet bgs (elevation 364.6 feet) and 35.9 feet bgs (elevation 358.7 feet) after drilling. The screened interval was positioned between the depths of 44.1 and 54.2 feet bgs (elevations 350.5 and 340.4 feet) and the bottom of well at 54.8 feet bgs (elevation 339.8 feet). A subsequent measurement within the well casing on September 7, 2016 revealed the water surface to be 38.1 feet btoc (elevation 360.3 feet), which corresponds to a 20.5-foot water column within the well.

2.1.13 Well CUF-209

Well CUF-209 was installed as a downgradient monitoring well in the alluvial sands and gravels for the Dry Ash Stack, Bottom Ash Pond, and Gypsum Storage Area. The near-surface conditions at CUF-209 consist of fat and lean clays, red-brown to brown, moist and soft to medium stiff to 12.5 feet bgs (elevation 382.0 feet). Below this depth, silt with varying amount of gravels and described as brown and gray, moist and soft to medium stiff was encountered that extended to 54.0 feet bgs (elevation 340.5 feet). Silty sand, brown in color, wet in natural moisture content and very loose to loose with small gravels was presented and extended to the bottom of the borehole at 61.4 feet bgs (elevation 333.1 feet).

Groundwater was noted at 16.4 feet bgs (elevation 378.1 feet) during drilling within the silt strata and then lower at 35.3 feet bgs (elevation 359.2 feet) after drilling. An approximate ten-foot screen length was positioned near the bottom of the borehole at a depth of 60.1 feet bgs (elevation 334.4 feet). The top of the screened interval is 49.4 feet bgs (elevation 345.1 feet). A subsequent measurement within the well casing on September 8, 2016 revealed the water surface to be 36.4 feet btoc (elevation 361.8 feet), which corresponds to a 27.4-foot water column within the well.

2.1.14 Well CUF-210

Well CUF-210 was installed as a downgradient monitoring well in the alluvial sands and gravels for the Dry Ash Stack. The near-surface conditions at CUF-210 consist of a thin mantle of topsoil underlain by red-brown fat clay, moist, and medium stiff to stiff with chert fragments to 15.0 feet bgs (elevation 379.5 feet). Underlying the fat clay, a brown and gray, moist, medium stiff to stiff, silt with chert fragments was present to a depth of 35.0 feet bgs (elevation 359.5 feet). Below this depth, less gravel was present in the silt and the color changed to a brown to light brown and extended to 46.5 feet bgs (elevation 348.0 feet). Underlying the silt, red-brown, moist, medium stiff to stiff, lean clay with chert gravel was present to a depth of 61.0 feet bgs (elevation 333.5 feet). The lean clay transitioned into silty sand to silt, brown and gray in color, wet, and loose/soft, which extended to the bottom of the borehole at 72.0 feet bgs (elevation 322.5 feet).

At the completion of drilling, the screened interval was positioned near the bottom of the borehole between the depths of 59.8 and 64.8 feet bgs (elevations 334.7 and 329.7 feet) within the silty sand strata. The bottom of well was set at 65.3 feet bgs (elevation 329.2 feet). A subsequent measurement within the well casing on September 8, 2016 revealed the water surface to be 27.7 feet btoc (elevation 370.5 feet), which corresponds to a 41.3-foot water column within the well.

2.1.15 Well CUF-211

Well CUF-211 was installed as a downgradient monitoring well in the alluvial sand and gravel deposits downgradient for the Dry Ash Stack. The near-surface conditions at CUF-211 consist of 12.5 feet of gravelly fat clay fill material underlain by lean clay with gravel. These soils are both described as red-brown in color, moist, and soft to stiff. Gravelly silt was encountered below the lean clay (elevation 377.0 feet) and is described as light brown, moist to wet, and medium stiff to soft. The silt material varied from light brown to gray in color with depth and extended to 60.5 feet bgs (elevation 334.5 feet). Underlying the silt, sandy gravel described as gray to light brown, wet and loose was present and extended to the bottom of the borehole at 71.5 feet bgs (elevation 323.5 feet).

At the completion of drilling, groundwater was measured at 37.2 feet bgs (elevation 357.8 feet). The screened interval was positioned between the depths of 53.9 and 64.1 feet bgs (elevations 341.1 and 330.9 feet) with the bottom of well at 64.8 feet bgs (elevation 330.2 feet). A subsequent measurement within the well casing on September 8, 2016 revealed the water surface to be 39.7 feet btoc (elevation 359.1 feet), which corresponds to a 28.9-foot water column within the well.

2.1.16 Well CUF-212

Well CUF-212 was installed as a downgradient monitoring well in the alluvial sand and gravel deposits for the Gypsum Storage Area. The near-surface conditions at CUF-212 consist of lean clay, red-brown and brown, moist and soft to medium stiff with chert gravel. At 10.0 feet bgs (elevation 385.0 feet), silt described as gray and brown, moist, soft to medium stiff was encountered. A 2.5-foot layer of dark gray sand with gravel, wet and loose was encountered at 18.5 feet bgs (elevation 376.5 feet). Silt continued to a depth of 58.0 feet bgs (elevation 337.0 feet) and transitioned into brown sandy gravel, wet and loose to medium dense to the bottom of the borehole at 70.0 feet bgs (elevation 325.0 feet).

Groundwater, or possibly a perched water zone, was first noted at 18.5 feet bgs (elevation 376.5 feet) during drilling at the top of a sand layer and measured at 40.1 feet bgs (elevation 354.9 feet) after completion of drilling. The bottom of the well was positioned near the bottom of the borehole at 69.5 feet bgs (elevation 325.5 feet). The top of the screened interval is 58.9 feet bgs (elevation 336.1 feet). A subsequent measurement within the well casing on September 8, 2016 revealed the water surface to be 43.2 feet btoc (elevation 355.5 feet), which corresponds to a 30.0-foot water column within the well.

2.1.17 Well CUF-213

Well CUF-213 was installed as a downgradient well within the alluvial sand and gravel deposits for the Gypsum Storage Area. The near-surface conditions at CUF-213 consist of 7.5 feet of lean clay with chert fragments described as red-brown in color, moist and soft to medium stiff. The lean clay was underlain by silt described as dark brown and gray to dark gray and black, moist to wet, soft to medium stiff, with varying amounts of chert and limestone gravel. Within the predominant silt horizon, lean clay partings at 20.0 to 21.0 feet bgs and 35.0 to 36.0 feet bgs (elevations 375.3 to 374.3 feet and 360.3 to 359.3 feet) were encountered. In addition, a dark gray and black silty sand parting was encountered between 25.0 and 30.0 feet bgs (elevations 370.3 and 365.3 feet). Silt extended to auger refusal and the bottom of the hole at 45.9 feet bgs (elevation 349.4 feet).

Groundwater was encountered at 21.0 feet bgs (elevation 374.3 feet) during drilling immediately below the lean clay parting. At the completion of drilling, groundwater was measured at 21.2 feet bgs (elevation 374.1 feet). A five-foot screen was positioned at a depth of 41.9 feet bgs (elevation 353.4 feet) and the top of the screened interval at 36.2 feet bgs (elevation 359.1 feet). A subsequent measurement within the well casing on September 8, 2016 revealed the water surface to be 20.9 feet btoc (elevation 378.2 feet), which corresponds to a 24.8-foot water column within the well.

2.1.18 Boring CUF-214

At the request of AECOM, boring CUF-214 was advanced adjacent to CUF-213 to establish a bedrock well. However, sufficient groundwater for monitoring purposes was not encountered after advancing 32.0 feet into dolomite bedrock. The borehole was subsequently backfilled from the bottom up with high solids (30%) bentonite grout after consultation with AECOM (see RFI 609389-011 in Appendix L). The location and boring log for CUF-214 is provided in Appendix C.

2.2 WELL DEVELOPMENT

Each new and existing well remaining in-service was developed by a combination of bailing, surging, and pumping. First, a bailer was lowered and raised within the screened intervals to create a slight surging action to dislodge particles within the wells and sand filter packs. A baseline reading of turbidity, pH, temperature, and specific conductance was then measured using Oakton® turbidity and PCSTestr 35 water testing meters. If the well contained heavy sediment, further bailing was performed before continuation of development with surge blocks and submersible pumps. A surge block was used within the screened interval to move water and particles through the screen and sand filter packs. This process was repeated several times to decrease the groundwater turbidity within the wells. Lastly, the submersible pump was employed to further develop the wells until negligible turbidity was achieved. Target turbidity values of five (5) and fifty (50) Nephelometric turbidity units (NTUs) were utilized for monitoring and observation wells, respectively. In cases where the final turbidity values were notably greater from the target values, an RFI was submitted to AECOM.

Recharge within the wells ranged from relatively slow (over a weekend) to rapid (less than an hour), and development typically continued over multiple days. A summary of well development is presented in Table 3. The field data sheets are included in Appendix D.

Table 3. Summary of Well Development

Well ID	Turbidity		Specific Conductance		pH		Temperature	
	Initial (NTU)	Final (NTU)	Initial (µS/cm)	Final (µS/cm)	Initial	Final	Initial (°F)	Final (°F)
93-1	597	5.0	2800	1798	7.25	6.40	68.4	70.4
93-2R	238	14.9	3800	3800	6.63	6.14	68.4	66.6
93-3	91.8	4.6	1292	1217	6.97	7.23	68.3	65.6
93-4	176	25.5	3380	2230	6.33	6.41	68.7	78.3
96-9*	>1000	52.3	1977	2260	6.37	6.26	71.9	73.3
B-103*	177	28.6	2280	1600	6.65	7.20	64.9	66.0
B-103*	177	28.6	2280	1600	6.65	7.20	64.9	66.0
B-106*	Well Not Found – Presumed Closed by Others							
CUF-101*	794	38.6	374	296	8.27	8.39	82.9	78.2
CUF-102*	Well was Dry (June, 2016) – No Development							
CUF-120*	249	23.4	323	316	8.51	8.54	71.2	71.6
CUF-201	15.41	4.7	323	195	7.92	7.24	69.7	64.5
CUF-202	887	14.1	378	360	7.65	7.98	67.1	61.3
CUF-204	266	11.8	606	472	7.76	7.23	66.3	70.5
CUF-205	>1000	3.9	473	601	7.91	7.12	63.6	70.1
CUF-206	>1000	18.8	1697	3090	7.28	6.98	64.9	66.5
CUF-207	963	4.7	2870	3080	6.99	7.08	65.7	63.9
CUF-208	683	11.7	2750	2550	6.99	6.60	66.2	66.8
CUF-209	259	3.6	2470	1810	7.23	7.61	68.7	68.2
CUF-210	962	29.3	2970	536	8.41	7.84	65.9	78.8
CUF-211	574	108	854	1425	7.03	6.90	71.2	69.3
CUF-212	181	3.8	3140	3300	7.46	7.20	67.2	68.5
CUF-213	69.4	3.0	3230	3270	9.93	9.94	70.3	70.3

* Observation well for water level measurements (target turbidity of 50 NTUs).
NTU – Nephelometric Turbidity Unit.
µS/cm – microSiemens per centimeter.
°F – degree Fahrenheit.

The target turbidity values were not reached for several wells during development activities presumably due to the fines content (clays and silts) of the soils within the screened intervals and the slow recovery (yield) of the well. Stantec submitted RFI 609389-012 to change the target turbidity for observation wells to 50 NTUs while maintain the target of 5 NTUs for compliance (monitoring) wells. Subsequent RFI 609389-014 recommended an increased target turbidity of 20 NTUs for monitoring wells and noted that the final turbidity in wells 93-4 and CUF-210 would likely be greater based on water parameter measurements during development. It's noted that development was terminated for CUF-211 after multiple days without significant improvement in turbidity. The RFIs related to well development are included at the end of this report in Appendix L.

2.3 WELLHEAD INSTALLATIONS

Each new well was completed with wellheads in accordance with the TVA-provided drawings presented in Appendix E. Each wellhead consists of a pre-cast concrete surface pad that measures four-foot square by twelve-inch thick and constructed with 3,000 pounds per square inch (psi) concrete and steel reinforcement (#5 rebar). Additionally, four-inch diameter steel bollards were installed and embedded approximately three feet deep near each corner of the pad. An eight-inch diameter opening is provided through the center of the pad to allow it to be lowered over the well casing during installation. The wellheads were fabricated by TVA in Muscle Shoals, Alabama.

Prior to placing into position, the pad footprint was excavated approximately six inches bgs (or to a level bearing surface) and a flowable cement mud mat was placed in the excavation. Once a pad was placed the annular space between the well casing and pad opening was backfilled with granular bentonite to prevent surface water infiltration. Each wellhead installation was completed with an above-grade, eight-inch square steel locking protective cover anchored to the pad. The protective cover extends approximately four-feet above the pad and the annular space between the well casing and cover was filled with pea gravel to about six-inches below the top of well casing.

2.4 FIELD SURVEY

Stantec completed a field survey of all wells remaining in service based on AECOM's Groundwater Optimization for CUF (May 2, 2016). The surveys were provided on August 30, 2016 and November 18, 2016. Wells open to unobscured satellite signals were surveyed utilizing a Trimble R6-4 GPS unit with R6 Glonass receiver. When trees or other objects obscured the wells temporary control coordinates were established in the open then a Trimble S5 Robotics total station was utilized to determine conventional locations of the wells. Survey data in the field was collected in North American Datum (NAD) 83 and North Geodetic Vertical Datum (NGVD) 88. The Corpscon6 program was then used to convert to NAD27 and NGVD29 data. See Appendix F for the field survey results.

2.5 DOWNHOLE WELL VIDEO LOGGING

Stantec was tasked with video logging the inside of the CCR and State of Tennessee compliance wells at CUF. The purpose of this logging is to evaluate the structural integrity of the wells and to confirm the following in each well:

- Screened interval
- Total depth
- Depth to water
- Inside and outside diameter of the wells
- Pump batch numbers
- Cell service signal strength

The downhole video logs were made at CUF between October and November, 2016 utilizing a Well-Vu DVCC15 model downhole camera. At the time of the video logging, a crack in the screen casing was observed in well CUF-206 starting at 92.4 feet btoc and continuing across and down for approximately ¾ of the circumference of the screen casing to 92.6 feet btoc. However, the crack is not detrimental to the screen integrity as no sand filter pack material was entering through the crack and no deformation was observed in the four-inch diameter PVC screen. No obstructions or damage were seen in any of the other wells. The well video logs are provided in Appendix G.

2.6 UPDATED WELL CONSTRUCTION DETAILS

Based on the field surveys and video logging, Stantec has updated the existing well construction diagrams provided by TVA. The revisions have been noted on the construction diagrams (see Appendix B) to include, in part, location and elevation data for screen intervals and well depths. A summary of the updated well construction data is provided in Table 4.

Table 4. Summary of Updated Well Construction Details

Well ID	TN State Plane Northing (ft NAD27)	TN State Plane Easting (ft NAD27)	Latitude NAD83 (DMS)	Longitude NAD83 (DMS)	Top of Casing Elevation (ft NAVD29)	Screen Interval[1]		Bottom of Well[1]	
						Depth (ft btoc)	Elevation (ft NAVD29)	Depth (ft btoc)	Elevation (ft NAVD29)
93-1	730,034.86	1,509,989.90	N36°23'10.14"	W87°39'52.95"	397.17	52.3 - 62.3	344.9 – 334.9	62.3	334.9
93-2R	728,859.59	1,510,842.10	N36°22'58.67"	W87°39'42.29"	397.88	62.3 - 72.0	335.6 – 325.9	71.8	325.1
93-3	728,035.37	1,513,325.36	N36°22'50.93"	W87°39'11.76"	397.50	45.0 - 55.0	352.5 – 342.5	55.1	342.4
93-4	732,258.75	1,511,362.72	N36°23'32.36"	W87°39'36.63"	397.34	27.2 - 36.6	370.1 – 360.7	36.6	360.7
96-9	731,388.41	1,515,397.29	N36°23'24.43"	W87°38'47.11"	392.59	16.1 - 30.9	376.5 – 361.7	31.4	361.2
B-103	732,854.52	1,509,708.25	N36°23'37.97"	W87°39'56.98"	395.97	74.0 – 84.0	322.0 – 312.0	85.7	310.3
B-110	727,929.15	1,513,716.59	N36°22'49.95"	W87°39'06.95"	398.27	48.3 – 52.5	350.0 – 345.8	52.5	345.8
CUF-101	731,687.01	1,513,777.18	N36°23'27.11"	W87°39'06.98"	385.68	2.0 - 17.2	383.7 – 368.5	17.7	368.0
CUF-102	730,912.45	1,513,919.62	N36°23'19.48"	W87°39'05.08"	402.93	3.8 - 13.8	399.2 – 389.1	14.5	388.4

NAD83 – North American Datum of 1983.
D M S – Degrees, Minutes, Seconds.
ft NGVD29 – feet National Geodetic Vertical Datum of 1929
ft btoc – feet below top of casing.
Survey data collected by Stantec on January 24, 2017.
[1] Screen interval and bottom of well measured by Stantec during video logging (October and November, 2016) except B-103 and B-110 with screen intervals estimated based on TVA-provided construction diagrams and Stantec measurements of well depths on July 22, 2016.

3.0 ANALYTICAL TESTING

3.1 SAMPLE SELECTION PROCEDURES

With the occurrence of new upgradient/background well installations, representative samples of the subsurface materials within the screen intervals were collected from background (upgradient) wells CUF-201 and CUF-202. These samples were containerized in pint-size glass jars with Teflon® seal lids, placed in a cooler on ice, and shipped to ESC Lab Sciences (Mount Juliet, Tennessee) for analytical testing including metals, general chemistry, and radiochemical analyses.

3.2 SAMPLE SELECTION

3.2.1 Well CUF-201

One representative composite of SPT soil samples collected between 15.0 and 24.0 feet bgs (elevations 381.7 and 372.7 feet) was subjected to analytical testing. The composite sample (CUF-201: 15.0 – 24.0 feet bgs) is visually described as silt, gray and brown in color, moist to wet, loose, with silty sand and chert gravel. No unnatural odors or unique features were noted in the samples.

3.2.2 Well CUF-202

Three SPT soil samples between 10.0 and 16.5 feet bgs (elevations 369.5 and 363.0 feet) collected during the drilling process for CUF-202 were composited into one representative sample for analytical testing. The composite sample (CUF-202: 11.0 – 16.0 feet bgs) is visually described as sandy silt with gravel, light brown in color, moist and stiff. No unnatural odors or unique features were noted in the samples.

3.3 ANALYTICAL RESULTS

The two composite soil samples from new wells CUF-201 and CUF-202 were tested for the presence of thirty (30) different metals and seven (7) general chemistry parameters. In addition, the composite sample from CUF-202 was subjected to radiochemical analyses. The results of the analytical testing for the selected soil samples are included in Appendix H. A summary of the test results of the soils is provided in Tables 5, 6 and 7 below.

Table 5. Summary of Analytical Testing - Metals

Parameter	Resident Soil Screening Level[1] (mg/Kg)	Industrial Soil Screening Level[1] (mg/Kg)	CUF-201 (Comp) 15 to 24 ft bgs (mg/Kg)	CUF-202 (Comp) 11 to 16 ft bgs (mg/Kg)
Aluminum	77,000	1,100,000	3320	12500
Antimony	31	470	ND	ND
Arsenic	0.68	3.0	ND	27.8
Barium	15,000	220,000	46.0	85.8
Beryllium	160	2,300	0.379	1.94
Boron	16,000	230,000	ND	NE
Cadmium	71	980	ND	0.526
Calcium	NE	NE	1030	1810
Chromium	120,000 [2]	1,800,000 [2]	10.1	14.3
Cobalt	23	350	5.38	60.6
Copper	3,100	47,000	5.70	28.2
Iron	55,000	820,000	6300	29000
Lead	400	800	11.5	13.4
Lithium	160	2,300	ND	13.4
Magnesium	NE	NE	NA	759
Manganese	1,800	26,000	117	657
Mercury	9.4	40	0.0332	0.0222
Molybdenum	390	5,800	ND	4.93
Nickel	1,500	22,000	7.41	191
Potassium	NE	NE	NA	1060
Selenium	390	5,800	ND	ND
Silver	390	5,800	ND	ND
Sodium	NE	NE	NA	ND
Strontium	47,000	700,000	4.85	35.9
Sulfur	NE	NE	ND	ND
Thallium	0.78	12	ND	ND
Tin	47,000	700,000	ND	ND
Uranium	230	3,500	ND	ND
Vanadium	390	5,800	12.7	30.1
Zinc	23,000	350,000	35.2	217

mg/kg – milligrams per kilograms = ppm (parts per million).
ft bgs – feet below ground surface.
ND – Not detected; NE – Not established; NA – Not analyzed.
[1] Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites for Resident and Industrial Soils with target hazard quotient of 1.0 (November, 2015)
[2] Preliminary Soil Remediation Goal (SRG) for total chromium has not been established. Values provided are for insoluble salts chromium (III).

Table 6. Summary of Analytical Testing – General Chemistry

Parameter	Residential Soil Screening Level[1] (mg/Kg)	Industrial Soil Screening Level[1] (mg/Kg)	CUF-201 (Comp) 15 to 24 ft bgs (mg/Kg)	CUF-202 (Comp) 11 to 16 ft bgs (mg/Kg)
Chloride	NE	NE	91.3	ND
Fluoride	3,100	47,000	2.19	ND
Nitrate-Nitrite	NE	NE	ND	ND
Phosphorus	NE	NE	3.55	1.08
pH	NE	NE	6.47	6.99
Total Kjeldahl Nitrogen	NE	NE	302	210
Total Organic Carbon	NE	NE	8190	6230

mg/kg – milligrams per kilograms = ppm (parts per million).
ft bgs – feet below ground surface.
ND – Not detected; NE – Not established.
[1] Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites for Resident and Industrial Soils with target hazard quotient of 1.0 (November, 2015)

Table 7. Summary of Radiochemical Analyses

Parameter	Method*	Detection Limit	CUF-201 (Comp) 15 to 24 ft bgs	CUF-202 (Comp) 11 to 16 ft bgs
Radium-226 (pCi/g)	SM 7500 Ra B M	0.054	NA	2.18 ± 0.166
Radium-228 (pCi/g)	EPA 904/9320	0.585	NA	0.400 ± 0.328
Uranium, Total (mg/kg)	ASTM D 5174	5.00	ND	ND

* NELAC Certified Parameter.
ft bgs – feet below ground surface.
pCi/g – pico Curie per gram.
mg/kg – milligram/kilogram.
ND – Not detected; NA – Not analyzed.

4.0 DEDICATED SAMPLING PUMPS

New dedicated sampling pumps supplied by QED Environmental Systems, Inc. have been installed within wells designated for groundwater monitoring. The installations were performed in September, 2016. Following well development, a Stantec representative measured the well depths and static groundwater levels to determine the proper intake depths for the dedicated well sampling pumps. Based on the measured water columns and transmissivity of wells noted during development, the pump intakes were generally set approximately two feet above the well bottom.

Pump installation checklists are provided in Appendix I along with manufacturer data. Table 8 below summarizes the installed well pumps (all measurements expressed in feet unless noted).

Table 8. Well Specifications for Dedicated Pumps

Well ID	Well Casing Dia. (inch)	Top of Casing Elevation (ft NAVD29)	Bottom of Well[1]		Groundwater Level[2]		Pump Intake		Water Column Above Intake
			Depth (ft btoc)	Elev. (ft NAVD29)	Depth (ft btoc)	Elev. (ft NAVD29)	Depth (ft btoc)	Elev. (ft NAVD29)	
93-1	2	397.17	62.3	334.9	35.6	361.5	60	337.2	24.4
93-2R	2	397.88	72.8	325.1	39.3	358.6	71	326.9	31.8
93-3	2	397.50	55.1	342.4	30.0	367.5	53	344.5	23.0
93-4	2	397.34	36.6	360.7	26.1	371.3	34	363.3	7.9
CUF-201	4	400.41	28.1	372.3	12.4	388.0	26	374.4	13.6
CUF-202	4	383.28	19.9	363.4	5.8	377.5	18	365.3	12.2
CUF-204	4	439.66	48.8	390.8	31.0	408.7	47	392.7	16.1
CUF-205	4	384.51	27.5	357.0	18.0	366.5	25	359.5	7.0
CUF-206	4	398.67	93.6	305.1	33.4	365.2	92	306.7	58.6
CUF-207	4	398.19	85.7	312.5	32.0	366.2	84	314.2	52.0
CUF-208	4	398.38	58.6	339.8	36.1	362.3	57	341.4	20.9
CUF-209	4	398.23	63.8	334.4	35.2	363.1	62	336.2	26.9
CUF-210	4	398.20	69.0	329.2	26.9	371.3	67	331.2	40.1
CUF-211	4	398.76	68.6	330.2	37.4	361.4	67	331.8	29.6
CUF-212	4	398.71	73.2	325.5	40.3	358.4	71	327.7	30.7
CUF-213	4	399.05	45.7	353.4	21.2	377.8	44	355.1	22.8

ft NAVD29 – feet North American Vertical Datum 1929
ft btoc – feet below top of casing.
Survey data collected by Stantec on November 18, 2016.
[1] Bottom of well depths measured by Stantec during video logging (October and November, 2016).
[2] Groundwater levels recorded by Stantec on July 22, 2016.

5.0 MONITORING WELL CLOSURE

5.1 CLOSURE PROCEDURE

A total of fifteen (15) existing wells were recommended for closure in AECOM's Groundwater Optimization for CUF (May 2, 2016). The closures followed the procedures outlined in the Stantec document titled Technical Specifications for Monitoring Well Decommissioning, Standard Procedure SCSI-TI-MW-02 (July 29, 2015).

TVA and Stantec personnel completed a checklist prior to closure activities to verify the well to be closed. Stantec provided a two-man crew and drill rig along with sonic drilling subcontractor to perform the well closure activities. A Stantec project engineer documented the closure activities and coordinated on-site activities with COF personnel. A Tennessee-licensed driller (#949) supervised the closure work.

Truck- and track-mounted drill units were used to access the wells. The drill rig and down-hole equipment were decontaminated prior to mobilization, upon arrival to the site, and at the completion of closure activities. High pressure potable water was utilized during decontamination activities.

The closure of each monitoring well generally followed the steps listed below:

- Confirm the well to be closed through available documentation and obtain confirmation from TVA personnel.
- Photograph and document the existing well condition at the surface.
- Record the static water level and depth of the well.
- Lower drill rods inside the well casing and knock-off the bottom well plug followed by tremmie-backfill from bottom up with high-solids (30%) bentonite grout.
- Remove the surface features (protective cover, concrete pad, bollards) using the drill rig winch.
- Attempt to pull the well casing using the drill rig winch.
- Depending upon location, either leave the well in place or over-drill to a depth of five feet below the well. Remove the upper five feet of the casing of wells left in place, if possible. Remove the casing (use drill rig winch, if necessary) and surrounding fill when over-drilled.

- Tremmie-backfill the resultant borehole with high-solids bentonite (30% solids) grout to the ground surface.

- The removed well casing and surface features will be transported to a designated location on-site for subsequent disposal by others. Drill cuttings will be spread-out and leveled at the drill location and the site reclaimed with grass seed and straw.

5.2 CLOSURE RESULTS

TVA and Stantec personnel located and closed ten (10) of the fifteen (15) existing wells planned for closure: 10-1, 10-2, 93-2, 96-6, 96-8, A-2, A-3, A-3 Offset, Unknown 1, and Unknown 2. Four (4) wells (B-111 through B115) could not be located and one well (96-7) was found to be previously closed by others. In addition, well B-106 that was included in AECOM's Groundwater Optimization for CUF to be retained as an observation well could not be located by TVA and Stantec personnel. It is presumed that this well was previously closed by others, and is included in this section for documentation purposes. A site plan, closure checklists, and abandonment forms are included in Appendix J. Pre-and post-closure photographs of the closed wells are presented in Appendix K. A summary of the well closures performed in June, 2016 is presented in Table 9.

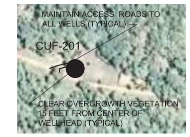
Table 9. Summary of Closed Wells

Well ID	TN State Plane Northing (ft NAD27)[1]	TN State Plane Easting (ft NAD27)[1]	Measured Depth of Well (ft btoc)	Measured Depth to Water (ft btoc)	Casing Diam. (inch)	Closure Method
10-1	733,964.17	1,510,857.48	47.0	18.0	2	Over-drilled with sonic full depth; extracted most of well casing and grouted
10-2	733,314.35	1,511,682.69	34.0	18.3	2	Over-drilled with sonic full depth; extracted most of well casing and grouted
93-2	728,878.79	1,510,835.68	45.3	11.4	2	Over-drilled full depth; extracted 12.4' bgs of casing and grouted
96-6	728,384.44	1,514,485.41	25.7	3.1	2	Well located off TVA property; backfilled with bentonite pellets; extracted casing 3' bgs and removed wellhead
96-7	731,602.79	1,512,058.75	Previously Closed By Others			
96-8	732,119.74	1,516,057.34	36.9	8.3	2	Over-drilled full depth; extracted 31.5' bgs of well casing and 15.9' bgs of overburden casing; grouted
A-2	728,746.39	1,510,853.35	54.0	28.1	4	Well inaccessible with rig; tremmie-backfilled casing and removed casing 39" bgs
A-3	728,764.24	1,510,884.74	43.2	9.0	2	Over-drilled full depth; extracted all well casing and grouted
A-3 Offset	728,610.11	1,510,905.65	28.2	9.4	2	Over-drilled full depth; extracted all well casing riser and portion of screen; grouted
B-106*	730,384.17	1,513,540.26	Unknown; Well Could Not Be Located			
B-112	730,213.26	1,512,266.89	Unknown; Well Could Not Be Located			
B-113	730,401.21	1,511,902.36	Unknown; Well Could Not Be Located			
B-114	729,321.95	1,510,823.51	Unknown; Well Could Not Be Located			
B-115	730,406.31	1,511,811.58	Unknown; Well Could Not Be Located			
Unknown 1	728,466.06	1,510,999.53	40.9	16.4	2	Well inaccessible with rig; tremmie-backfilled casing and removed casing 10' bgs
Unknown 2	728,433.46	1,510,977.12	53.2	26.4	4	Over-drilled full depth; extracted all 4" PVC riser and 20' of PVC screen; grouted

* B-106 was recommended to be retained as observation well by AECOM. However, this well could not be located by TVA and Stantec and is included as a closed well for documentation purposes.
[1] State plane coordinates taken from AECOM's Groundwater Optimization for CUF.
ft NAV27 – feet North American Datum of 1927.
ft btoc – feet below top of casing.
bgs – below ground surface.

Stantec submitted RFIs 609389-013 and 609389-016 for wells A-2 and Unknown 1, respectively, for the in-place closures. These RFIs are included in Appendix L.

APPENDIX A
GROUNDWATER MONITORING NETWORK



WELLHEAD MAINTANCE

NOTES:

1. THE AERIAL MAPPING PROVIDED BY USDA NAIP IS BASED ON HORIZONTAL DATUM NAD27 USING STATE PLANE TENNESSEE COORDINATE SYSTEM AND VERTICAL DATUM NGVD29. THE ORTHO-PHOTOGRAPHY WAS PERFORMED IN 2014.
2. ALL BOUNDARY LINES ARE APPROXIMATE WORKING BOUNDARIES, TO BE CONFIRMED BY TVA.
3. SEE SHEET 10W858-04 FOR GROUNDWATER MONITORING WELL NETWORK AND OBSERVATION WELLS COORDINATE AND ELEVATION TABLE.

LEGEND

TVA BOUNDARY LINE
GROUNDWATER MONITORING WELL
OBSERVATION MONITORING WELL

RECORD DRAWING

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
R 0	11/19/15	DRP	MSJ	JGB	BLB	SEB	MST	JCK	609389	–	–

ISSUED AS_BUILT AS PER PROJECT ID 609389

SCALE: 1"=400' EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

MONITORING WELL NETWORK
AND OBSERVATION WELLS
LOCATION PLAN

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D.R. PLEIMAN	M.S. JENNINGS	J.G. BANTON	B.L. BRYANT	S.E. BENNET	M.S. TURNBOW	J.C. KAMMEYER

Stantec
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Lexington, Kentucky 40513
www.stantec.com

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2013 | DATE 02/10/17 | 46 | C | 10W858–03 | R 0

PLOT FACTOR:400
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY: | REV NO.

46 C 10W858–03

GROUNDWATER MONITORING WELL NETWORK AND OBSERVATION WELLS								
WELL ID	NORTHING (FEET)	EASTING (FEET)	LATITUDE (D–M–S)	LONGITUDE (D–M–S)	TOP OF STEEL COVER	TOP OF RISER CASING	TOP OF CONCRETE PAD	GROUND SURFACE
93–1	730034.86	1509989.90	N36°23'10.14"	W87°39'52.95"	397.79	397.17	395.23	394.9
93–2R	728859.59	1510842.10	N36°22'58.67"	W87°39'42.29"	398.21	397.88	395.36	395.3
93–3	728035.37	1513325.36	N36°22'50.93"	W87°39'11.76"	398.20	397.50	395.64	395.2
93–4	732258.75	1511362.72	N36°23'32.36"	W87°39'36.63"	397.52	397.34	394.60	394.6
96–9	731388.41	1515397.29	N36°23'24.43"	W87°38'47.11"	392.86	392.59	392.86	392.7
B–103	732854.52	1509708.25	N36°23'37.97"	W87°39'56.98"	396.42	395.97	394.44	394.4
B–110	727929.15	1513716.59	N36°22'49.95"	W87°39'06.95"	398.68	398.27	395.76	395.7
CUF–101	731687.01	1513777.18	N36°23'27.11"	W87°39'06.98"	386.15	385.68	386.15	385.9
CUF–102	730912.45	1513919.62	N36°23'19.48"	W87°39'05.08"	403.19	402.93	403.19	403.2
CUF–120	730384.17	1513540.26	N36°23'14.19"	W87°39'09.61"	394.27	393.19	390.26	389.4
CUF–201	730765.35	1505625.26	N36°23'16.63"	W87°40'46.48"	401.27	400.41	397.18	396.7
CUF–202	730347.74	1506636.70	N36°23'12.67"	W87°40'34.02"	384.17	383.28	380.09	379.5
CUF–204	726557.28	1506364.04	N36°22'35.15"	W87°40'36.56"	440.91	439.66	436.84	435.9
CUF–205	733581.23	1511258.33	N36°23'45.42"	W87°39'38.18"	385.46	384.51	381.36	308.8
CUF–206	733499.10	1510518.16	N36°23'44.48"	W87°39'47.21"	399.68	398.67	395.57	394.9
CUF–207	733146.70	1510018.97	N36°23'40.91"	W87°39'53.24"	399.03	398.19	394.94	394.4
CUF–208	732242.48	1509462.75	N36°23'31.88"	W87°39'59.86"	399.48	398.38	395.38	394.6
CUF–209	731074.78	1509317.09	N36°23'20.31"	W87°40'01.40"	399.19	398.23	395.11	394.5
CUF–210	730478.75	1509519.11	N36°23'14.45"	W87°39'58.80"	399.23	398.20	395.12	394.5
CUF–211	729830.15	1510203.78	N36°23'08.15"	W87°39'50.30"	399.77	398.76	395.72	395.0
CUF–212	728016.94	1511935.77	N36°22'50.52"	W87°39'28.74"	399.61	398.71	395.58	395.0
CUF–213	727951.80	1513737.18	N36°22'50.17"	W87°39'06.70"	400.09	399.05	396.04	395.3

NOTE:

1. ALL WELLS WERE SURVEYED BY STANTEC ON AUGUST 30, 2016 AND NOVEMBER 18, 2016. STATE PLANE COORDINATES ARE NAD27 (TENNESSEE) AND VERTICAL DATUM NGVD29. GEODETIC COORDINATES SHOWN ARE NAD83.

RECORD DRAWING

R 0 02/06/17 DRP MSJ JGB BLB SEB MST JCK 609389
ISSUED AS-BUILT AS PER PROJECT ID 609389

SCALE: AS SHOWN EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

MONITORING WELL NETWORK
AND OBSERVATION WELLS
COORDINATE AND ELEVATION TABLE

DESIGNED BY: D.R. PLEIMAN | DRAWN BY: M.S. JENNINGS | CHECKED BY: J.G. BANTON | SUPERVISED BY: B.L. BRYANT | REVIEWED BY: S.E. BENNET | APPROVED BY: M.S. TURNBOW | ISSUED BY: J.C. KAMMEYER

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CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2013 | DATE 02/10/17 | 46 | C | 10W858–04 | R 0

PLOT FACTOR:400
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY: | REV NO.

46 C 10W858–04

APPENDIX B
WELL CONSTRUCTION DIAGRAMS

MONITORING WELL INSTALLATION RECORD

Project Cumberland Fossil Plant

Well Number 93-1

Installation Date 2/19/93

~~Plant~~ Coordinates ~~East~~ WEST 87° 39' 52.95"

North 36° 23' 10.14"

Ground Surface Elevation ~~120.44 m~~ 394.9'

Top Of Inner Casing ~~121.16 m~~ 397.17'

Backfill Material Bentonite and Grout

Slot Size ~~Open Borehole/0.025 cm~~ 0.010"

Screen Material Schedule 40 PVC

Riser Diameter ~~10.2 cm~~ 4" Outer/ ~~5.08 cm~~ 2" Inner

Drilling Technique In Soil Auger

Drilling Technique in Rock HQ

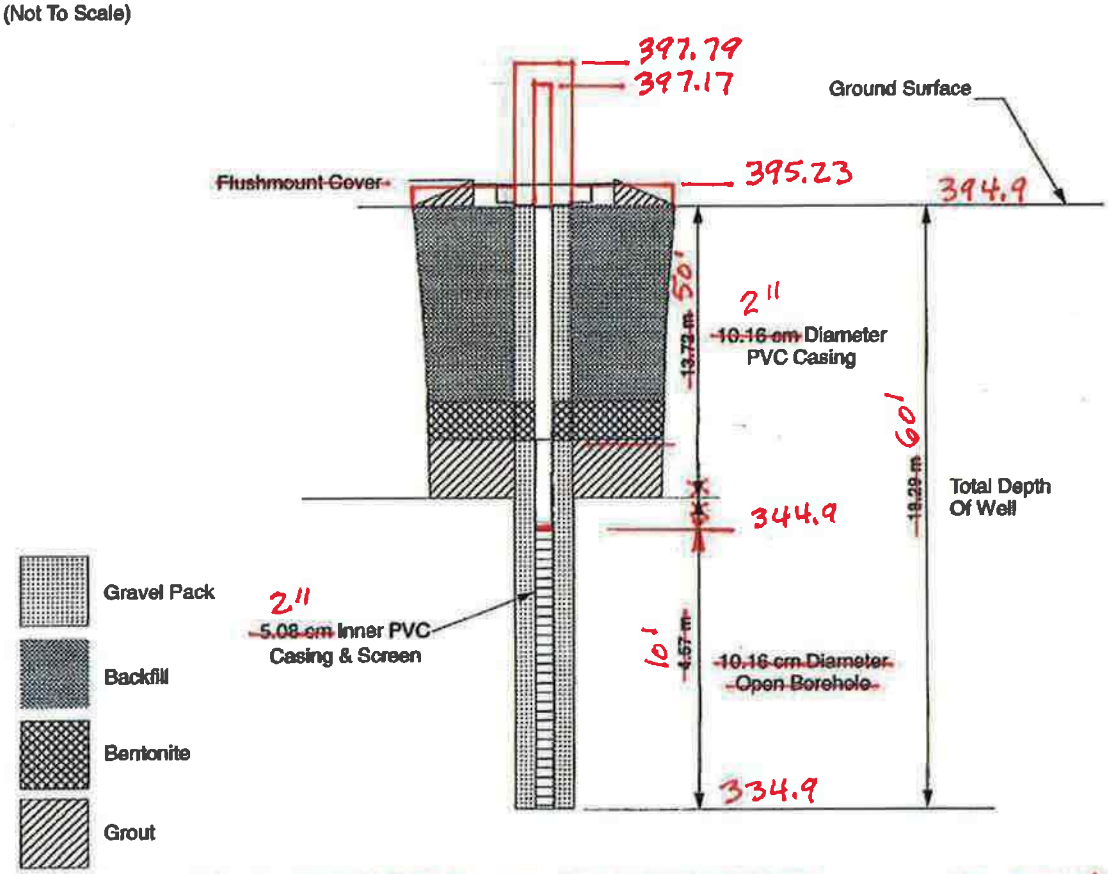
Outer Borehole Diameter ~~26.98 cm~~ 10 5/8"

Drilling Contractor Law Engineering

Logger/Engineer Scott McGilvray

Remarks SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 11/9/16)

(Not To Scale)



ENG LAB 7/13/98 WEL96-5.PRE REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

Boring Log

Project:	TVA's Cumberland Fossil Plant Cumberland City, Tennessee	BORING	83-2R 93-2R
Project No.:	1432-05-673	Elevation:	Unknown
Logged by:	R.L. Russell, R.G. (TN Reg. Geo. Lic. #4979)	Depth:	70'
Drillers:	S&ME, Inc. (Tim Hall - TN Driller #813)	Start:	September 26, 2005
Equipment:	CME 55 with 4 1/4" and 6 5/8" augers	Complete:	September 29, 2005

Notes: Descriptions based on visual observation of obtained samples.

Depth (ft)	Elevation (ft)	Lithology	Boring	Run Length	Recovered	% Recovered	RQD	Lithologic Description
1								Top of 8" vertical wall box - ~~3~~ 2.9 feet above ground surface 398.21
								Top of 2" dia. PVC casing - ~~2.5~~ 2.6 feet above ground surface 397.88
0	Unknown							395.36 Ground Surface 395.3
1								TOP CONC Clay - Fill material (0.0' - 38.0')
2								Saturated Conditions at 2'
3								LOCATION: N36° 22' 58.67" W87° 39' 42.29" (NAD 83)
4								
5								
6								
7								
8								
9								2" dia. PVC casing
10								Grout
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/7/16)
26								
27								
28								
29								
30								

REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

S&ME

Boring Log

Project:	TVA's Cumberland Fossil Plant Cumberland City, Tennessee			BORING	93-2R
Project No.:	1432-05-673	Elevation:	Unknown	Notes:	
...ged by:	R.L. Russell, R.G. (TN Reg. Geo. Lic. #4979)	Depth:	70'	Descriptions based on visual	
...ws:	S&ME, Inc. (Tim Hall - TN Driller #813)	Start:	September 26, 2005	observation of obtained samples.	
Equipment:	CME 55 with 4 1/4" and 6 5/8" augers	Complete:	September 29, 2005		

Depth (ft)	Elevation (ft)	Lithology	Boring	Run Length	Recovered	% Recovered	RQD	Lithologic Description
31								Clay - Fill material (0.0' - 38.0')
32								
33								
34								
35								
36								
37								
38								Boulders and gravel - Intermixed with redsidual clay, sand and river cobbles (alluvial material) (38.0' - 41.0')
39								
40								
41								Clay - intermixed with sands and river cobbles (alluvial material) (41.0' - 73.0')
42								
43								
44								
45								
46								
47								
48			Grout					
49			2" dia. PVC casing					
50								
51								
52			Hydrated bentonite seal					
53								
54								
55								
56								
57			Sand filter					
58								
59			335.6					
60			2" dia. PVC screen with pre-pack sand filter					

S&ME

Boring Log

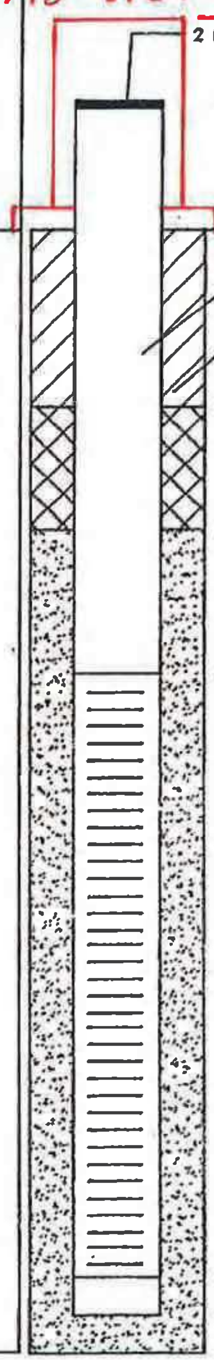
Project:	TVA's Cumberland Fossil Plant Cumberland City, Tennessee			BORING	93-2R
Project No.:	1432-05-673	Elevation:	Unknown	Notes:	
ged by:	R.L. Russell, R.G. (TN Reg. Geo. Lic. #4979)	Depth:	70'	Descriptions based on visual observation of obtained samples.	
ws:	S&ME, Inc. (Tim Hall - TN Driller #813)	Start:	September 26, 2005		
Equipment:	CME 55 with 4 1/4" and 6 5/8" augers	Complete:	September 29, 2005		

Depth (ft)	Elevation (ft)	Lithology	Boring	Run Length	Recovered	% Recovered	RQD	Lithologic Description
61								Clay - intermixed with sands and river cobbles (residual alluvial material) (41.0' - 73.0')
62								
63								2" dia. PVC screen with pre-pack sand filter
64								
65								Sand filter
66								
67								
68								
69								
70								325.9 325.1
71								Boring Terminated - bottom of boring at 70.0'
72								
73								
74								
75								
76								
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								
87								
88								
89								
90								

S&ME

MONITOR WELL INSTALLATION REPORT
LOG OF BORING AND MONITOR WELL

LOCATION: N 36°22'50.93" W 87°39'11.76" (NAD83)



DEPTH (FEET)	STRATIGRAPHIC DESCRIPTION	OVA (PPM)	TYPE II MONITOR WELL	DEPTH (FEET)	ELEV. (FEET,MSL)
			398.20 2 INCH ø WELL CAP		
		DEPTH (FEET)	TOP OF WELL	+2.30	397.50 ~~397.89~~
0.0			395.64 GROUND SURFACE	0.0	395.2 ~~395.59~~
	Ash		2 INCH ø SOLID PVC RISER		
35	Clay		CONCRETE GROUT		
			TOP OF BENTONITE SEAL	-39.0	356.59
			TOP OF SILICA SAND FILTER PACK	-41.0	354.59
			TOP OF 2 INCH ø 0.010 SLOT SCREEN	42.7 ~~-42.5~~	352.5 ~~353.09~~
			SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 11/9/16)		
			BOTTOM OF SCREEN	52.7 ~~-52.5~~	342.5 ~~343.09~~
			BOTTOM OF WELL	52.8 ~~-53.0~~	342.4 ~~342.59~~
46.6	REFUSAL ENCOUNTERED		BOTTOM OF BORING	-53.0	342.2 ~~342.59~~

MONITOR WELL NO. 93–3
START DATE: 2/18/93
COMPLETION DATE: 2/18/93
DRILLED BY: LAW NASHVILLE
DRILLING METHOD: HSA
LAW ENGINEERING PROFESSIONAL: C. K. LATHAM
NOTES: N728035.32, E1513325.09

CUMBERLAND STEAM PLANT
CUMBERLAND CITY, TENNESSEE
LAW ENGINEERING PROJECT NO. 417.93368.01

LAW ENGINEERING, INC.
NASHVILLE, TENNESSEE

REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
395.2 395.6	0.0	N 36° 22' 50.93" W 87° 39' 11.76" (NAD 83)							
395	0.1	GRAVEL							
		CLAY (CH), stiff to very stiff, reddish-brown to brown, with some chert (FILL)	1.0	8		11			SURFACE COVER: Gravel DRILLED BY: G. Powers DRILLING METHOD: HSA LOGGED BY: K. Latham N 728035.32 E 1513325.09
390			5.0	18		14			
385			10.0	12		12			
380			15.0	18		13			
375			20.0	14		15			Water level on 2/19/93 Water level at TOB
	23.0	ASH, black							
370			25.0	18		18			
365			30.0	0		1			

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	93-3
DATE DRILLED	February 18, 1993
PROJECT NUMBER	417.93368.01
PROJECT	CUMBERLAND STEAM
PAGE 1 OF 2	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
360	35.2	CLAY (CH), soft, reddish-brown (FILL)	35.0	18		6			
	39.0	CLAY (CH), firm, grey (CALLUVIUM)							
355			40.0	18		9			
350			45.0	18		9			
345			50.0	18		8			
	53.0	342.2 AUGER REFUSAL AT 53 FEET; BORING TERMINATED	53.0	0		*			* 50/0,-,-
340									
335									
330									

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

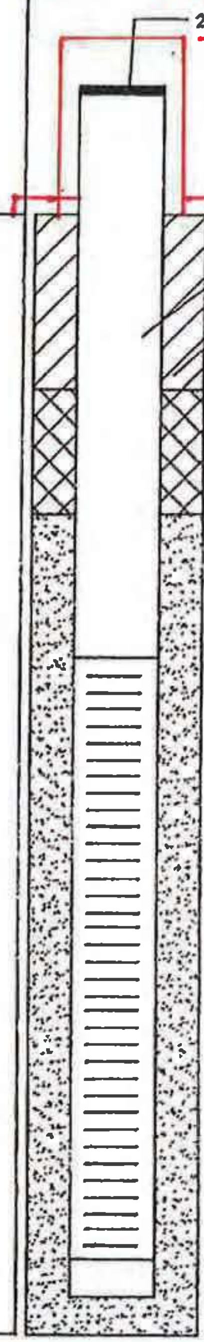
BORING NUMBER	93-3
DATE DRILLED	February 18, 1993
PROJECT NUMBER	417.93368.01
PROJECT	CUMBERLAND STEAM
PAGE 2 OF 2	

LAW ENGINEERING

MONITOR WELL INSTALLATION REPORT
LOG OF BORING AND MONITOR WELL

LOCATION: N 36° 23' 32.36" W87° 39' 36.63" (NAD83)

DEPTH (FEET)	STRATIGRAPHIC DESCRIPTION	OVA (PPM)	TYPE II MONITOR WELL	DEPTH (FEET)	ELEV. (FEET,MSL)
			2 INCH ø WELL CAP 397.52		
			TOP OF WELL	2.7 ~~+2.01~~	397.34 ~~396.64~~
0.0			394.60 GROUND SURFACE	0.0	394.6 ~~394.63~~
			2 INCH ø SOLID PVC RISER		
			CONCRETE GROUT		
			TOP OF BENTONITE SEAL	−20.0	374.63
			TOP OF SILICA SAND FILTER PACK	−22.0	372.63
23	clay / ls.				
			TOP OF 2 INCH ø 0.010 SLOT SCREEN	24.5 ~~−24.0~~	370.1 ~~370.63~~
			SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 11/9/16)		
			BOTTOM OF SCREEN	33.9 ~~−34.0~~	360.7 ~~360.63~~
			BOTTOM OF WELL	33.9 ~~−34.5~~	~~360.13~~ 360.7
	REFUSAL ENCOUNTERED		BOTTOM OF BORING	−34.5	~~360.13~~ 360.1



MONITOR WELL NO. 93−4
START DATE: 2/17/93
COMPLETION DATE: 2/17/93
DRILLED BY: LAW NASHVILLE
DRILLING METHOD: HSA
LAW ENGINEERING PROFESSIONAL: C. K. LATHAM
NOTES: N732258.78, E1511362.87

CUMBERLAND STEAM PLANT
CUMBERLAND CITY, TENNESSEE
LAW ENGINEERING PROJECT NO. 417.93368.01

LAW ENGINEERING, INC.
NASHVILLE, TENNESSEE

REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
394.6 ✓	0.0	N36° 23' 32.36" W87° 39' 36.63" (NAD83)							
	0.1	GRAVEL							
		CLAY (CH), stiff to very stiff, reddish-brown, with chert (FILL)	1.0	12		10			SURFACE COVER: Gravel DRILLED BY: G. Powers DRILLING METHOD: HSA LOGGED BY: K. Latham
390			4.5	8		5			N 732258.78 E 1511362.87
385			9.8	6		9			
380			14.5	12		24			
	17.0	AUGER REFUSAL AT 17.0 FEET; MOVE BORING 5 FEET AND AUGER TO 18.5 FEET LIMESTONE, weathered							Water level at TOB Water level on 2/19/93
375			19.5	3		*			* 50/3",-,-
	23.5	AUGER REFUSAL AT 23.3 FEET; CHANGE TO WASH DRILL	23.5	0		*			
370									* 50/0,-,-
365									
	31.0 31.4	VOID, clay filled							
360	34.5	ROLLER CONE TERMINATION; BORING TERMINATED							

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	93-4
DATE DRILLED	February 17, 1993
PROJECT NUMBER	417.93368.01
PROJECT	CUMBERLAND STEAM
PAGE 1 OF 1	

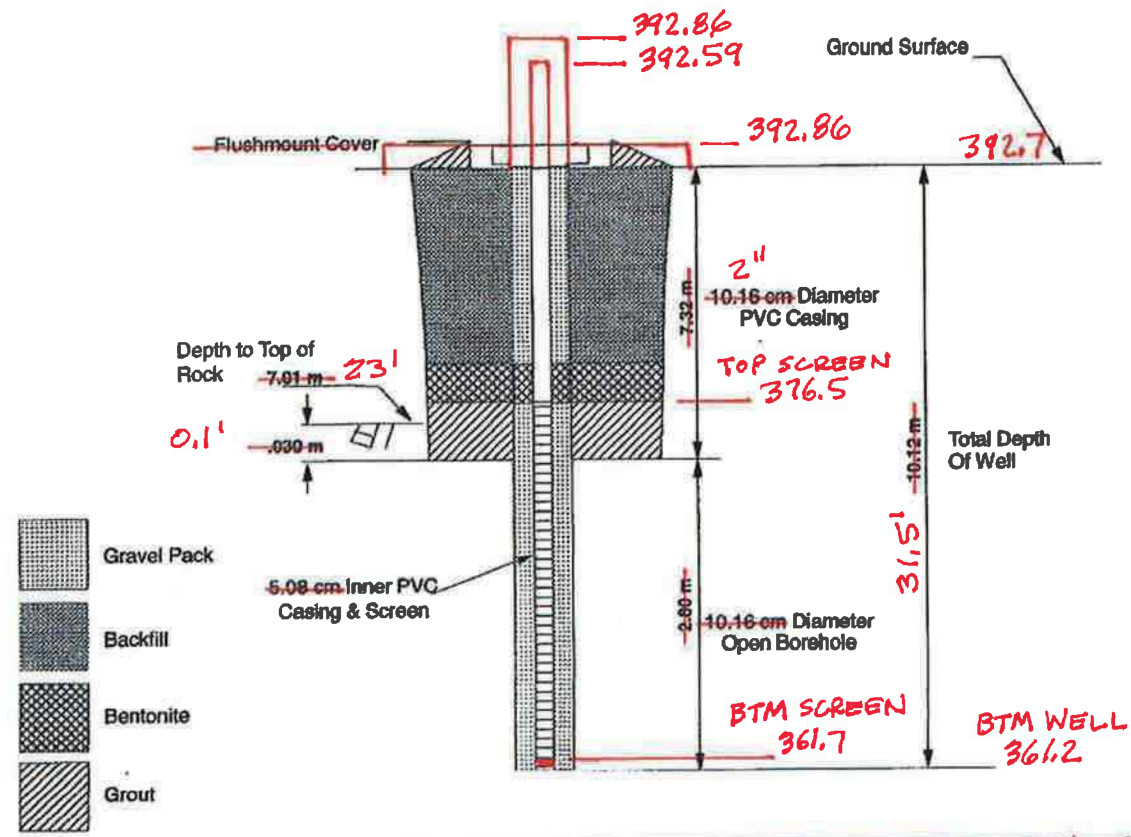
LAW ENGINEERING

MONITORING WELL INSTALLATION RECORD

Project	Cumberland Fossil Plant		
Well Number	96-9	Installation Date	May 8, 1996
NAD 83 ~~Plant~~ Coordinates	WEST ~~East~~ 87°38' 47.11"	North	36°23' 24.43"
Ground Surface Elevation	392.7 ~~119.75 m~~	Top Of Inner Casing	~~119.76 m~~
Backfill Material	Bentonite and Grout	Slot Size	Open Borehole/~~0.025 cm~~
Screen Material	Schedule 40 PVC	Riser Diameter	~~10.2 cm~~ Outer/~~5.08 cm~~ Inner
Drilling Technique In Soil	Auger	Drilling Technique in Rock	HQ
Outer Borehole Diameter	~~26.98 cm~~	Drilling Contractor	Law Engineering
Logger/Engineer	Scott McGilvray		

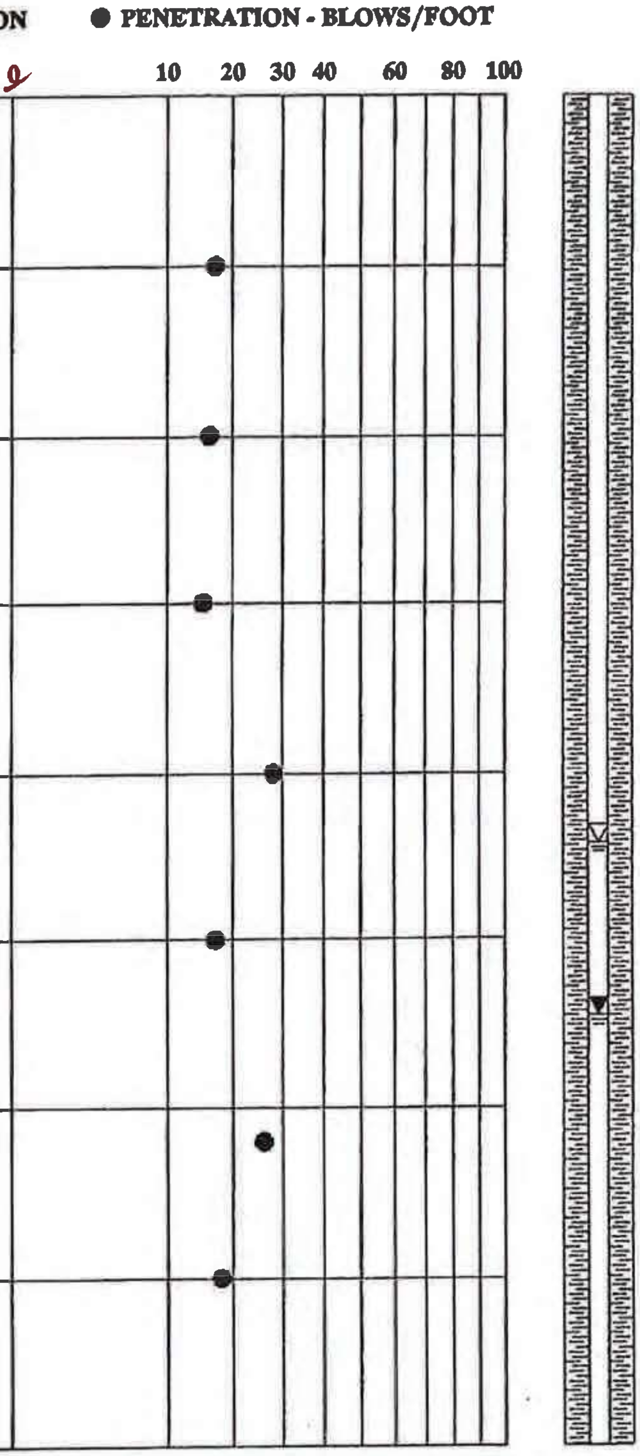
Remarks: SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/7/16)

(Not To Scale)



ENG LAB 7/13/98 WEL96-5.PRE REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	N 36°23'37.97" W87°39'56.98" (NAD83)	394.4
	STIFF TO VERY STIFF RED SANDY CLAY WITH CHERT FRAGMENTS - FILL	389.4, 384.4
14.0	STIFF BROWN SLIGHTLY SANDY CLAY WITH CHERT FRAGMENTS - FILL	379.4
19.0	FIRM GRAY AND BROWN SLIGHTLY CLAYEY SAND WITH CRUSHED STONE - FILL	374.4
24.0	VERY STIFF RED AND BROWN SLIGHTLY SANDY CLAY WITH CHERT AND LIMESTONE FRAGMENTS - FILL UNDISTURBED SAMPLE OBTAINED FROM 29.0 TO 31.0 FEET	369.4, 364.4, 359.4
37.0	AUGER REFUSAL AT 37.0 FEET ROCK TYPE - RED AND WHITE ARGILLACEOUS LIMESTONE, PROBABLE DIXON FORMATION, HIGHLY	



REMARKS:
INSTALLED TWO INCH DIAMETER PVC TYPE II PIEZOMETER, STABILIZED GROUNDWATER MEASURED AT 27.3 FEET ON MAY 1, 1992.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

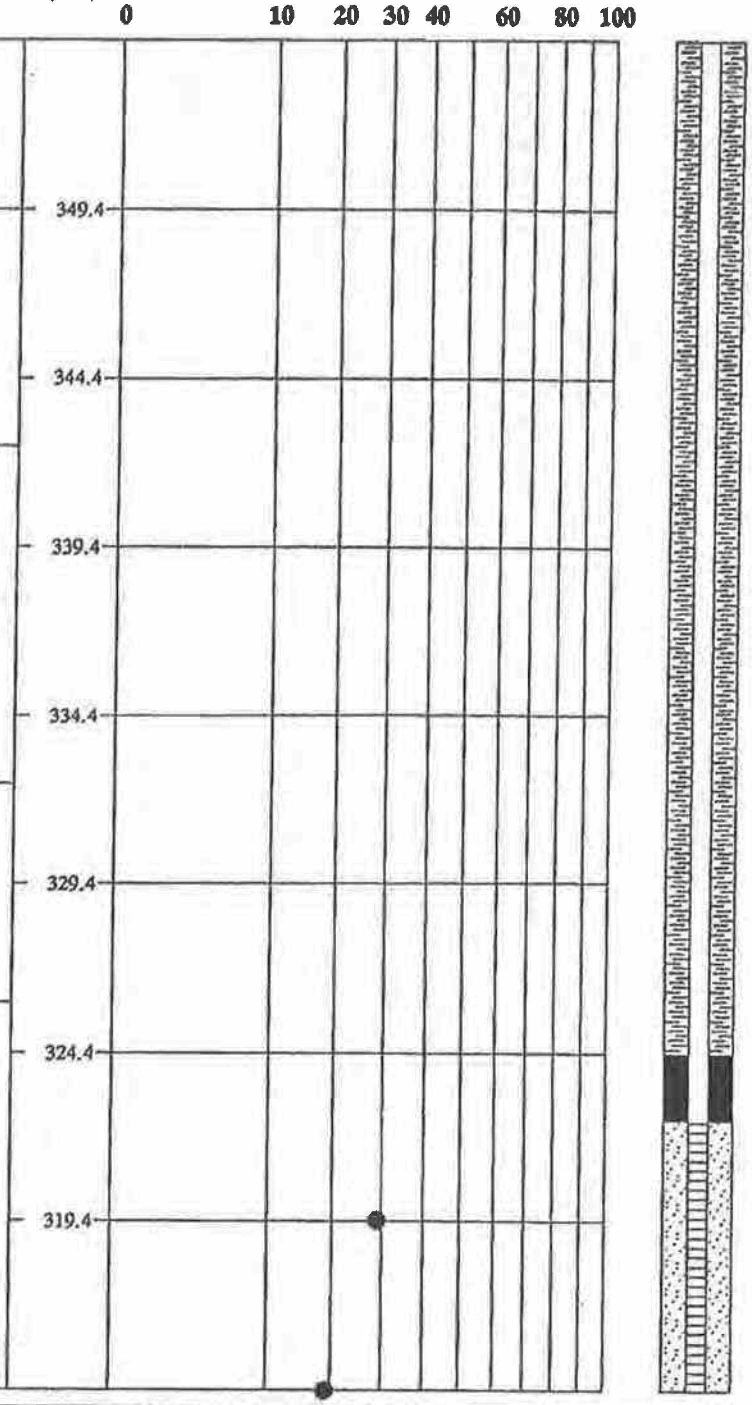
SOIL TEST BORING RECORD

BORING NUMBER	B-103
DATE DRILLED	April 7, 1992
PROJECT NUMBER	57401442.04
PROJECT	TVA - CUMBERLAND
PAGE 1 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION
	WEATHERED/SOLUTIONED CORE RUN #1 - FROM 37.0' TO 42.0' CAVITIES FROM 40.0 TO 45.5' PARTIALLY MUD FILLED REC. = 30.4% RQD. = 7.1% SET NW CASING TO 45.0 FEET
45.0	CORE RUN #2 - FROM 45.5' TO 52.5' CAVITIES FROM 55.5' TO 63.5' PARTIALLY MUD FILLED WITH SOME ORGANIC FIBERS
52.0	CORE RUN #3 - FROM 52.5' TO 62.5' CAVITIES FROM 55.5' TO 63.5' PARTIALLY MUD FILLED WITH SOME ORGANIC FIBERS REC. = 35% RQD. = 35%
62.0	CORE RUN #4 - FROM 62.5' TO 68.5' INTERMITTENT THIN ROCK LENSES AND MUD FROM 62.5' TO 68.5' REC. = 8.3% RQD. = 0%
68.5	BEGIN SOIL TEST BORING AT 68.5 FEET

ELEVATION (FT.) ● PENETRATION - BLOWS/FOOT



REMARKS:
INSTALLED TWO INCH DIAMETER PVC TYPE II PIEZOMETER, STABILIZED GROUNDWATER MEASURED AT 27.3 FEET ON MAY 1, 1992.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-103
DATE DRILLED	April 7, 1992
PROJECT NUMBER	57401442.04
PROJECT	TVA - CUMBERLAND
PAGE 2 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT
	WASH BORING - 68.5' TO 85.0' VERY STIFF TAN AND RED CLAY WITH CHERT AND LIMESTONE FRAGMENTS - RESIDUAL		
85.0	STIFF WHITE TO LIGHT GRAY CLAY - RESIDUAL	309.4	
87.0	BORING TERMINATED AT 87.0 FEET		310.3
		304.4	
	WELL DEPTH MEASURED DURING RE-DEVELOPMENT BY STANTEC (June, 2016)	299.4	
		294.4	
		289.4	
		284.4	
		279.4	

0 10 20 30 40 60 80 100

REMARKS:

INSTALLED TWO INCH DIAMETER PVC TYPE II PIEZOMETER, STABILIZED GROUNDWATER MEASURED AT 27.3 FEET ON MAY 1, 1992.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

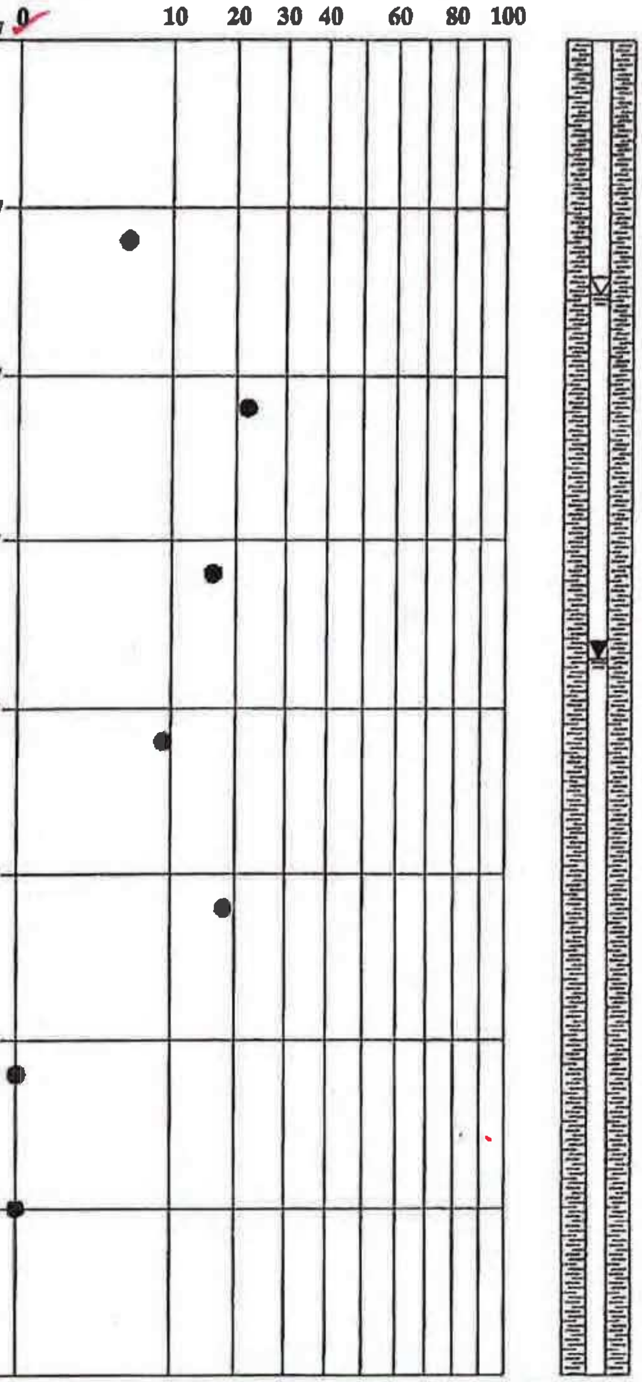
SOIL TEST BORING RECORD

BORING NUMBER	B-103
DATE DRILLED	April 7, 1992
PROJECT NUMBER	57401442.04
PROJECT	TVA - CUMBERLAND
PAGE 3 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	N36°22'49.95" W87°39'06.95" (NAD83)	395.7
0.5	GRAVEL	
	FILL - FIRM RED SLIGHTLY SANDY CLAY WITH SOME GRAVEL	390.7
10.0	FILL - STIFF TO VERY STIFF BROWN SLIGHTLY SANDY SILTY CLAY WITH SOME GRAVEL	385.7
		380.7
		375.7
25.0	FILL - FIRM GRAY SILTY SAND	370.7
26.0	FLY ASH - VERY SOFT GRAY SILT BOTTOM ASH - VERY LOOSE CINDERS AND SLAG UNDISTURBED SAMPLE ATTEMPTED FROM 32.0-34.0 FEET (NO RECOVERY)	365.7
35.5	ALLUVIAL - FIRM TO VERY STIFF BROWN AND GRAY SLIGHTLY SANDY CLAY WITH SOME PEBBLES	360.7

● PENETRATION - BLOWS/FOOT



REMARKS:

INSTALLED TWO INCH PVC DIAMETER PVC TYPE II PIEZOMETER, STABILIZED GROUNDWATER MEASURED 18.5 FEET ON MAY 1, 1992.

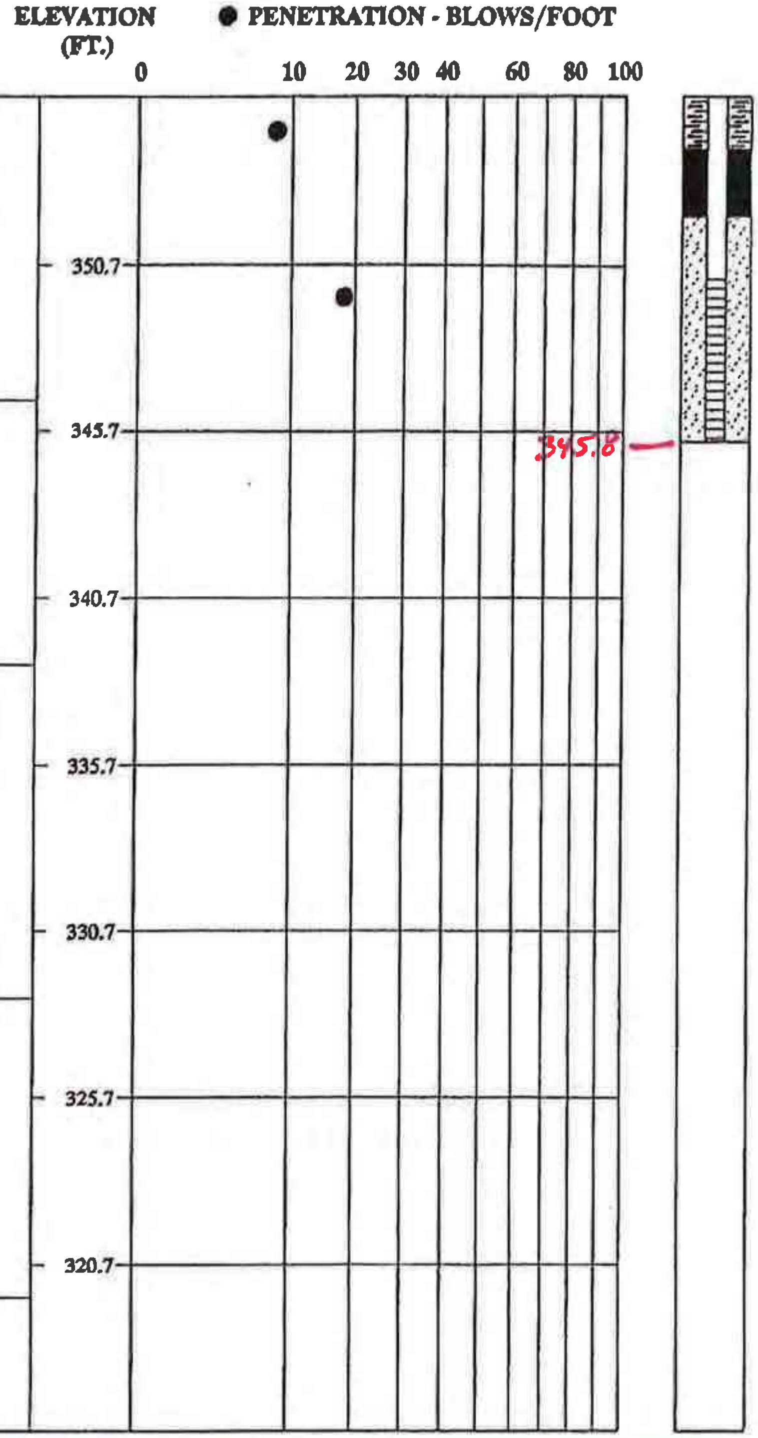
SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-110
DATE DRILLED	April 14, 1992
PROJECT NUMBER	57401442.04
PROJECT	TVA - CUMBERLAND
PAGE 1 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION
	FIRM TO VERY STIFF BROWN AND GRAY SLIGHTLY SANDY CLAY WITH SOME PEBBLES
49.1	AUGER REFUSAL AT 49.1 FEET ROCK TYPE - LIGHT GRAY LIMESTONE REC. = 100% RQD. = 98% PROBABLE KNOX FORMATION CRACKLE BRECCIATED MODERATELY FRACTURED IN RANDOM DIRECTIONS. FRACTURED TYPICALYY RECEMENTED WITH CALCITE OR DOLOMITE.
57.0	CORE RUN #2 - FROM 57.3' TO 67.3' REC. = 95.8% RQD. = 89.2%
67.0	CORE RUN #3 - FROM 67.3' TO 76.9' REC. = 97.4% RQD. = 89.2%
76.0	CORE RUN #4 - FROM 76.9' TO 86.9' REC. = 100% RQD. = 95%



REMARKS:

INSTALLED TWO INCH PVC DIAMETER PVC TYPE II PIEZOMETER, STABILIZED GROUNDWATER MEASURED 18.5 FEET ON MAY 1, 1992.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-110
DATE DRILLED	April 14, 1992
PROJECT NUMBER	57401442.04
PROJECT	TVA - CUMBERLAND

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT
	CORE RUN #4 - FROM 76.9' TO 86.9' REC. = 100% RQD. = 95%		
85.5		310.7	
	CORE RUN #5 - FROM 86.9' TO 94.6' REC. = 100% RQD. = 95%	305.7	
93.5	CORE RUN #6 - FROM 94.6' TO 100.0' REC. = 100% RQD. = 58.5%	300.7	
100.0	CORE TERMINATED AT 100.0 FEET	295.7	
	WELL DEPTH MEASURED DURING RE-DEVELOPMENT BY STANTEC (June, 2016)	290.7	
		285.7	
		280.7	

Penetration scale: 0, 10, 20, 30, 40, 60, 80, 100

REMARKS:

INSTALLED TWO INCH PVC DIAMETER PVC TYPE II PIEZOMETER, STABILIZED GROUNDWATER MEASURED 18.5 FEET ON MAY 1, 1992.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-110
DATE DRILLED	April 14, 1992
PROJECT NUMBER	57401442.04
PROJECT	TVA - CUMBERLAND
PAGE 3 OF 3	

LAW ENGINEERING

AECOM

Boring Log

BORING #: CUF-101

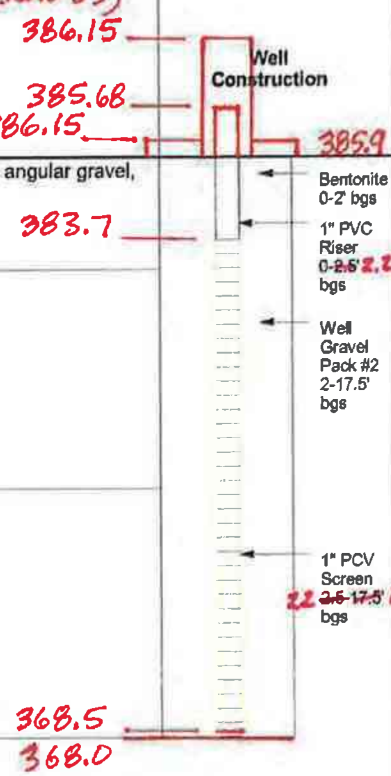
Client: Tennessee Valley Authority		**Logged By:** Phillip Van Winkle
Location: 815 Cumberland City Rd, Cumberland City, TN 37050		**Drilling Company:** Delta Well & Pump
Project #: 60436800	**Ground Elevation (msl):** ~~386.25~~ 385.9	**Well Screen Interval (ft):** 2.5-17.5'
Start Date: 11/23/2015	**Drilling Method:** CME 55 HSA / Air Hammer	**Water Level (ft btoc):** 12/28/15: 0.8'
Finish Date: 11/24/2015	~~**Northing:** 731680.706~~ ~~**Easting:** 1513783.33~~	**Total Depth (ft):** 17.5

N 36° 23' 27.11" W 87° 39' 06.98" (NAD 83)

Depth (ft bgs)	Recovery Length (inches)	PID (ppm)	USCS Code	Graphic	Soil and Rock Description Classification Scheme: USCS
0 – 3.4			FILL		Brown, SILTY CLAY with Cobbles, some Sand, little angular gravel, moist, petroleum odor. Bolder at 3.4' (fill material)
3.4 – 10.0			CH		Brown, fat CLAY, wet
10.0 – 17.5			CH		Dark brown fat CLAY, wet

End of boring at ~~17.5~~ 17.9 ft. bgs.

Well Construction



SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/16)

REVIEWED: JGB   CHECKED: MSJ   REV'D: 1/28/17

Remarks: Boring Terminated (ft): 17.5

1" Piezometer installed

AECOM
500 Enterprise Drive Suite 1A
Rocky Hill, CT 06067

AECOM

Boring Log

BORING #: CUF-102

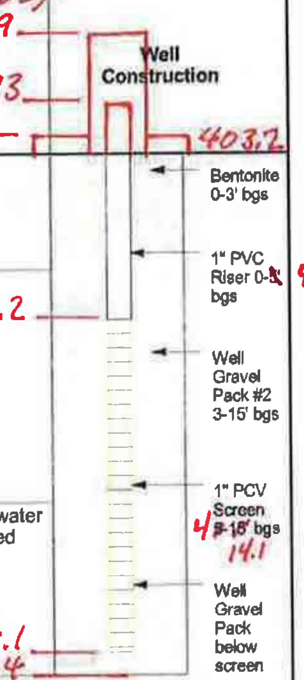
Client: Tennessee Valley Authority		**Logged By:** Phillip Van Winkle
Location: 815 Cumberland City Rd, Cumberland City, TN 37050		**Drilling Company:** Delta Well & Pump
Project #: 60436800	**Ground Elevation (msl):** ~~403.32~~ 403.2	**Well Screen Interval (ft):** 5-15'
Start Date: 11/23/2015	**Drilling Method:** CME 55 HSA / Air Hammer	**Water Level (ft btoc):** 12/28/15: 7.29'
Finish Date: 11/23/2015	~~**Northing:** 730918.489 **Easting:** 1513923.175~~	**Total Depth (ft):** 15.7

N 36° 23' 19.48" W 87° 39' 05.08" (NAD 83)

Depth (ft bgs)	Recovery Length (inches)	PID (ppm)	USCS Code	Graphic	Soil and Rock Description Classification Scheme: USCS
0			FILL		Gray, angular GRAVEL, dry (fill material).
3.5			LIMESTONE		Gray, LIMESTONE, fossiliferous, microcrystalline, moist
10.5			LIMESTONE		Gray, LIMESTONE, fossiliferous, microcrystalline, wet. Groundwater encountered at 10' bgs during air hammer advancement. Switched back to HSA at 10.5' bgs
15.7					End of boring at 15.7 ft. bgs.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14

Well Construction



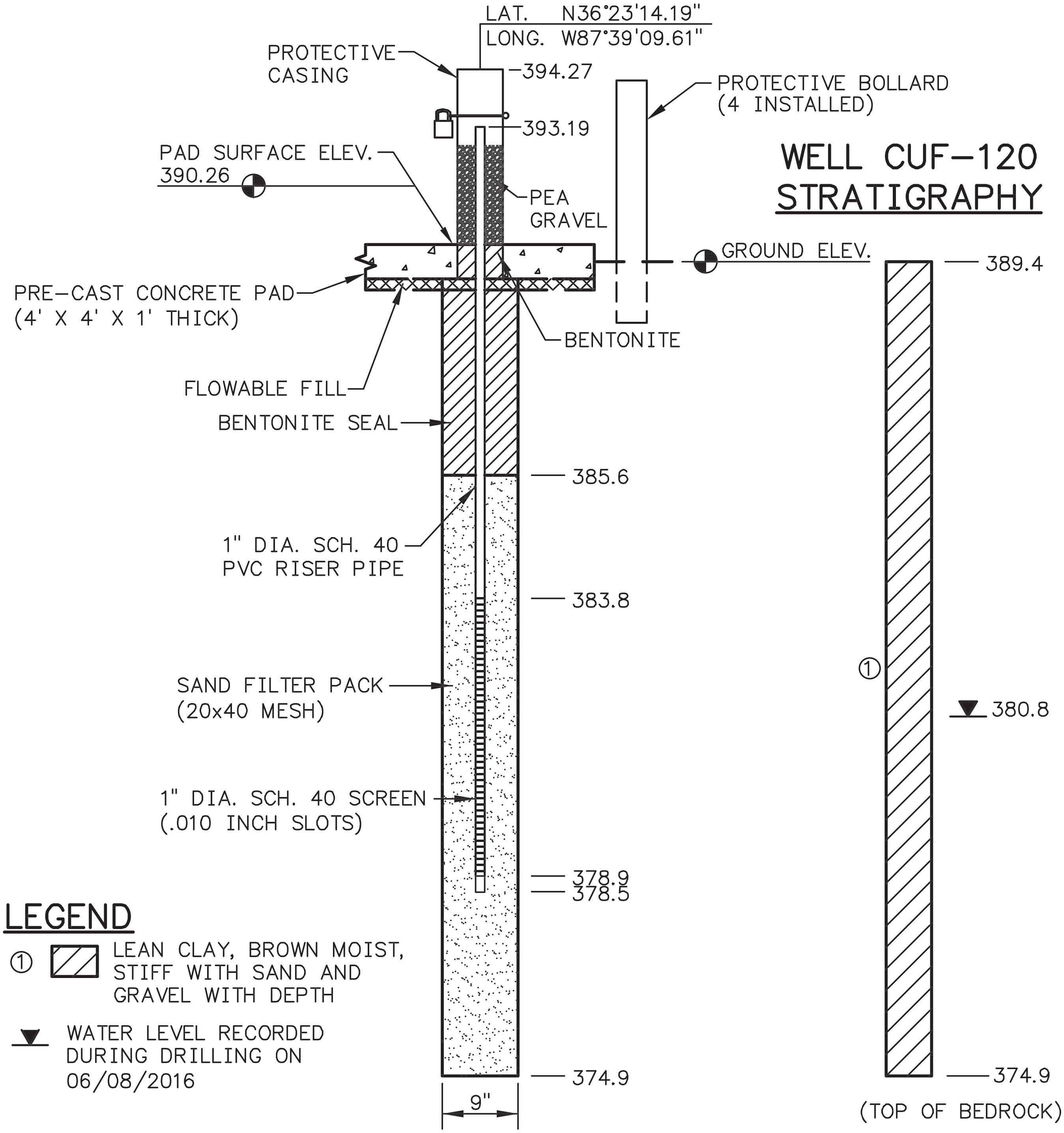
SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/7/16)

REVIEWED: JGB CHECKED: MSJ REV'D: 1/28/17

Remarks: Boring Terminated (ft): 15.7

1" Piezometer installed

AECOM
500 Enterprise Drive Suite 1A
Rocky Hill, CT 06067



LEGEND

① LEAN CLAY, BROWN MOIST, STIFF WITH SAND AND GRAVEL WITH DEPTH

WATER LEVEL RECORDED DURING DRILLING ON 06/08/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 06/08/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/2016).

PLOT DATE: 01/30/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_120.DWG

CUF-120 OBSERVATION WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

Stantec

Stantec Consulting Services Inc.
3052 Beaumont Centre Circle
Lexington, Kentucky
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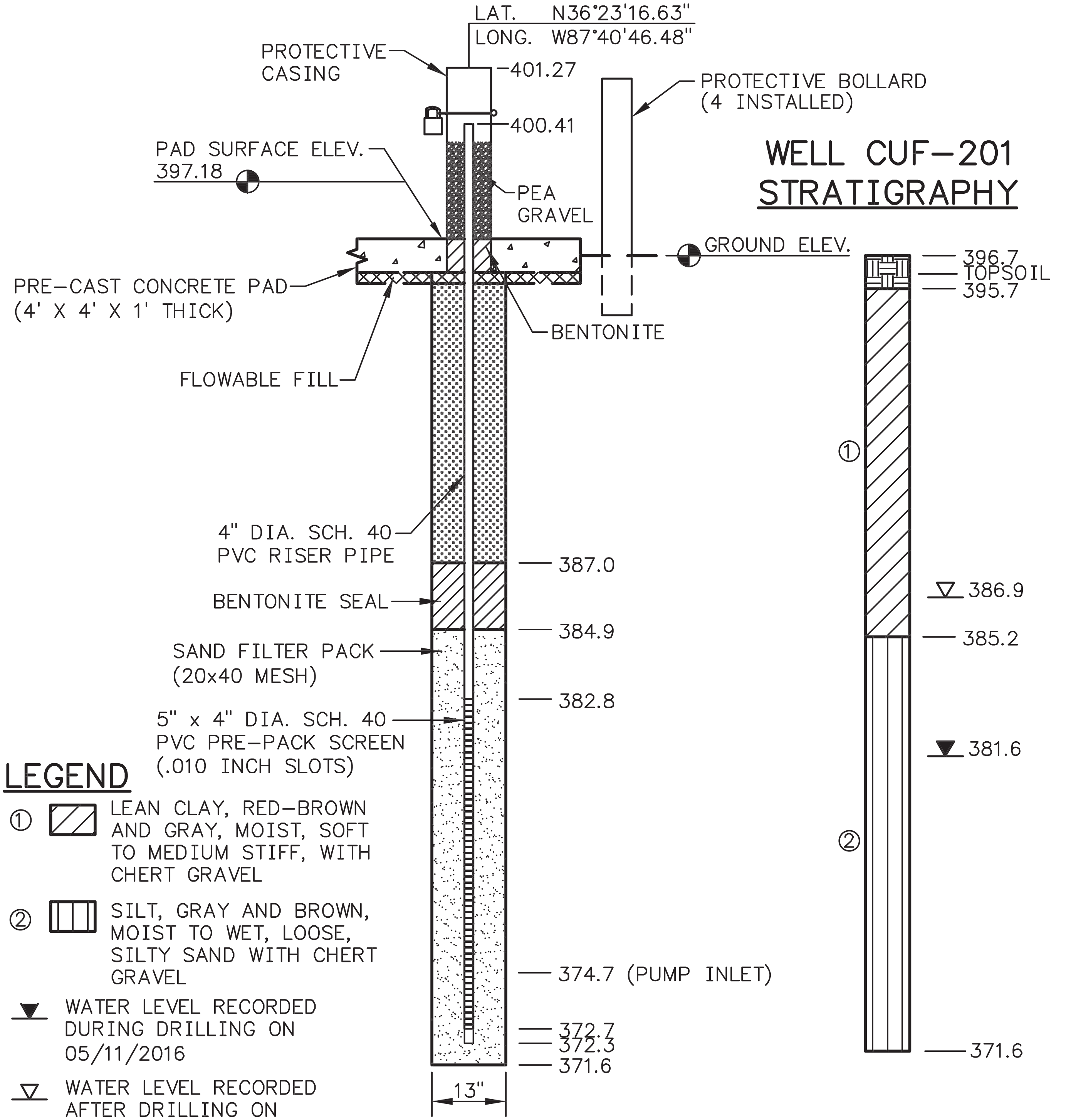
CHECKED BY	DRP	PROJ. NO. 175565299	1.	3.		1 of 1
CHECKED BY	BLB	SCALE NTS	2.	4.		



LEGEND

① LEAN CLAY, RED-BROWN AND GRAY, MOIST, SOFT TO MEDIUM STIFF, WITH CHERT GRAVEL

② SILT, GRAY AND BROWN, MOIST TO WET, LOOSE, SILTY SAND WITH CHERT GRAVEL

▼ WATER LEVEL RECORDED DURING DRILLING ON 05/11/2016

▽ WATER LEVEL RECORDED AFTER DRILLING ON 05/11/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/11/2016 BTY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_201.DWG

CUF-201 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

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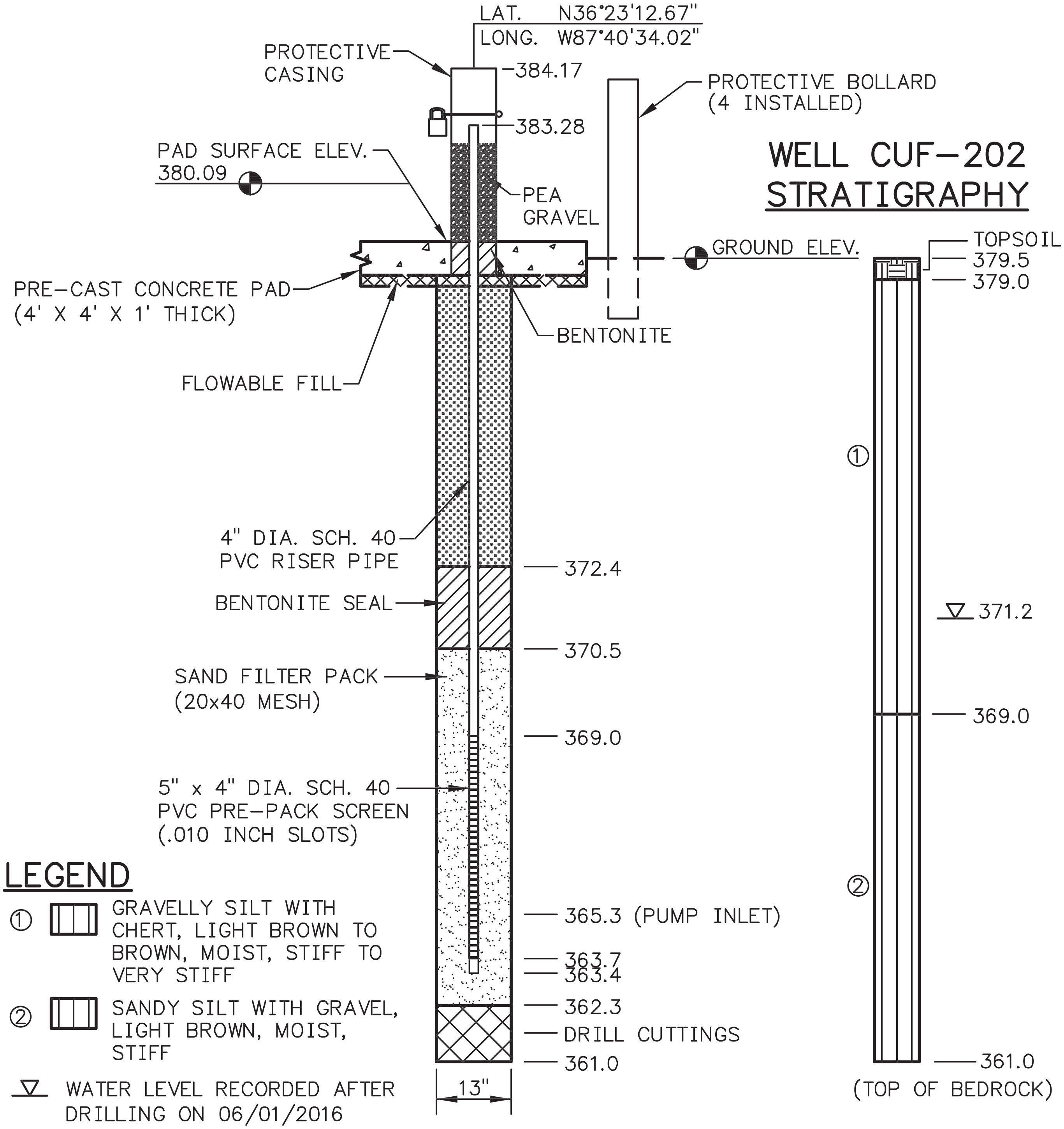

LEGEND

① GRAVELLY SILT WITH CHERT, LIGHT BROWN TO BROWN, MOIST, STIFF TO VERY STIFF

② SANDY SILT WITH GRAVEL, LIGHT BROWN, MOIST, STIFF

▽ WATER LEVEL RECORDED AFTER DRILLING ON 06/01/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 06/01/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/2016).

CUF-202 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
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CHECKED BY	BLB	SCALE	NTS	2.	4.	

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
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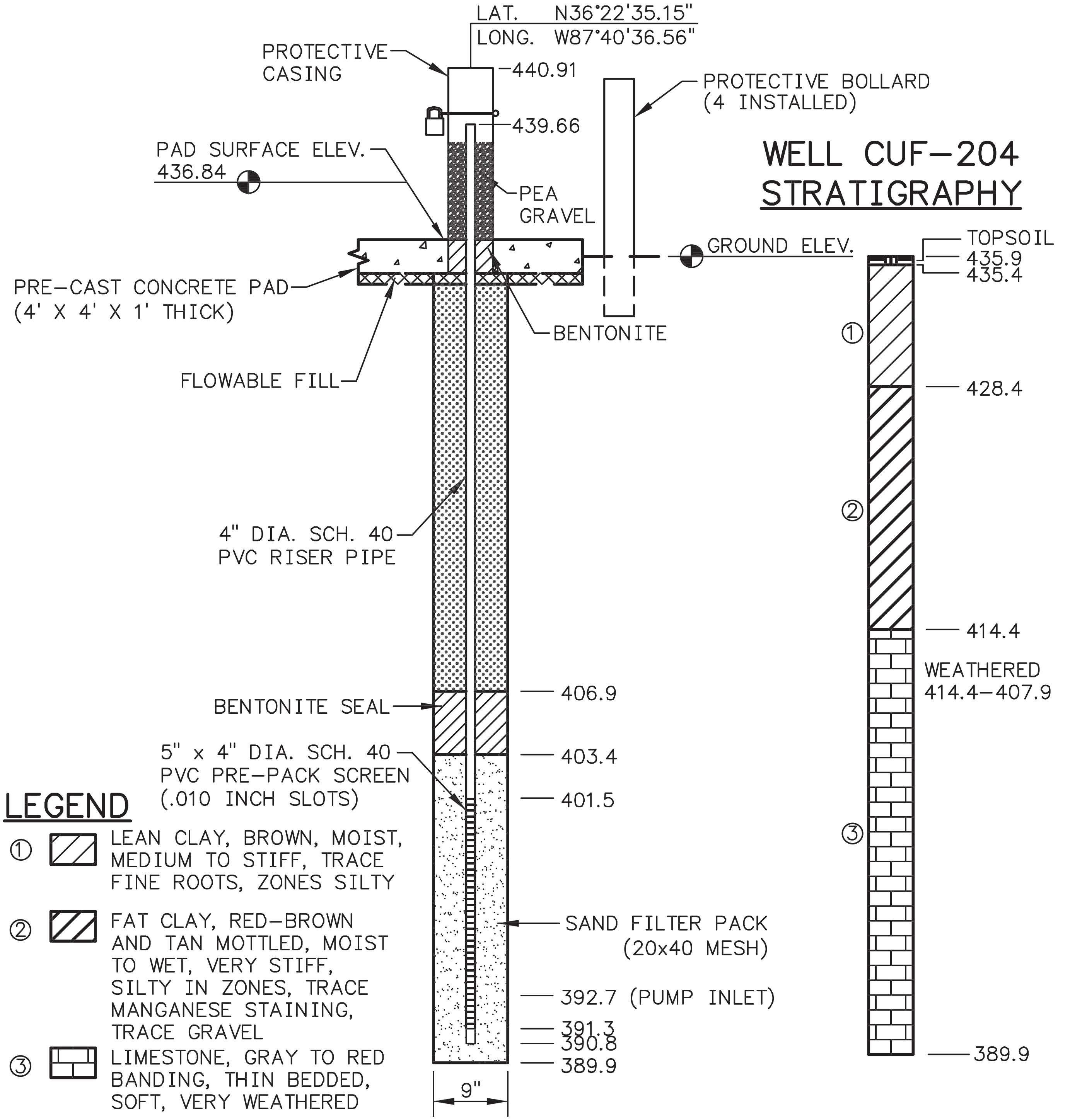
WELL CUF-204 STRATIGRAPHY



LEGEND

① LEAN CLAY, BROWN, MOIST, MEDIUM TO STIFF, TRACE FINE ROOTS, ZONES SILTY

② FAT CLAY, RED-BROWN AND TAN MOTTLED, MOIST TO WET, VERY STIFF, SILTY IN ZONES, TRACE MANGANESE STAINING, TRACE GRAVEL

③ LIMESTONE, GRAY TO RED BANDING, THIN BEDDED, SOFT, VERY WEATHERED

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/25/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_204.DWG

CUF-204 MONITORING WELL INSTALLATION DETAIL
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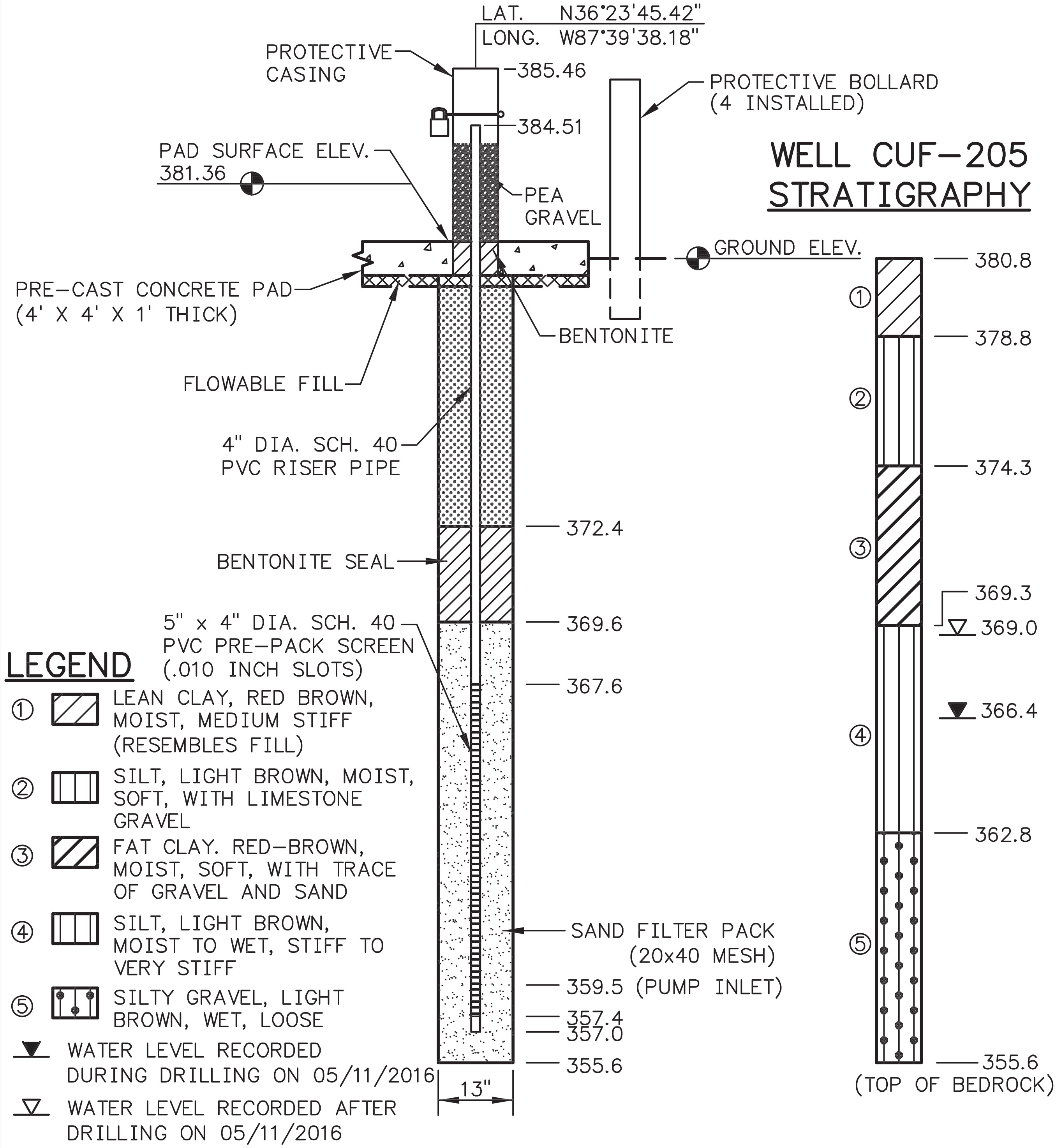

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/11/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/07/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
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CUF-205 MONITORING WELL INSTALLATION DETAIL
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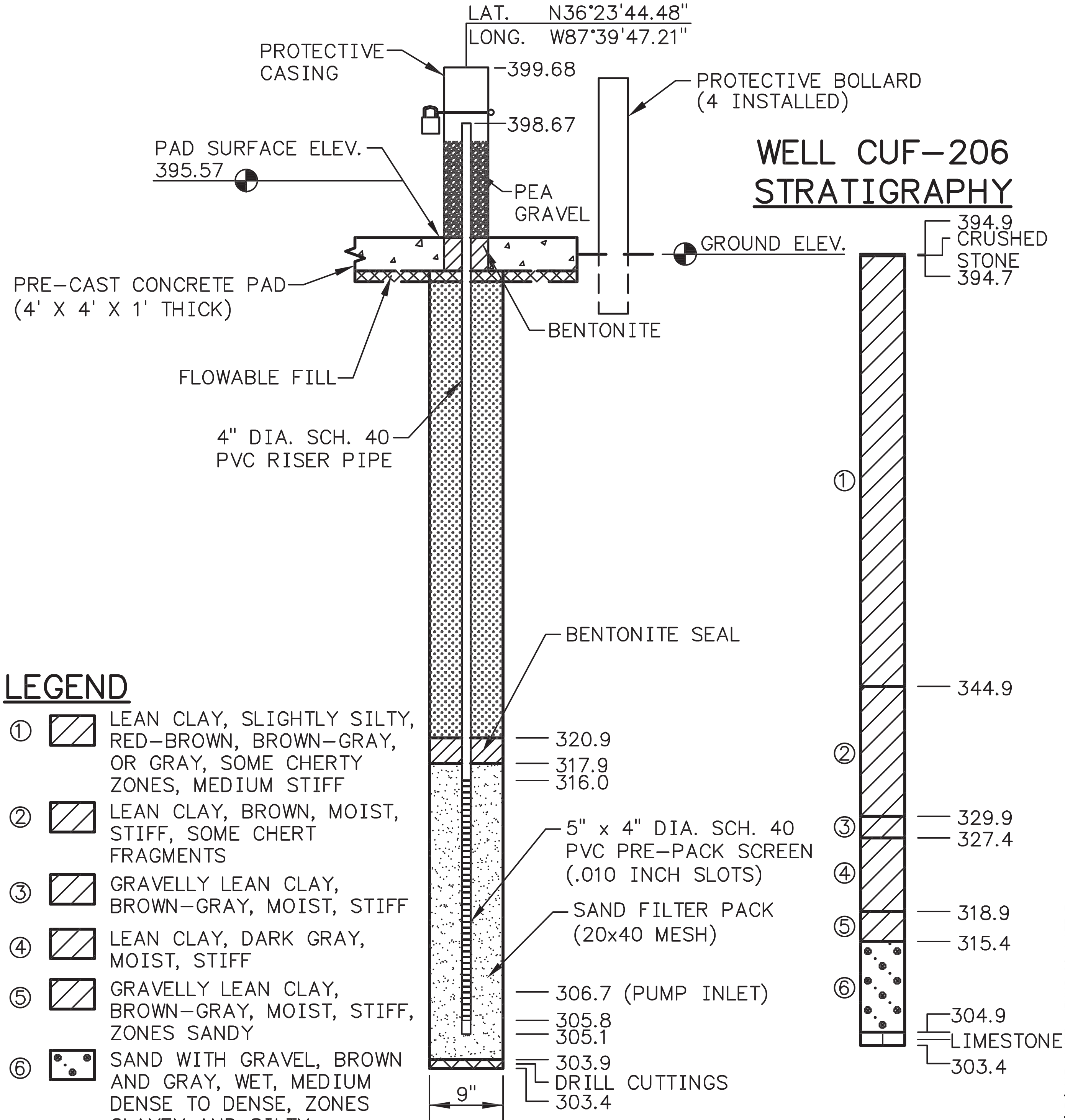
CHECKED BY	DRP	PROJ. NO. 175565299	1.	3.		1 of 1
CHECKED BY	BLB	SCALE NTS	2.	4.		



LEGEND

1. LEAN CLAY, SLIGHTLY SILTY, RED-BROWN, BROWN-GRAY, OR GRAY, SOME CHERTY ZONES, MEDIUM STIFF
2. LEAN CLAY, BROWN, MOIST, STIFF, SOME CHERT FRAGMENTS
3. GRAVELLY LEAN CLAY, BROWN-GRAY, MOIST, STIFF
4. LEAN CLAY, DARK GRAY, MOIST, STIFF
5. GRAVELLY LEAN CLAY, BROWN-GRAY, MOIST, STIFF, ZONES SANDY
6. SAND WITH GRAVEL, BROWN AND GRAY, WET, MEDIUM DENSE TO DENSE, ZONES CLAYEY AND SILTY

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 06/02/2016 BY STANNTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/06/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_206.DWG

CUF-206 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

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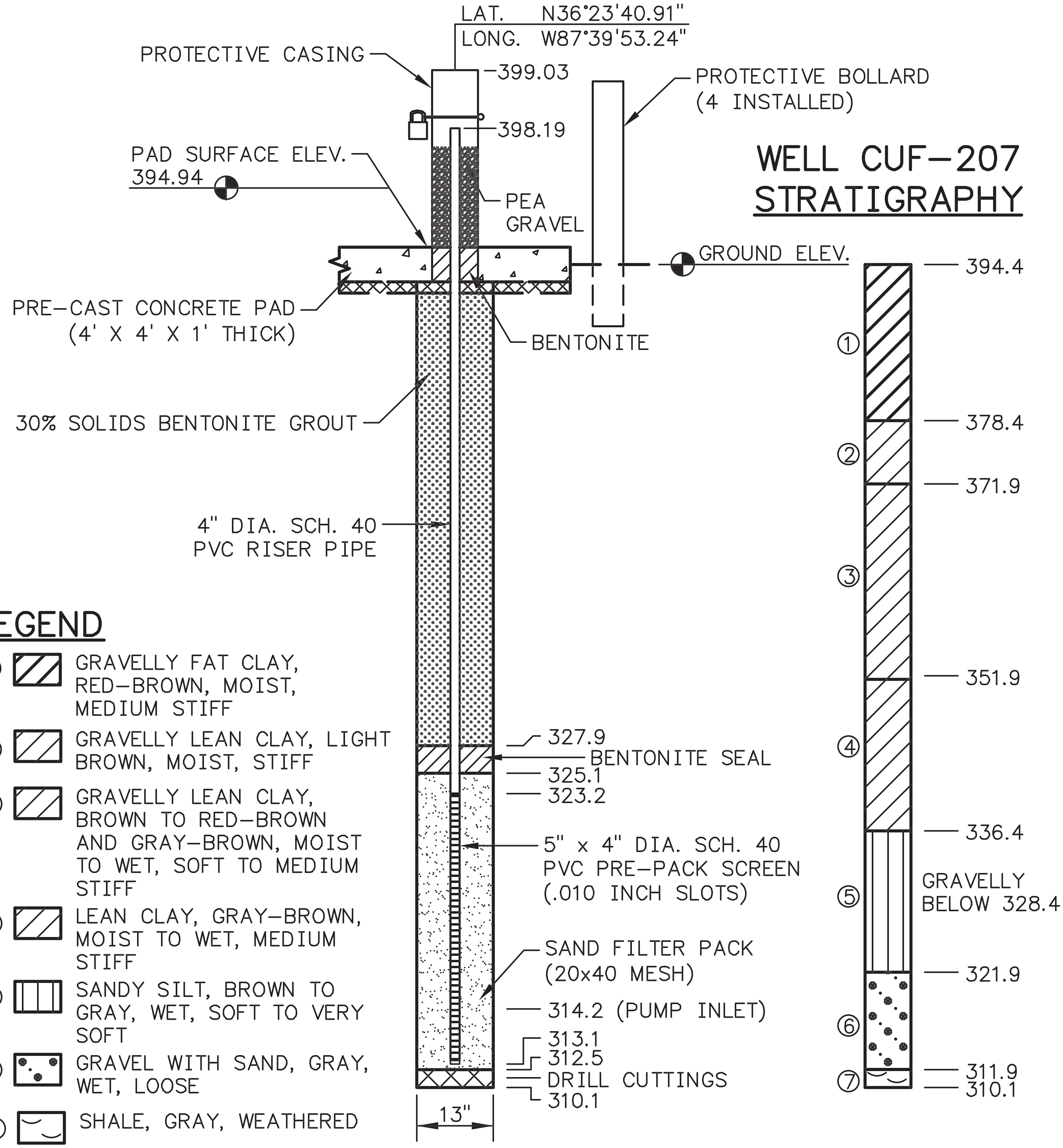

LEGEND

① GRAVELLY FAT CLAY, RED-BROWN, MOIST, MEDIUM STIFF

② GRAVELLY LEAN CLAY, LIGHT BROWN, MOIST, STIFF

③ GRAVELLY LEAN CLAY, BROWN TO RED-BROWN AND GRAY-BROWN, MOIST TO WET, SOFT TO MEDIUM STIFF

④ LEAN CLAY, GRAY-BROWN, MOIST TO WET, MEDIUM STIFF

⑤ SANDY SILT, BROWN TO GRAY, WET, SOFT TO VERY SOFT

⑥ GRAVEL WITH SAND, GRAY, WET, LOOSE

⑦ SHALE, GRAY, WEATHERED

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/12/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/06/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_207.DWG

CUF-207 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

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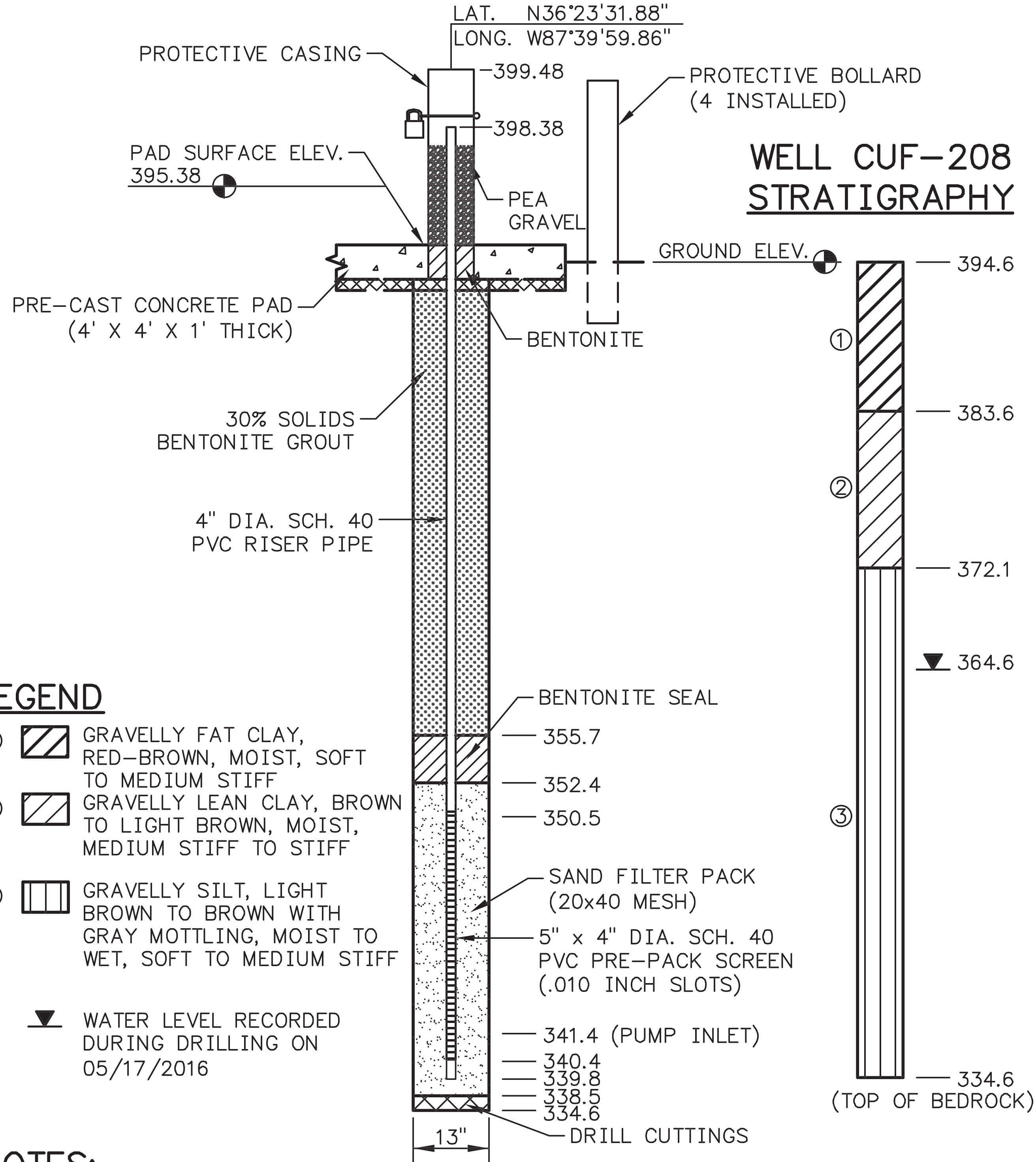

LEGEND

① GRAVELLY FAT CLAY, RED-BROWN, MOIST, SOFT TO MEDIUM STIFF

② GRAVELLY LEAN CLAY, BROWN TO LIGHT BROWN, MOIST, MEDIUM STIFF TO STIFF

③ GRAVELLY SILT, LIGHT BROWN TO BROWN WITH GRAY MOTTLING, MOIST TO WET, SOFT TO MEDIUM STIFF

▼ WATER LEVEL RECORDED DURING DRILLING ON 05/17/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/17/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/06/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_208.DWG

CUF-208 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
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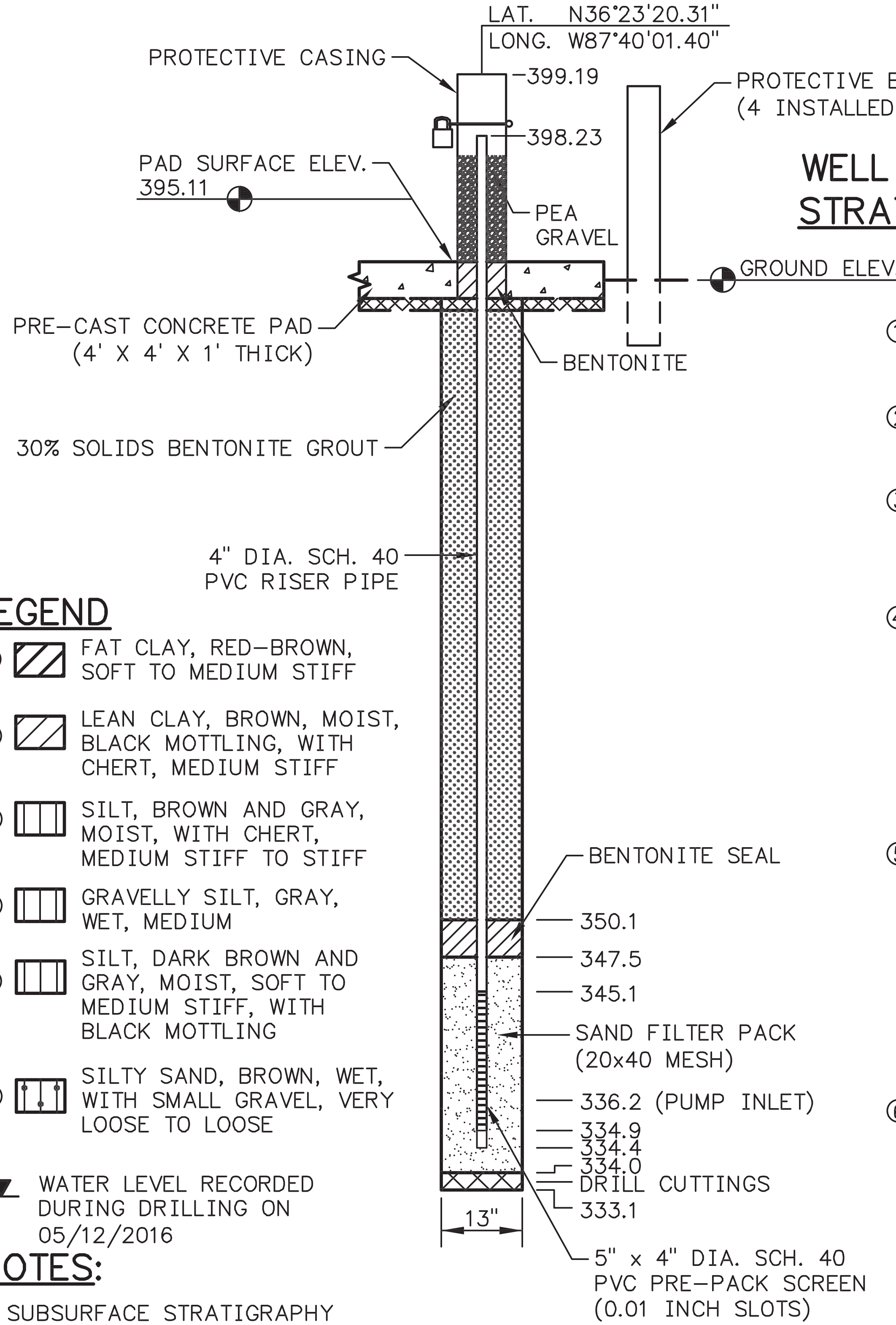
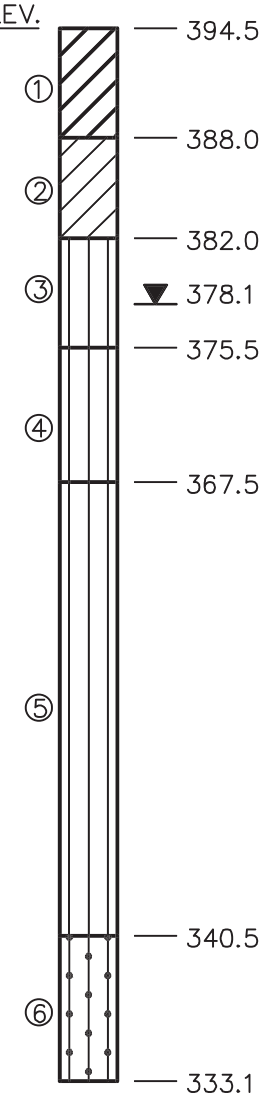


WELL CUF-209 STRATIGRAPHY



LEGEND

① FAT CLAY, RED-BROWN, SOFT TO MEDIUM STIFF

② LEAN CLAY, BROWN, MOIST, BLACK MOTTLING, WITH CHERT, MEDIUM STIFF

③ SILT, BROWN AND GRAY, MOIST, WITH CHERT, MEDIUM STIFF TO STIFF

④ GRAVELLY SILT, GRAY, WET, MEDIUM

⑤ SILT, DARK BROWN AND GRAY, MOIST, SOFT TO MEDIUM STIFF, WITH BLACK MOTTLING

⑥ SILTY SAND, BROWN, WET, WITH SMALL GRAVEL, VERY LOOSE TO LOOSE

▼ WATER LEVEL RECORDED DURING DRILLING ON 05/12/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/12/2016 BY STANTEC
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/06/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_209.DWG

CUF- 209 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
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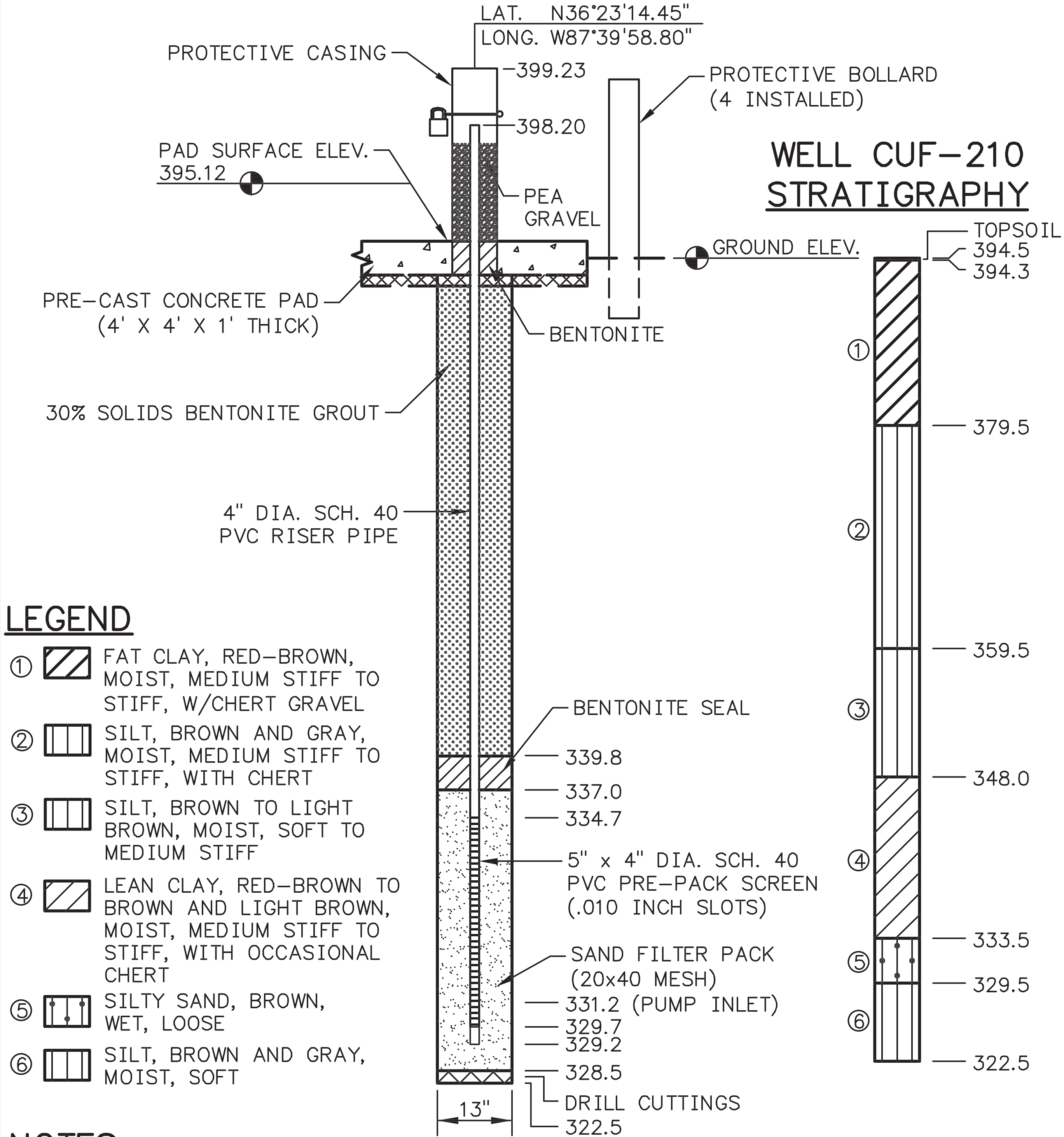
CHECKED BY	BLB	SCALE	NTS	2.	4.	



NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/17/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/06/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_210.DWG

CUF-210 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

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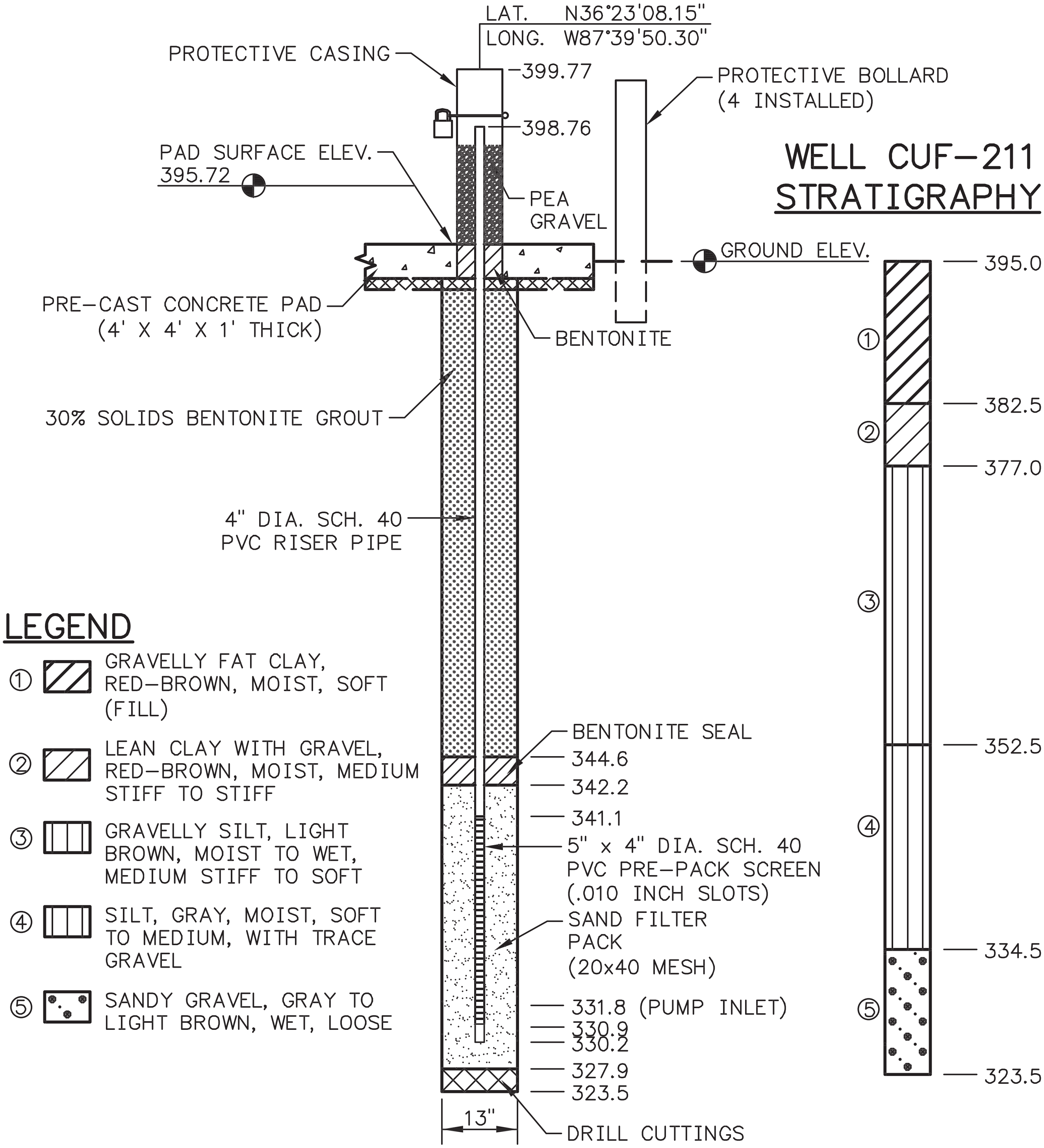
CHECKED BY	BLB	SCALE	NTS	2.	4.	



NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/19/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/06/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_211.DWG

CUF- 211 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
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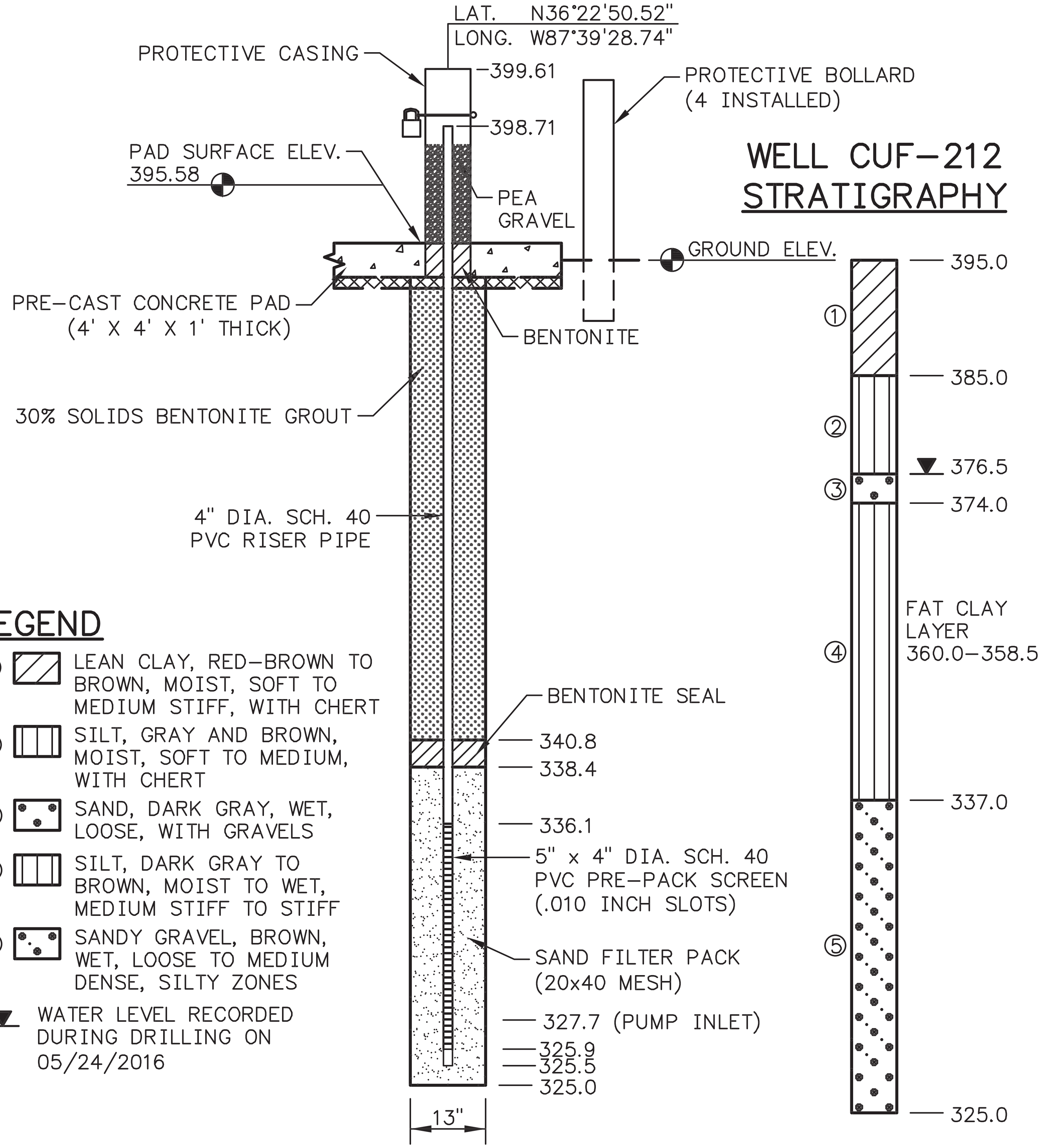
CHECKED BY	BLB	SCALE	NTS	2.	4.	



LEGEND

① LEAN CLAY, RED-BROWN TO BROWN, MOIST, SOFT TO MEDIUM STIFF, WITH CHERT

② SILT, GRAY AND BROWN, MOIST, SOFT TO MEDIUM, WITH CHERT

③ SAND, DARK GRAY, WET, LOOSE, WITH GRAVELS

④ SILT, DARK GRAY TO BROWN, MOIST TO WET, MEDIUM STIFF TO STIFF

⑤ SANDY GRAVEL, BROWN, WET, LOOSE TO MEDIUM DENSE, SILTY ZONES

▼ WATER LEVEL RECORDED DURING DRILLING ON 05/24/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/24/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/06/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_212.DWG

CUF-212 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
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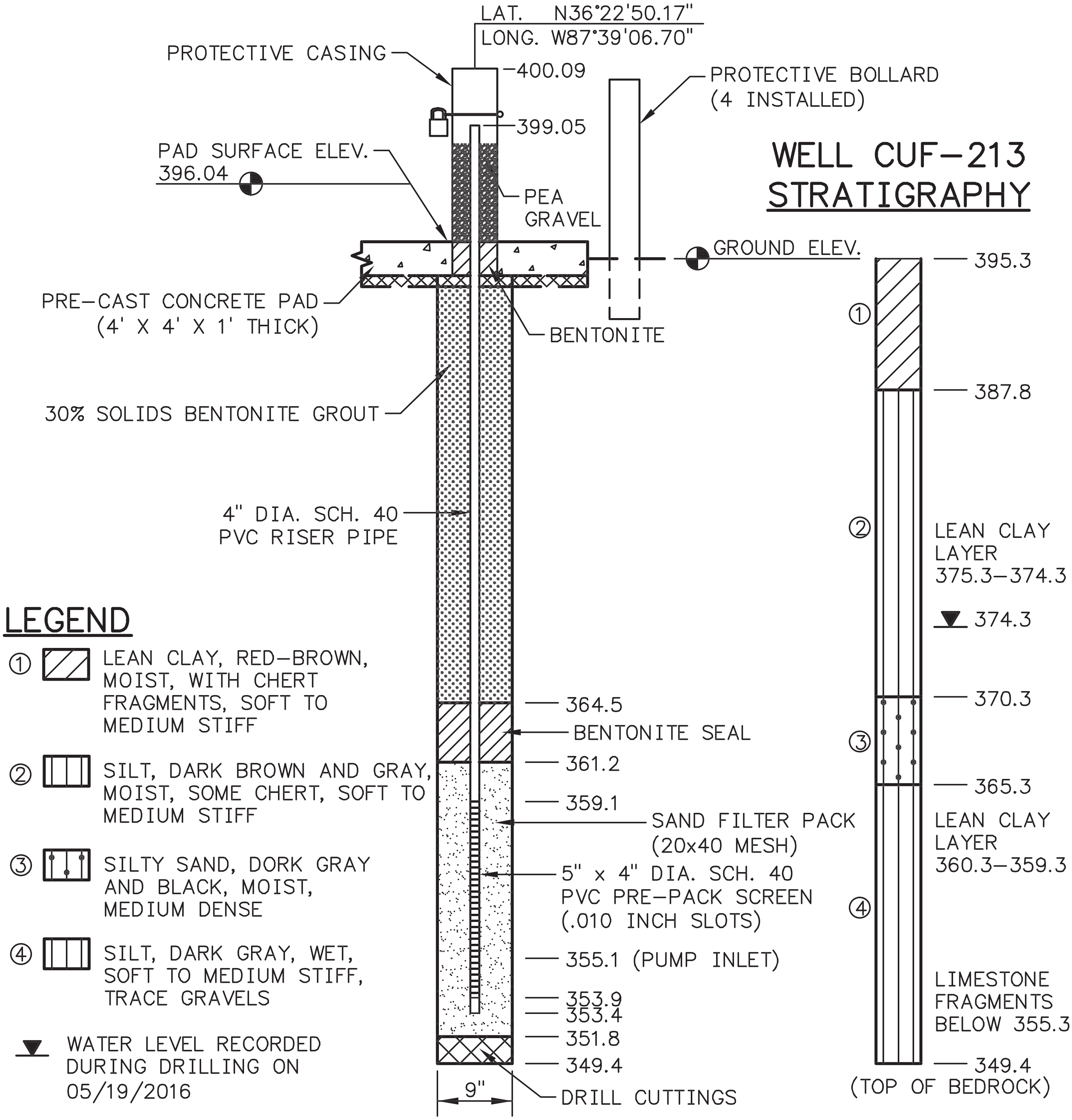

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_213.DWG

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/19/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/06/2016).

CUF-213 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

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APPENDIX C
SOIL BORING LOGS AND PLAN VIEW

SOIL BORING LOCATIONS					
WELL ID	NORTHING (FEET)	EASTING (FEET)	LATITUDE (D–M–S)	LONGITUDE (D–M–S)	GROUND SURFACE
CUF–120	730384.17	1513540.26	N36°23'14.19"	W87°39'09.61"	389.4
CUF–120A	730379.26	1513536.18	N36°23'14.14"	W87°39'09.66"	388.0
CUF–201	730765.35	1505625.26	N36°23'16.63"	W87°40'46.48"	396.7
CUF–202	730347.74	1506636.70	N36°23'12.67"	W87°40'34.02"	379.5
CUF–202A	729833.21	1506809.10	N36°23'07.61"	W87°40'31.81"	412.3
CUF–202B	730302.00	1506772.65	N36°23'12.24"	W87°40'32.35"	390.7
CUF–203A	727192.01	1509863.93	N36°22'42.01"	W87°39'53.90"	409.5
CUF–203B	727398.56	1509388.20	N36°22'43.98"	W87°39'59.76"	378.0
CUF–204	726557.28	1506364.04	N36°22'35.15"	W87°40'36.56"	435.9
CUF–204A	726274.53	1506340.23	N36°22'32.35"	W87°40'36.80"	458.3
CUF–205	733581.23	1511258.33	N36°23'45.42"	W87°39'38.18"	380.8
CUF–206	733499.10	1510518.16	N36°23'44.48"	W87°39'47.21"	394.9
CUF–207	733146.70	1510018.98	N36°23'40.91"	W87°39'53.24"	394.4
CUF–208	732242.48	1509462.75	N36°23'31.88"	W87°39'59.86"	394.6
CUF–209	731074.78	1509317.09	N36°23'20.31"	W87°40'01.40"	394.5
CUF–210	730478.75	1509519.11	N36°23'14.45"	W87°39'58.80"	394.5
CUF–211	729830.15	1510203.78	N36°23'08.15"	W87°39'50.30"	395.0
CUF–212	728016.94	1511935.77	N36°22'50.52"	W87°39'28.74"	395.0
CUF–213	727951.80	1513737.18	N36°22'50.17"	W87°39'06.70"	395.3
CUF–214	727943.74	1513730.37	N36°22'50.09"	W87°39'06.79"	395.3

NOTES:

1. THE AERIAL MAPPING PROVIDED BY USDA NAIP IS BASED ON HORIZONTAL DATUM NAD27 USING STATE PLANE TENNESSEE COORDINATE SYSTEM AND VERTICAL DATUM NGVD29. THE ORTHO-PHOTOGRAPHY WAS PERFORMED IN 2014. GEODETIC COORDINATES SHOWN ARE NAD83.
2. ALL BOUNDARY LINES ARE APPROXIMATE WORKING BOUNDARIES, TO BE CONFIRMED BY TVA.
3. SOIL BORING LOCATIONS WERE SURVEYED BY STANTEC ON AUGUST 30, 2016, AND NOVEMBER 18, 2016

LEGEND

TVA BOUNDARY LINE

SOIL BORING LOCATION WITH INSTALLED WELL

SOIL BORING (DRY HOLE – NO WELL INSTALLED)

RECORD DRAWING

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R –	–	–	–	–	–	–	–	–	–	–	–
R 0	11/19/15	DRP	MSJ	JGB	BLB	SEB	MST	JCK	609389	–	–

ISSED AS–BUILT AS PER PROJECT ID 609389

DISCIPLINE INTERFACE

SCALE: 1"=400' EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

MONITORING WELL NETWORK AND OBSERVATION WELLS SOIL BORING LOCATION PLAN

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D.R. PLEIMAN	M.S. JENNINGS	J.G. BANTON	B.L. BRYANT	S.E. BENNET	M.S. TURNBOW	J.C. KAMMEYER

Stantec
3052 Beaumont Centre Circle
Lexington, Kentucky 40513
www.stantec.com

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2013 | DATE 02/10/17 | 46 | C | 10W858–05 | R 0

PLOT FACTOR:400
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

STANTEC | 0
TASK COMPLETED BY: | REV NO.

46 C 10W858–05

PLOT DATE: 02/10/2017 USER: JOHNSON, C:\USERS\TJOHNSON\DESKTOP\NEW FOLDER

Project Number	175565299	Location	N36°23'14.19", W87°39'09.61" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-120** Total Depth 14.5 ft
County	Stewart, TN	Surface Elevation	389.4 ft (NGVD29)
Project Type	Piezometer Installation	Date Started	6/8/16 Completed 6/8/16
Supervisor	D. Pleiman Driller T. Caudill	Depth to Water	8.6 ft Date/Time 6/8/16
Logged By	B. Rosen	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
389.4	0.0	Top of Hole							
		Lean Clay, brown, moist, stiff, with sand and gravels with the depth (Drilled without sampling)							1" diameter piezometer installed Becomes wet @ 8.6'
374.9	14.5								
		Auger Refusal / Bottom of Hole							

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'14.14", W87°39'09.66" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-120A** Total Depth 29.0 ft
County	Stewart, TN	Surface Elevation	388.0 ft (NGVD29)
Project Type	Piezometer Installation	Date Started	6/6/16 Completed 6/6/16
Supervisor	D. Pleiman Driller T. Taylor	Depth to Water	8.1 ft Date/Time 6/7/16
Logged By	B. Rosen	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
388.0	0.0	Top of Hole							
382.0	6.0	Lean Clay, brown, moist, stiff			0.0 - 10.0	10.0		--	6" Sonic to 29.0' Backfilled with bentonite grout; no water encountered within bedrock Becomes wet @ 8.1'
376.0	12.0	Lean Clay, brown, moist, stiff, with sand and gravel			10.0 - 20.0	10.0		--	
359.0	29.0	Limestone			20.0 - 29.0	9.0		--	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'16.63", W87°40'46.48" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-201** Total Depth 25.1 ft
County	Stewart, TN	Surface Elevation	396.7 ft (NGVD29)
Project Type	Well Installations	Date Started	5/11/16 Completed 5/11/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	15.1 ft Date/Time 5/11/16
Logged By	J. Andrew	Depth to Water	9.8 ft Date/Time 5/11/16

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
396.7	0.0	Top of Hole						
395.7	1.0	Topsoil						4" diameter well installed
		Lean Clay, reddish brown and gray, moist, soft to medium stiff, with chert gravel	SPT-1	2.5 - 4.0	0.4	3-3-5	--	
			SPT-2	5.0 - 6.5	1.0	2-3-4	--	
			SPT-3	7.5 - 9.0	1.0	3-5-8	--	
385.2	11.5		SPT-4	10.0 - 11.5	0.3	3-5-9	--	
		Silt, gray and brown, moist to wet, loose, silty sand with chert gravel	SPT-5	12.5 - 14.0	1.5	1-2-2	--	
			SPT-6	15.0 - 16.5	1.5	2-2-3	--	Water @ 15.1' during drilling
			SPT-7	17.5 - 19.0	1.5	2-5-5	--	
			SPT-8	20.0 - 21.5	1.0	13-10-16	--	
			SPT-9	22.5 - 24.0	0.6	3-5-8	--	
371.6	25.1							

No Refusal /
Bottom of Hole

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'12.67", W87°40'34.02" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-202** Total Depth 18.5 ft
County	Stewart, TN	Surface Elevation	379.5 ft (NGVD29)
Project Type	Well Installations	Date Started	6/1/16 Completed 6/1/16
Supervisor	D. Pleiman Driller D. Jessie	Depth to Water	8.3 ft Date/Time 6/1/16
Logged By	J. Matthews	Depth to Water	5.9 ft Date/Time 7/22/16

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
379.5	0.0	Top of Hole						
379.0	0.5	Topsoil	SPT-1	0.0 - 1.5	1.4	3-1-1	--	4" diameter well installed
		Gravelly Silt with chert, light brown to brown, moist, stiff to very stiff	SPT-2	2.5 - 4.0	0.8	WOH-1-13	--	
			SPT-3	5.0 - 6.5	1.5	10-9-12	--	
			SPT-4	7.5 - 9.0	1.4	13-9-17	--	Water @ 8.3' during drilling
369.0	10.5	Sandy Silt with Gravel, light brown, moist, stiff	SPT-5	10.0 - 11.5	1.5	9-10-10	--	
			SPT-6	12.5 - 14.0	1.0	7-13-10	--	
		Less gravel below 16.0'	SPT-7	15.0 - 16.5	1.4	6-6-4	--	
361.0	18.5		SPT-8	17.5 - 18.5	0.7	50+/.5	--	
		Auger Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'07.61", W87°40'31.81"(NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-202A** Total Depth 9.0 ft
County	Stewart, TN	Surface Elevation	412.3 ft (NGVD29)
Project Type	Well Installations	Date Started	5/12/16 Completed 5/12/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	Dry Date/Time 5/12/16
Logged By	J. Andrew	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
412.3	0.0	Top of Hole							
403.3	9.0	Lean Clay, brown and red-brown with dark brown mottling, moist, soft to medium stiff, with chert gravel							Backfilled with Bentonite. Shallow bedrock encountered at 9'

Auger Refusal / Bottom of Hole

Top of Rock = 9.0
Elevation (403.3)

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/9/17

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'12.24", W87°40'32.35"(NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	CUF-202B
		Total Depth	31.0 ft
County	Stewart, TN	Surface Elevation	390.7 ft (NGVD29)
Project Type	Well Installations	Date Started	5/31/16
		Completed	5/31/16
Supervisor	D. Pleiman	Depth to Water	28.5 ft
Driller	G. Thompson	Date/Time	5/31/16
Logged By	J. Andrew	Depth to Water	26.8 ft
		Date/Time	5/31/16

Lithology Elevation	Lithology Depth	Description	Sample # / RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
390.7	0.0	Top of Hole						
390.5	0.2	Topsoil						Dry hole: backfilled with bentonite grout on 6/2/16
		Lean Clay, brown and red-brown with dark brown mottling, moist, soft to medium stiff, with chert gravel	SPT-1	2.5 - 4.0	0.8	8-11-14	--	Large chert gravel in SPT-1
			SPT-2	5.0 - 6.5	1.1	7-6-8	--	
			SPT-3	7.5 - 9.0	1.5	4-6-10	--	
			SPT-4	10.0 - 11.5	1.3	8-12-13	--	Large chert gravel in SPT-4
			SPT-5	12.5 - 14.0	0.9	10-18-13	--	
			SPT-6	15.0 - 16.5	1.5	8-7-8	--	
			SPT-7	17.5 - 19.0	0.8	2-5-6	--	
			SPT-8	20.0 - 21.5	1.3	3-7-8	--	
			SPT-9	22.5 - 24.0	1.3	4-11-8	--	
			SPT-10	25.0 - 26.5	1.3	3-5-6	--	
362.2	28.5		SPT-11	27.5 - 29.0	1.5	3-3-6	--	Water @ 28.5' during drilling
		Sand and Gravel, brown, wet, loose, silty zones	SPT-12	30.0 - 30.6	0.2	WOH-50+/0.1	--	
359.7	31.0	Auger Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/9/17

Project Number	175565299	Location	N36°22'42.01", W87°39'53.90" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-203A** Total Depth 50.0 ft
County	Stewart, TN	Surface Elevation	409.5 ft (NGVD29)
Project Type	Well Installations	Date Started	5/18/16 Completed 5/18/16
Supervisor	D. Pleiman Driller A. Marshall	Depth to Water	Dry Date/Time 5/18/16
Logged By	B. Evans	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
409.5	0.0	Top of Hole							
407.5	2.0	Topsoil, brown, moist, medium to stiff, small roots							9" Sonic Dry hole: backfilled with bentonite grout upon completion
405.5	4.0	Lean Clay, red-brown, moist, crumbly, trace to some chert gravel							
399.5	10.0	Fat Clay, red, moist, very stiff, trace chert gravel, trace manganese staining			10.0	10.0	100	10.0	
		Dolomite, thin bedded, hard, very finely crystalline, buff colored, very fractured and healed 15.0-18.0: brown and fractured			10.0	10.0	100	20.0	Note: Water used to advance sonic casing in bedrock No loss and return of water
		21.5-24.0: fractures 24.5-25.5: open vertical fracture and stain, becomes light gray. 27.0-27.5: vertical fracture, weathered. 28.0-30.0: numerous horizontal fractures			10.0	10.0	100	30.0	No loss and return of water
		30.0-35.0: very fractured							No loss and return of water

SUBSURFACE LOG

Project Number	175565299	Location	N36°22'42.01", W87°39'53.90" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-203A** Total Depth 50.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Dolomite, thin bedded, hard, very finely crystalline, buff colored, very fractured and healed *(Continued)*			10.0	10.0	100	40.0	
		36.0-37.0: fractures 38.0-39.5: fractures 40.5-50.0: very fractured and broken							No loss and return of water
359.5	50.0				10.0	10.0	100	50.0	

Bottom of Hole

Top of Rock = 10.0
Elevation (399.5)

Stantec

SUBSURFACE LOG

Project Number	175565299	Location	N36°22'43.98", W87°39'59.76" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-203B** Total Depth 50.0 ft
County	Stewart, TN	Surface Elevation	378.0 ft (NGVD29)
Project Type	Well Installations	Date Started	5/26/16 Completed 5/27/16
Supervisor	D. Pleiman Driller T. Taylor	Depth to Water	Dry Date/Time 5/27/16
Logged By	B. Evans	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
378.0	0.0	Top of Hole							
375.8	2.2	Topsoil							9" Sonic Note: Water used to advance sonic casing in bedrock
		Dolomite, thin bedded, moderately hard to hard, finely crystalline, buff to light gray, zones of high angle bedding (Knox formation) 7.5 - 11.0: 70 degree bedding with fractures			7.8	6.5	83	10.0	
		14.0: Fracture 15.0-17.0: Fracture zone 16.0: Mechanical break 17.5-18.5: Fractures			10.0	10.0	100	20.0	
		20.0-23.5: High angle bedding 23.5-30.0: Very broken, mostly mechanical fracture due to the nature of the rock and sonic drilling			10.0	10.0	100	30.0	
		30.0-39.0: Some Knox dolomite very broken with mechanical fractures from sonic drilling							

Project Number	175565299	Location	N36°22'43.98", W87°39'59.76" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	CUF-203B Total Depth 50.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Dolomite, thin bedded, moderately hard to hard, finely crystalline, buff to light gray, zones of high angle bedding (Knox formation) *(Continued)*			10.0	10.0	100	40.0	
		40.0-41.0: Mechanical breaks 42.0: Mechanical break 43.0: Mechanical break 46.0: High angle fracture along bedding plane 46.5: Mechanical break 47.5: Mechanical break 48.0: Mechanical break 49.5: Mechanical break							
328.0	50.0				10.0	10.0	100	50.0	

Bottom of Hole

Top of Rock = 2.2
Elevation (375.8)

Stantec

SUBSURFACE LOG

Project Number	175565299	Location	N36°22'35.15", W87°40'36.56" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-204** Total Depth 46.0 ft
County	Stewart, TN	Surface Elevation	435.9 ft (NGVD29)
Project Type	Well Installations	Date Started	5/25/16 Completed 5/25/16
Supervisor	D. Pleiman Driller T. Taylor	Depth to Water	Dry Date/Time 5/25/16
Logged By	B. Evans	Depth to Water	29.7 ft Date/Time 7/22/16

Lithology: Elevation	Lithology: Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
435.9	0.0	Top of Hole							
435.4	0.5	Topsoil							9" Sonic
		Lean Clay, brown, moist, medium to stiff, crumbly, trace fine roots, zones silty							4" diameter well installed
428.4	7.5								
		Fat Clay, red-brown and tan mottled, moist to wet, very stiff, silty in zones, trace manganese staining, trace gravel			10.0	10.0	100	10.0	
		15.1-18.2: Silty, wet, soft zone							
					10.0	10.0	100	20.0	Note: Water used to advance sonic casing in bedrock
414.4	21.5	21.0-21.5: Gravelly							
		Limestone, gray to red banding, thin bedded, soft, very weathered, soft to moderately hard							
407.9	28.0				8.0	8.0	100	28.0	Began Core 28.0'
		28.0-30.5: No recovery							
		Limestone, gray and red banding, thin bedded, very finely crystalline grained, fossiliferous, hard							
		34.0-35.0: Fracture zone, weathered							

Project Number	175565299	Location	N36°22'35.15", W87°40'36.56" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	CUF-204
		Total Depth	46.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		36.0-37.5: Fracture zone, weathered Limestone, gray and red banding, thin bedded, very finely crystalline grained, fossiliferous, hard *(Continued)* 40.0-41.0: Very broken 42.0-43.5: Fracture zone			12.0	10.0	83	40.0	
389.9	46.0				6.0	6.0	100	46.0	

Bottom of Hole

Top of Rock = 21.5
Elevation (414.4)

Stantec

SUBSURFACE LOG

Project Number	175565299	Location	N36°22'32.35", W87°40'36.80" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-204A**
		Total Depth	45.0 ft
County	Stewart, TN	Surface Elevation	458.3 ft (NGVD29)
Project Type	Well Installations	Date Started	5/17/16
		Completed	5/17/16
Supervisor	D. Pleiman	Depth to Water	Dry
Driller	A. Marshall	Date/Time	5/17/16
Logged By	B. Evans	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
458.3	0.0	Top of Hole							
		Lean Clay, brown to dark brown and brown-gray, moist, medium to stiff, zones silty							9" Sonic Dry Hole: Backfilled with bentonite grout
451.8	6.5	Fat Clay, brown to dark brown, damp to moist, very stiff, with silt lenses/layers			10.0	12.0	120	10.0	
		Silty zone from 8.5' to 10.0'							
444.8	13.5	Limestone, gray with red banding, very fine crystalline grained, thick bedded, hard 13.5-15.0: Highly weathered 17.5-18.0: Clay seam			10.0	10.0	100	20.0	Note: Water used to advance sonic casing in bedrock
		20.0-21.5: Very fractured 22.0-23.0: Open fracture zone 24.0-27.0: Fracture zone no recovery 27.5-28.5: Fracture 29.0: Angle fracture or bedding plane			10.0	5.5	55	30.0	
		30.5-31.0: Fracture 32.0: Fracture 33.0: Angle fracture or bedding plane 33.5: Fracture			5.0	5.0	100	35.0	
		35.0-36.5: Fractures							

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

Project Number	175565299	Location	N36°22'32.35", W87°40'36.80" (NAD83)		
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-204A**	Total Depth	45.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		36.5-41.0: Highly fractured zone, no recovery Limestone, gray with red banding, very fine crystalline grained, thick bedded, hard *(Continued)* 42.5: Angle fracture or bedding plane							
413.3	45.0	44.5: Fracture			10.0	5.0	50	45.0	

Bottom of Hole

Top of Rock = 13.5
Elevation (444.8)

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'45.42", W87°39'38.18" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-205** Total Depth 25.2 ft
County	Stewart, TN	Surface Elevation	380.8 ft (NGVD29)
Project Type	Well Installations	Date Started	5/11/16 Completed 5/11/16
Supervisor	D. Pleiman Driller D. Jessie	Depth to Water	14.4 ft Date/Time 5/11/16
Logged By	J. Matthews	Depth to Water	11.8 ft Date/Time 5/11/16

Lithology: Elevation	Lithology: Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
380.8	0.0	Top of Hole						
378.8	2.0	Lean Clay, red brown to light brown, moist, medium stiff, with limestone gravel (resembles fill)	SPT-1	0.0 - 1.5	1.3	10-4-4	--	4" diameter well installed
374.3	6.5	Silt, light brown, moist, soft, with limestone gravel	SPT-2	2.5 - 4.0	1.1	10-1-2	--	
			SPT-3	5.0 - 6.5	1.3	1-1-1	--	
369.3	11.5	Fat Clay, red-brown, moist, soft, with trace of gravel and sand	SPT-4	7.5 - 9.0	1.0	4-WOH-1	--	
			SPT-5	10.0 - 11.5	1.0	4-16-8	--	
362.8	18.0	Silt, light brown, moist to wet, stiff to very stiff	SPT-6	12.5 - 14.0	0.0	3-6-7	--	
			SPT-7	15.0 - 16.5	1.5	8-13-23	--	Water @ 14.4' during drilling
355.6	25.2	Silty Gravel, light brown, wet, loose	SPT-8	17.5 - 19.0	0.8	10-3-2	--	
			SPT-9	20.0 - 21.5	1.1	4-7-7	--	
			SPT-10	22.5 - 24.0	1.2	5-13-15	--	
			SPT-11	25.0 - 25.2	0.0	50+/.1	--	
		Auger Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'44.48", W87°39'47.21" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-206** Total Depth 91.5 ft
County	Stewart, TN	Surface Elevation	394.9 ft (NGVD29)
Project Type	Well Installations	Date Started 6/2/16	Completed 6/2/16
Supervisor	D. Pleiman Driller T. Taylor	Depth to Water Dry	Date/Time 6/2/16
Logged By	B. Rosen	Depth to Water 33.7 ft	Date/Time 7/22/16

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
394.9	0.0	Top of Hole							
394.7	0.2	Crushed stone							9" Sonic 4" diameter well installed
		Lean Clay, slightly silty, red-brown, brown-gray, or gray, damp to moist, some cherty zones, medium stiff							
		24.5-25.5: Limestone boulder							

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

Project Number	175565299	Location	N36°23'44.48", W87°39'47.21" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-206** Total Depth 91.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
344.9	50.0	Lean Clay, slightly silty, red-brown, brown-gray, or gray, damp to moist, some cherty zones, medium stiff *(Continued)* 39.5-40.0: Limestone boulder							
329.9	65.0	Lean Clay, brown, moist, stiff, some chert fragments							
327.4	67.5	Gravelly Lean Clay, brown-gray, moist, stiff							
318.9	76.0	Lean Clay, dark gray, moist, stiff							

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'44.48", W87°39'47.21" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-206** Total Depth 91.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
315.4	79.5	Gravelly Lean Clay, brown to gray, moist, medium stiff to stiff, zones sandy *(Continued)*							
		Sand with Gravel, brown and gray, wet, medium dense to dense, zones clayey and silty							
304.9	90.0								
		Limestone							
303.4	91.5								
		No Refusal / Bottom of Hole							

Project Number	175565299	Location	N36°23'40.91", W87°39'53.24" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-207** Total Depth 84.3 ft
County	Stewart, TN	Surface Elevation	394.4 ft (NGVD29)
Project Type	Well Installations	Date Started	5/12/16 Completed 5/12/16
Supervisor	D. Pleiman Driller D. Jessie	Depth to Water	Dry Date/Time 5/12/16
Logged By	Jordan Matthews	Depth to Water	31.9 ft Date/Time 7/22/16

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
394.4	0.0	Top of Hole						
		Gravelly Fat Clay, red-brown, moist, medium stiff	SPT-1	0.0 - 1.5	1.1	3-4-4	--	4" diameter well installed
			SPT-2	2.5 - 4.0	0.7	2-2-4	--	
			SPT-3	5.0 - 6.5	1.1	3-3-4	--	
			SPT-4	7.5 - 9.0	1.2	4-4-3	--	
			SPT-5	10.0 - 11.5	1.3	7-7-5	--	
			SPT-6	12.5 - 14.0	1.1	4-5-5	--	
378.4	16.0		SPT-7	15.0 - 16.5	1.0	4-5-9	--	
		Gravelly Lean Clay, light brown, moist, stiff	SPT-8	17.5 - 19.0	1.1	2-3-16	--	
			SPT-9	20.0 - 21.5	0.6	4-4-4	--	
371.9	22.5	Gravelly Lean Clay, brown to red-brown and gray-brown, moist to wet, soft to medium stiff	SPT-10	22.5 - 24.0	1.4	2-2-3	--	
			SPT-11	25.0 - 26.5	0.3	1-2-3	--	
			SPT-12	27.5 - 29.0	0.5	3-3-3	--	
			SPT-13	30.0 - 31.5	1.5	WOH-2-3	--	
			SPT-14	32.5 - 34.0	1.5	3-3-4	--	
			SPT-15	35.0 - 36.5	1.4	5-4-6	--	

Project Number	175565299	Location	N36°23'40.91", W87°39'53.24" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-207** Total Depth 84.3 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Gravelly Lean Clay, brown to red-brown and gray-brown, moist to wet, soft to medium stiff *(Continued)*	SPT-16	37.5 - 39.0	0.9	3-6-11	--	
			SPT-17	40.0 - 41.5	0.8	8-11-8	--	
351.9	42.5	Lean Clay, gray-brown, moist to wet, medium stiff	SPT-18	42.5 - 44.0	1.0	3-2-3	--	
			SPT-19	45.0 - 46.5	1.5	3-5-8	--	
			SPT-20	47.5 - 49.0	1.3	7-4-7	--	
			SPT-21	50.0 - 51.5	0.8	6-4-6	--	
			SPT-22	52.5 - 54.0	1.5	3-3-3	--	
			SPT-23	55.0 - 56.5	1.5	2-2-2	--	
336.4	58.0	Sandy Silt, brown to gray, wet, soft to very soft	SPT-24	57.5 - 59.0	1.5	2-1-2	--	
			SPT-25	60.0 - 61.5	1.5	1-3-5	--	
			SPT-26	62.5 - 64.0	1.5	3-3-1	--	
		Gravelly below 66.0	SPT-27	65.0 - 66.5	1.5	WOH-1-WOH	--	
			SPT-28	67.5 - 69.0	1.2	2-WOH-1	--	
			SPT-29	70.0 - 71.5	1.3	8-3-WOH	--	
321.9	72.5	Gravel w/ Sand, gray, wet, loose	SPT-30	72.5 - 74.0	0.8	12-16-12	--	
			SPT-31	75.0 - 76.5	0.7	7-9-13	--	

Project Number	175565299	Location	N36°23'40.91", W87°39'53.24" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-207** Total Depth 84.3 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Gravel w/ Sand, gray, wet, loose *(Continued)*		SPT-32	77.5 - 79.0	0.8	7-10-5	--	
				SPT-33	80.0 - 81.5	0.8	7-11-10	--	
311.9	82.5								
		Shale, gray, weathered		SPT-34	82.5 - 83.2	0.8	41-50+/.2	--	
310.1	84.3			SPT-35	84.0 - 84.3	0.3	50+/.3	--	
		Auger Refusal / Bottom of Hole Top of Rock = 82.5 Elevation (311.9)							

Stantec

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'31.88", W87°39'59.86" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-208** Total Depth 60.0 ft
County	Stewart, TN	Surface Elevation	394.6 ft (NGVD29)
Project Type	Well Installations	Date Started	5/17/16 Completed 5/17/16
Supervisor	D. Pleiman Driller D. Jessie	Depth to Water	30.0 ft Date/Time 5/17/16
Logged By	Jordan Matthews	Depth to Water	35.9 ft Date/Time 7/22/16

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
394.6	0.0	Top of Hole							
		Gravelly Fat Clay, red-brown, moist, soft to medium stiff		SPT-1	0.0 - 1.5	1.1	3-3-4	--	4" diameter well installed
				SPT-2	2.5 - 4.0	1.2	2-1-2	--	
				SPT-3	5.0 - 6.5	1.2	5-8-7	--	
				SPT-4	7.5 - 9.0	0.9	3-4-6	--	
383.6	11.0			SPT-5	10.0 - 11.5	1.3	7-6-7	--	
		Gravelly Lean Clay, brown to light brown, moist, medium stiff to stiff		SPT-6	12.5 - 14.0	1.1	4-5-6	--	
				SPT-7	15.0 - 16.5	0.4	3-4-5	--	
				SPT-8	17.5 - 19.0	1.0	8-8-9	--	
				SPT-9	20.0 - 21.5	0.3	4-4-2	--	
372.1	22.5								
		Gravelly Silt, light brown to brown with gray mottling, moist to wet, soft to medium stiff		SPT-10	22.5 - 24.0	0.1	1-1-1	--	
				SPT-11	25.0 - 26.5	0.2	2-5-6	--	
				SPT-12	27.5 - 29.0	0.6	2-2-2	--	
				SPT-13	30.0 - 31.5	1.4	2-2-3	--	Water @ 30.0' during drilling
				SPT-14	32.5 - 34.0	0.8	2-2-3	--	
				SPT-15	35.0 - 36.5	1.5	2-2-4	--	

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

Project Number	175565299	Location	N36°23'31.88", W87°39'59.86" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-208** Total Depth 60.0 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		Gravelly Silt, light brown to brown with gray mottling, moist to wet, soft to medium stiff *(Continued)*		SPT-16	37.5 - 39.0	1.5	1-1-1	--	
				SPT-17	40.0 - 41.5	1.4	3-3-4	--	
				SPT-18	42.5 - 44.0	1.5	3-4-7	--	
				SPT-19	45.0 - 46.5	0.7	2-3-4	--	
				SPT-20	47.5 - 49.0	1.5	4-6-7	--	
				SPT-21	50.0 - 51.5	1.5	4-6-7	--	
				SPT-22	52.5 - 54.0	1.5	7-7-7	--	
				SPT-23	55.0 - 56.5	1.3	6-8-15	--	
				SPT-24	57.5 - 59.0	0.6	50+	--	
334.6	60.0	Auger Refusal / Bottom of Hole							

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'20.31", W87°40'01.40" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-209** Total Depth 61.4 ft
County	Stewart, TN	Surface Elevation	394.5 ft (NGVD29)
Project Type	Well Installations	Date Started	5/12/16 Completed 5/12/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	16.4 ft Date/Time 5/12/16
Logged By	J. Andrew	Depth to Water	35.3 ft Date/Time 7/22/16

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
394.5	0.0	Top of Hole						
		Fat Clay, red-brown, moist, soft to medium stiff						4" diameter well installed
			SPT-1	2.5 - 4.0	1.5	2-4-4	--	
			SPT-2	5.0 - 6.5	1.5	3-4-7	--	
388.0	6.5	Lean Clay, brown, moist, black mottling, with chert, medium stiff						
			SPT-3	7.5 - 9.0	1.3	5-4-9	--	
			SPT-4	10.0 - 11.5	1.4	4-6-7	--	
382.0	12.5	Silt, brown and gray, moist, with chert gravel, medium stiff to stiff						
			SPT-5	12.5 - 14.0	1.5	3-3-4	--	
			SPT-6	15.0 - 16.5	0.3	4-7-10	--	Water @ 16.4' during drilling
			SPT-7	17.5 - 19.0	0.7	4-9-10	--	
375.5	19.0	Gravelly Silt, gray, wet, medium stiff						
			SPT-8	20.0 - 21.5	0.6	3-4-4	--	
			SPT-9	22.5 - 24.0	1.0	6-7-6	--	
			SPT-10	25.0 - 26.5	0.8	15-7-5	--	
367.5	27.0	Silt, dark brown and gray, moist to wet, soft to medium stiff, with black mottling						
			SPT-11	27.5 - 29.0	1.2	1-WOH-3	--	
			SPT-12	30.0 - 31.5	1.5	4-3-3	--	
			SPT-13	32.5 - 34.0	1.4	3-2-3	--	
			SPT-14	35.0 - 36.5	1.4	3-2-3	--	

Project Number	175565299	Location	N36°23'20.31", W87°40'01.40" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-209** Total Depth 61.4 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Silt, dark brown and gray, moist to wet, soft to medium stiff, with black mottling *(Continued)*	SPT-15	37.5 - 39.0	1.5	5-2-2	--	
			SPT-16	40.0 - 41.5	1.1	7-6-5	--	
			SPT-17	42.5 - 44.0	1.5	4-4-6	--	
			SPT-18	45.0 - 46.5	1.5	5-5-6	--	
			SPT-19	47.5 - 49.0	1.5	6-5-6	--	
			SPT-20	50.0 - 51.5	1.5	3-2-3	--	
340.5	54.0		SPT-21	52.5 - 54.0	1.5	1-4-10	--	
		Silty Sand, brown, wet, with small gravel, very loose to loose	SPT-22	55.0 - 56.5	0.3	WOR	--	WOR = weight of rod
			SPT-23	57.5 - 59.0	1.1	WOR	--	
333.1	61.4		SPT-24	60.0 - 61.0	1.0	WOR	--	
		No Refusal / Bottom of Hole						

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'14.45", W87°39'58.80" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-210** Total Depth 72.0 ft
County	Stewart, TN	Surface Elevation	394.5 ft (NGVD29)
Project Type	Well Installations	Date Started	5/17/16 Completed 5/17/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	Dry Date/Time 5/17/16
Logged By	J. Andrew	Depth to Water	28.6 ft Date/Time 7/22/16

Lithology Elevation	Lithology Depth	Description	Overburden: Sample # / Rock Core: RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
394.5	0.0	Top of Hole						
394.3	0.2	Topsoil						4" diameter well installed
		Fat Clay, red-brown, moist, medium stiff to stiff, w/ chert gravel	SPT-1	2.5 - 4.0	1.2	2-3-4	--	
			SPT-2	5.0 - 6.5	1.0	4-7-9	--	
			SPT-3	7.5 - 9.0	1.5	4-5-7	--	
			SPT-4	10.0 - 11.5	1.5	4-6-9	--	
			SPT-5	12.5 - 14.0	0.9	5-7-10	--	
379.5	15.0	Silt, brown and gray, moist, medium stiff to stiff, w/ chert gravel	SPT-6	15.0 - 16.5	1.3	6-8-9	--	
			SPT-7	17.5 - 19.0	1.0	6-10-11	--	
			SPT-8	20.0 - 21.5	1.4	6-5-16	--	
			SPT-9	22.5 - 24.0	0.8	2-2-2	--	
			SPT-10	25.0 - 26.5	1.0	1-1-2	--	
			SPT-11	27.5 - 29.0	1.1	4-3-3	--	
		30.0 - 35.0: Trace Organics, Coarse Sand and Gravel	SPT-12	30.0 - 31.5	1.5	4-2-1	--	
			SPT-13	32.5 - 34.0	0.9	2-3-3	--	
359.5	35.0	Silt, brown to light brown, moist, soft to medium stiff	SPT-14	35.0 - 36.5	1.2	3-3-7	--	

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'14.45", W87°39'58.80" (NAD83)		
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-210**	Total Depth	72.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Silt, brown to light brown, moist, soft to medium stiff *(Continued)*		SPT-15	37.5 - 39.0	1.5	4-3-5	--	
				SPT-16	40.0 - 41.5	1.5	3-3-5	--	
				SPT-17	42.5 - 44.0	1.5	3-3-6	--	
348.0	46.5			SPT-18	45.0 - 46.5	1.5	5-7-8	--	
		Lean Clay, red-brown to brown and light brown, moist, medium stiff to stiff, with occasional chert gravel		SPT-19	47.5 - 49.0	1.5	6-7-10	--	
				SPT-20	50.0 - 51.5	1.5	7-8-9	--	
				SPT-21	52.5 - 54.0	1.5	3-3-5	--	
				SPT-22	55.0 - 56.5	1.5	4-7-8	--	
				SPT-23	57.5 - 59.0	1.5	3-4-6	--	
333.5	61.0			SPT-24	60.0 - 61.5	1.5	2-4-9	--	
		Silty Sand, brown, wet, loose		SPT-25	62.5 - 64.0	1.5	3-5-8	--	
329.5	65.0								
		Silt, brown and gray, moist, soft		SPT-26	65.0 - 66.5	1.5	3-4-4	--	
				SPT-27	67.5 - 69.0	1.5	2-2-3	--	
322.5	72.0			SPT-28	70.0 - 71.5	1.5	9-14-3	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'08.15", W87°39'50.30" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-211** Total Depth 71.5 ft
County	Stewart, TN	Surface Elevation	395.0 ft (NGVD29)
Project Type	Well Installations	Date Started	5/19/16 Completed 5/19/16
Supervisor	D. Pleiman Driller D. Jessie	Depth to Water	Dry Date/Time 5/19/16
Logged By	J. Matthews	Depth to Water	37.2 ft Date/Time 7/22/16

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
395.0	0.0	Top of Hole							
		Gravelly Fat Clay, red-brown, moist, soft (fill)		SPT-1	0.0 - 1.5	1.0	4-6-4	--	4" diameter well installed
				SPT-2	2.5 - 4.0	0.6	3-3-4	--	
				SPT-3	5.0 - 6.5	1.3	3-3-4	--	
				SPT-4	7.5 - 9.0	0.8	3-4-2	--	
				SPT-5	10.0 - 11.5	0.0	3-3-5	--	
382.5	12.5	Lean Clay with Gravel, red-brown, moist, medium stiff to stiff		SPT-6	12.5 - 14.0	1.3	7-7-8	--	
				SPT-7	15.0 - 16.5	1.4	3-4-9	--	
377.0	18.0	Gravelly Silt, light brown, moist to wet, medium stiff to soft		SPT-8	17.5 - 19.0	1.2	4-5-9	--	
				SPT-9	20.0 - 21.5	0.7	4-7-5	--	
				SPT-10	22.5 - 24.0	1.3	WOH-1-2	--	
				SPT-11	25.0 - 26.5	1.1	5-4-4	--	
				SPT-12	27.5 - 29.0	0.0	1-3-1	--	
				SPT-13	30.0 - 31.5	1.3	2-2-3	--	
				SPT-14	32.5 - 34.0	0.7	1-4-5	--	
				SPT-15	35.0 - 36.5	1.5	3-3-5	--	

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

Project Number	175565299	Location	N36°23'08.15", W87°39'50.30" (NAD83)		
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-211**	Total Depth	71.5 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Gravelly Silt, light brown, moist to wet, medium stiff to soft *(Continued)*		SPT-16	37.5 - 39.0	0.5	WOH-2-2	--	
		40.5 - 42.5: Dense gravelly (chert) zone		SPT-17	40.0 - 41.5	1.2	2-30-16	--	
352.5	42.5								
		Silt, gray, moist, soft to medium stiff, trace gravels		SPT-18	42.5 - 44.0	0.8	4-1-3	--	
				SPT-19	45.0 - 46.5	1.5	1-1-1	--	
				SPT-20	47.5 - 49.0	1.5	3-1-3	--	
				SPT-21	50.0 - 51.5	0.0	6-6-1	--	
				SPT-22	52.5 - 54.0	0.0	2-2-4	--	
		55.5 - 60.5: Becomes gravelly, sandy		SPT-23	55.0 - 56.5	1.3	3-2-3	--	
				SPT-24	57.5 - 59.0	0.4	4-2-6	--	
334.5	60.5								
		Sandy Gravel, gray to light brown, wet, loose		SPT-25	60.0 - 61.5	0.8	6-8-14	--	
				SPT-26	62.5 - 64.0	0.0	9-13-10	--	
				SPT-27	65.0 - 66.5	0.0	7-6-9	--	
				SPT-28	67.5 - 69.0	0.9	7-15-16	--	
323.5	71.5			SPT-29	70.0 - 71.5	1.0	12-16-16	--	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG

Project Number	175565299	Location	N36°22'50.52", W87°39'28.74" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-212** Total Depth 70.0 ft
County	Stewart, TN	Surface Elevation	395.0 ft (NGVD29)
Project Type	Well Installations	Date Started	5/24/16 Completed 5/24/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	18.5 ft Date/Time 5/24/16
Logged By	J. Andrew	Depth to Water	40.1 ft Date/Time 7/22/16

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
395.0	0.0	Top of Hole						
		Lean Clay, red-brown and brown, moist, soft to medium stiff with chert gravel	SPT-1	2.5 - 4.0	0.5	2-3-4	--	4" diameter well installed
			SPT-2	5.0 - 6.5	1.1	4-3-3	--	
			SPT-3	7.5 - 9.0	1.0	3-4-8	--	
385.0	10.0	Silt, gray and brown, moist, soft to medium stiff with chert gravel	SPT-4	10.0 - 11.5	0.9	3-5-5	--	
			SPT-5	12.5 - 14.0	1.0	4-6-10	--	
			SPT-6	15.0 - 16.5	1.1	6-7-8	--	
			SPT-7	17.5 - 19.0	1.0	5-7-16	--	Water @ 18.5' at time of drilling
376.5	18.5	Sand, dark gray, wet, with gravel, loose						
			SPT-8	20.0 - 21.5	1.5	3-10-3	--	
374.0	21.0	Silt, dark gray to brown, moist to wet, with sand, medium stiff to stiff						
			SPT-9	22.5 - 24.0	1.2	6-12-10	--	
			SPT-10	25.0 - 26.5	0.9	1-1-1	--	
			SPT-11	27.5 - 29.0	0.8	4-2-3	--	
			SPT-12	30.0 - 31.5	1.5	4-6-8	--	
			SPT-13	32.5 - 34.0	1.3	4-6-7	--	

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

SUBSURFACE LOG

Project Number	175565299	Location	N36°22'50.52", W87°39'28.74" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-212** Total Depth 70.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Silt, dark gray to brown, moist to wet, with sand, medium stiff to stiff *(Continued)* 35.5 - 36.5: Fat Clay, red-brown, gravelly	SPT-14	35.0 - 36.5	1.5	5-7-7	--	
			SPT-15	37.5 - 39.0	1.5	3-7-10	--	
			SPT-16	40.0 - 41.5	1.5	3-2-3	--	
			SPT-17	42.5 - 44.0	1.5	3-3-4	--	
			SPT-18	45.0 - 46.5	1.5	1-1-3	--	
			SPT-19	47.5 - 49.0	1.5	3-2-2	--	
			SPT-20	50.0 - 51.5	1.5	4-2-2	--	
			SPT-21	52.5 - 54.0	1.5	3-2-3	--	
337.0	58.0	55.0 - 58.0: Dark red mottling, wet, very soft	SPT-22	55.0 - 56.5	1.5	WOH-WOH-WOH	--	
		Sandy Gravel, brown, wet, loose to medium dense, silty zones	SPT-23	57.5 - 59.0	0.4	1-3-7	--	
			SPT-24	60.0 - 61.5	0.9	8-10-11	--	
			SPT-25	62.5 - 64.0	0.8	8-11-12	--	
			SPT-26	65.0 - 66.5	1.3	2-17-23	--	
325.0	70.0		SPT-27	67.5 - 69.0	0.9	WOH-3-2	--	
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

Project Number	175565299	Location	N36°22'50.17", W87°39'06.70" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-213** Total Depth 45.9 ft
County	Stewart, TN	Surface Elevation	395.3 ft (NGVD29)
Project Type	Well Installations	Date Started	5/19/16 Completed 5/19/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	21.0 ft Date/Time 5/19/16
Logged By	J. Andrew	Depth to Water	21.2 ft Date/Time 7/22/16

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
395.3	0.0	Top of Hole							
		Lean Clay, red-brown, moist, with chert fragments, soft to medium stiff		SPT-1	2.5 - 4.0	0.7	4-4-3	--	4" diameter well installed
				SPT-2	5.0 - 6.5	1.0	2-5-8	--	
387.8	7.5	Silt, dark brown and gray, moist, some chert fragments, soft to medium stiff		SPT-3	7.5 - 9.0	1.2	4-6-8	--	
				SPT-4	10.0 - 11.5	1.2	5-5-7	--	
				SPT-5	12.5 - 14.0	1.3	4-4-4	--	
				SPT-6	15.0 - 16.5	1.4	3-4-7	--	
				SPT-7	17.5 - 19.0	1.1	3-3-6	--	
		20.0 - 21.0: Lean Clay, red-brown Becomes wet below 21.0'		SPT-8	20.0 - 21.5	1.2	3-4-4	--	Water @ 21.0' during drilling
				SPT-9	22.5 - 24.0	1.5	WOH-1-1	--	
370.3	25.0	Silty Sand, dark gray and black, moist, medium dense		SPT-10	25.0 - 26.5	1.5	20-9-14	--	
				SPT-11	27.5 - 29.0	1.3	12-16-3	--	
365.3	30.0	Silt, dark gray, wet, soft to medium stiff, trace gravels		SPT-12	30.0 - 31.5	1.5	2-2-2	--	
				SPT-13	32.5 - 34.0	1.5	1-1-1	--	
		35.0 - 36.0: Lean Clay, red-brown		SPT-14	35.0 - 36.5	0.8	1-3-12	--	

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

Project Number	175565299	Location	N36°22'50.17", W87°39'06.70" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-213** Total Depth 45.9 ft

Lithology: Elevation	Lithology: Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		Silt, dark gray, wet, soft to medium stiff, trace gravels *(Continued)*		SPT-15	37.5 - 39.0	0.5	4-4-5	--	
		Limestone fragments increasing below 40.0'		SPT-16	40.0 - 41.5	1.5	5-6-7	--	
				SPT-17	42.5 - 44.0	1.3	20-11-17	--	
349.4	45.9			SPT-18	45.0 - 45.5	0.2	WOH-50+/.4	--	
		Auger Refusal / Bottom of Hole							

SUBSURFACE LOG

Project Number	175565299	Location	N36°22'50.09", W87°39'06.79" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	CUF-214
		Total Depth	77.0 ft
County	Stewart, TN	Surface Elevation	395.3 ft (NGVD29)
Project Type	Well Installations	Date Started	6/1/16
		Completed	6/1/16
Supervisor	D. Pleiman	Depth to Water	Dry
Driller	T. Taylor	Date/Time	6/1/16
Logged By	B. Evans	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
395.3	0.0	Top of Hole							
		Fat Clay, red-brown, stiff, damp to moist with chert fragments							9" Sonic No well installed Backfilled with bentonite grout
390.3	5.0	Lean Clay, brown to red-brown, damp to moist, medium stiff, with gravel (chert)			10.0			10.0	
		20.0-23.0: Becoming saturated and gravelly			10.0			20.0	
370.3	25.0	Silt, gray-green, wet, soft 26.5-27.0: Zone of cemented bottom ash 28.0-28.5: Zone of cemented material 29.5-30.0: Fine bottom ash lense			10.0	10.0	100	30.0	
365.3	30.0	Fly ash							

![Stantec]

SUBSURFACE LOG

Project Number	175565299	Location	N36°22'50.09", W87°39'06.79" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-214** Total Depth 77.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
354.8	40.5	36.0-36.4: Boulder Fly ash *(Continued)*			10.0	10.0	100	40.0	
350.3	45.0	Fat Clay, gray and brown mottled, stiff, moist, manganese staining, trace chert gravel			5.0	5.0	100	45.0	
		Dolomite, light gray to light tan, thin to thick bedded, very finely crystalline grained, hard 45.0-49.0: Very broken along thin bedding planes			5.0	5.0	100	50.0	Note: Water used to advance sonic casing in bedrock
		Becoming gray, hard, very fine grained 52.0: Mechanical break 53.0-54.0: Mechanical break 54.5: Mechanical break 56.0-56.5: Mechanical vertical fractures 57.5-58.5: Vertical fractures and mechanical breaks			10.0	10.0	100	60.0	
		61.5-63.0: Broken from drilling 65.0-65.5: Mechanical breaks 67.0-69.0: Mechanical breaks			10.0	7.5	75	70.0	
318.3	77.0	71.5: Mechanical break 72.5: Mechanical break 73.0-74.0: Fractured 74.5-77.0: Very broken along thin bedding from drilling			7.0	7.0	100	77.0	

Project Number	175565299	Location	N36°22'50.09", W87°39'06.79" (NAD83)		
Project Name	TVA - CUF Well Installations	Boring No.	CUF-214	Total Depth	77.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Bottom of Hole Top of Rock = 45.0 Elevation (350.3)							

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

APPENDIX D
WELL DEVELOPMENT LOGS

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Well Development Form

General Information TVA CUF GWMW Installations 175565299 93-1 P. 1

Date: 06/07/2016
Well ID: 93-1
Facility: TVA-CUF
Well Depth: 62.06 ft TOR
Developed By: Caudill
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Matthews
Well Condition: Fair

Initial Measurements (Before Development)

Time: 3:08 p.m.
Depth to Water: 35.13 ft TOR
Development/Collection Method: Bailed
Temp (°F): 68.4
Turbidity (NTU): 597
Specific Conductance (mS/cm): 2.80
pH: 7.25
Visual/Odor Observations: Muddy; Opaque; No odor

During Development Surged, pumped, and allowed to re-charge

Time: 5:20 p.m.
Depth to Water: 43.60 ft TOR
Development/Collection Method: Pump
Temp (°F): 70.1
Turbidity (NTU): 934
Specific Conductance (mS/cm): 2.47
pH: 6.95
Visual/Odor Observations: Opaque; No Odor

During Development

6/6/2016 Time: 9:24 a.m.
Depth to Water: 35.1 ft TOR
Development/Collection Method: Pump
Temp (°F): 72.3
Turbidity (NTU): 245
Specific Conductance (mS/cm): 2.43
pH: 6.48
Visual/Odor Observations: Opaque; No Odor

Stantec

Well Development Form

During Development 93-1 P. 2

Time: 11:55 a.m.
Depth to Water: 34.9 ft TOR
Development/Collection Method: Pump
Temp (°F): 72.8
Turbidity (NTU): 262
Specific Conductance (mS/cm): 2.52
pH: 6.32
Visual/Odor Observations: Opaque; No Odor

During Development

Time: 1:25 p.m.
Depth to Water: 46.33 ft TOR
Development/Collection Method: Pump
Temp (°F): 72.4
Turbidity (NTU): 34.2
Specific Conductance (mS/cm): 2.35
pH: 6.30
Visual/Odor Observations: Cloudy; No Odor

During Development

Time: 2:50 p.m.
Depth to Water: 46.25 ft TOR
Development/Collection Method: Pump
Temp (°F): 73.0
Turbidity (NTU): 82.5
Specific Conductance (mS/cm):
pH: 6.26
Visual/Odor Observations: Very Cloudy; No Odor

During Development

Time: 5:25 p.m.
Depth to Water: 46.30 ft TOR
Development/Collection Method: Pump
Temp (°F): 72.1
Turbidity (NTU): 21.4
Specific Conductance (mS/cm): 2.07
pH: 6.32
Visual/Odor Observations: Clear; No Odor

Stantec

Well Development Form

During Development 93-1 P. 3

6/9/16 Time: 8:47 a.m. Depth to Water: 36.10 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.3

Turbidity (NTU): 20.1

Specific Conductance (mS/cm): 2.07

pH: 6.48

Visual/Odor Observations: Clear; No Odor

During Development

Time: 10:05 a.m. Depth to Water: 47.10 ft TOR

Development/Collection Method: Pump

Temp (°F): 72.4

Turbidity (NTU): 12.95

Specific Conductance (µS/cm): 1892

pH: 6.36

Visual/Odor Observations: Clear; No Odor

Final Measurements

Time: 10:33 a.m. Depth to Water: 46.50 ft TOR

Development/Collection Method: Pump

Temp (°F): 70.4

Turbidity (NTU): 4.95

Specific Conductance (µS/cm): 1798

pH: 6.40

Visual/Odor Observations: Clear; No Odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 93-2R P. 1

Date: 06/08/2016
Well ID: 93-2R
Facility: TVA-CUF
Well Depth: 72.85 ft TOR
Developed By: Jessie
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Andrew
Well Condition: Good

Initial Measurements (Before Development)

Time: 9:15 a.m.
Depth to Water: 38.52 ft TOR
Development/Collection Method: Pumped
Temp (°F): 68.4
Turbidity (NTU): 238
Specific Conductance (mS/cm): 3.80
pH: 6.63
Visual/Odor Observations: Opaque; No odor

During Development Bailed, pumped, and surged

Time: 9:45 a.m.
Depth to Water: 39.0 ft TOR
Development/Collection Method: Pump
Temp (°F): 71.9
Turbidity (NTU): 31.9
Specific Conductance (mS/cm): 3.96
pH: 6.19
Visual/Odor Observations: Cloudy; No odor

During Development

Time: 10:15 a.m.
Depth to Water: 39.0 ft TOR
Development/Collection Method: Pump
Temp (°F): 73.0
Turbidity (NTU): 20.9
Specific Conductance (mS/cm): 4.05
pH: 6.45
Visual/Odor Observations: Translucent; No odor

Stantec

Well Development Form

During Development

93-2R P. 2

Time: 10:45 a.m.

Depth to Water: 39.0 ft TOR

Development/Collection Method: Pump

Temp (°F): 73.9

Turbidity (NTU): 19.07

Specific Conductance (mS/cm): 3.66

pH: 6.27

Visual/Odor Observations: Clear; No odor

Final Measurements

Time: 11:00 a.m.

Depth to Water: 39.0 ft TOR

Development/Collection Method: Pump

Temp (°F): 66.6

Turbidity (NTU): 14.92

Specific Conductance (mS/cm): 3.80

pH: 6.14

Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 93-3 P. 1

Date: 06/01/2016
Well ID: 93-3
Facility: TVA-CUF
Well Depth: 45.0 ft TOR
Developed By: Thompson
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Andrew
Well Condition: Fair

Initial Measurements (Before Development)

Time: 8:00 a.m.
Depth to Water: 28.90 ft TOR
Development/Collection Method: Pumped
Temp (°F): 68.3
Turbidity (NTU): 91.8
Specific Conductance (µS/cm): 1292
pH: 6.97
Visual/Odor Observations: Cloudy; No odor

During Development Surged

Time: 8:35 a.m.
Depth to Water: 32.35 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.3
Turbidity (NTU): 442
Specific Conductance (µS/cm): 1286
pH: 6.66
Visual/Odor Observations: Opaque; No Odor

During Development

Time: 9:05 a.m.
Depth to Water: 48.89 ft TOR
Development/Collection Method: Pump
Temp (°F): 63.7
Turbidity (NTU): 163
Specific Conductance (µS/cm): 1285
pH: 6.46
Visual/Odor Observations: Cloudy; No odor

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Well Development Form

During Development 93-3 P. 2

Time: 3:15 p.m.
Depth to Water: 28.92 ft TOR
Development/Collection Method: Pump
Temp (°F): 65.2
Turbidity (NTU): 108
Specific Conductance (µS/cm): 1308
pH: 6.97
Visual/Odor Observations: Cloudy; No odor

During Development Bottom of well re-measured on 6/2/2016; Well depth 55.12 ft (top)

06/02/2016 Time: 7:30 a.m.
Depth to Water: 29.33 ft TOR
Development/Collection Method: Pump
Temp (°F): 63.6
Turbidity (NTU): 47.9
Specific Conductance (µS/cm): 1287
pH: 6.82
Visual/Odor Observations: Cloudy; No odor

During Development

Time: 11:20 a.m.
Depth to Water: 48.09 ft TOR
Development/Collection Method: Pump
Temp (°F): 64.8
Turbidity (NTU): 67.8
Specific Conductance (µS/cm): 1298
pH: 6.91
Visual/Odor Observations: Cloudy; No odor

During Development

Time: 3:30 p.m.
Depth to Water: 32.57 ft TOR
Development/Collection Method: Pump
Temp (°F): 65.6
Turbidity (NTU): 29.6
Specific Conductance (µS/cm): 1249
pH: 7.17
Visual/Odor Observations: Cloudy; No odor

Well Development Form

During Development 93-3 P. 3

06/02/2016 Time: 7:50 a.m. Depth to Water: 31.54 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.4

Turbidity (NTU): 1.55

Specific Conductance (µS/cm): 1247

pH: 7.18

Visual/Odor Observations: Clear; No odor

Final Measurements

Time: 9:40 a.m. Depth to Water: 36.27 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.6

Turbidity (NTU): 4.63

Specific Conductance (µS/cm): 1217

pH: 7.23

Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 93-4 P. 1

Date: 05/27/2016
Well ID: 93-4
Facility: TVA-CUF
Well Depth: 36.43 ft TOR
Developed By: Thompson
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Andrew
Well Condition: Good

Initial Measurements (Before Development)

Time: 9:35 a.m.
Depth to Water: 23.98 ft TOR
Development/Collection Method: Pumped
Temp (°F): 68.7
Turbidity (NTU): 176
Specific Conductance (mS/cm): 3.38
pH: 6.33
Visual/Odor Observations: Opaque; No odor

During Development Surged, Allowed to Re-charge

Time: 9:55 a.m.
Depth to Water: 28.25 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.9
Turbidity (NTU): 942
Specific Conductance (mS/cm): 3.40
pH: 6.69
Visual/Odor Observations: Opaque; No Odor

During Development

Time: 10:15 a.m.
Depth to Water: 26.55 ft TOR
Development/Collection Method: Pump
Temp (°F): 70.2
Turbidity (NTU): 989
Specific Conductance (mS/cm): 3.46
pH: 6.49
Visual/Odor Observations: Opaque; No Odor

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Well Development Form

During Development

93-4 P. 2

Time: 11:25 a.m.

Depth to Water: 24.55 ft TOR

Development/Collection Method: Pump

Temp (°F): 77.1

Turbidity (NTU): 948

Specific Conductance (mS/cm): 3.48

pH: 6.62

Visual/Odor Observations: Opaque; No Odor

During Development

Time: 11:57 a.m.

Depth to Water: 28.01 ft TOR

Development/Collection Method: Pump

Temp (°F): 82.3

Turbidity (NTU): 215

Specific Conductance (mS/cm): 3.47

pH: 6.31

Visual/Odor Observations: Cloudy; No odor

During Development

Time: 12:32 p.m.

Depth to Water: 24.15 ft TOR

Development/Collection Method: Pump

Temp (°F): 80.1

Turbidity (NTU): 169

Specific Conductance (mS/cm): 3.29

pH: 6.47

Visual/Odor Observations: Cloudy; No odor

During Development

06/01/2016 Time: 9:45 a.m.

Depth to Water: 27.30 ft TOR

Development/Collection Method: Pump

Temp (°F): 69.6

Turbidity (NTU): 538

Specific Conductance (mS/cm): 3.41

pH: 6.66

Visual/Odor Observations: Cloudy; No odor

Stantec

Well Development Form

During Development 93-4 P. 3

Time: 12:32 p.m.
Depth to Water: 26.66 ft TOR
Development/Collection Method: Pump
Temp (°F): 72.5
Turbidity (NTU): 128
Specific Conductance (mS/cm): 3.41
pH: 6.32
Visual/Odor Observations: Cloudy; No odor

During Development

Time: 1:55 P.M.
Depth to Water: 26.71 ft TOR
Development/Collection Method: Pump
Temp (°F): 71.3
Turbidity (NTU): 59.7
Specific Conductance (mS/cm): 3.44
pH: 6.38
Visual/Odor Observations:

During Development

06/02/2016 Time: 2:15 p.m.
Depth to Water: 25.63 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.4
Turbidity (NTU): 90.0
Specific Conductance (mS/cm): 3.17
pH: 6.28
Visual/Odor Observations: Cloudy; No odor

During Development

Time: 5:15 p.m.
Depth to Water: 26.43 ft TOR
Development/Collection Method: Pump
Temp (°F): 71.5
Turbidity (NTU): 66.5
Specific Conductance (mS/cm): 3.16
pH: 6.40
Visual/Odor Observations: Cloudy; No odor

Stantec

Well Development Form

During Development 93-4 P. 4

06/03/2016 Time: 9:05 a.m. Depth to Water: 25.8 ft TOR

Development/Collection Method: Pump

Temp (°F): 67.6

Turbidity (NTU): 627

Specific Conductance (mS/cm): 3.09

pH: 6.54

Visual/Odor Observations: Opaque; No odor

During Development

Time: 9:35 a.m. Depth to Water: 32.30 ft TOR

Development/Collection Method: Pump

Temp (°F): 67.5

Turbidity (NTU): 81.6

Specific Conductance (mS/cm): 3.12

pH: 6.65

Visual/Odor Observations: Cloudy; No Odor

During Development

Time: 12:25 p.m. Depth to Water: 26.04 ft TOR

Development/Collection Method: Pump

Temp (°F): 67.0

Turbidity (NTU): 114

Specific Conductance (mS/cm): 3.08

pH: 6.34

Visual/Odor Observations: Cloudy; No odor

During Development Surged, pumped, and allowed to recharge

06/06/2016 Time: 2:20 p.m. Depth to Water: 25.59 ft TOR

Development/Collection Method: pump

Temp (°F): 68.9

Turbidity (NTU): 808

Specific Conductance (mS/cm): 3.15

pH: 6.59

Visual/Odor Observations: Opaque; No odor

Stantec

Well Development Form

During Development

93-4 P. 5

Time: 4:35 p.m.

Depth to Water: 25.59 ft TOR

Development/Collection Method: Pump

Temp (°F): 67.2

Turbidity (NTU): 549

Specific Conductance (mS/cm): 3.06

pH: 6.45

Visual/Odor Observations: Very Cloudy; No odor

During Development

Time: 5:10 p.m.

Depth to Water: 26.38 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.1

Turbidity (NTU): 224

Specific Conductance (mS/cm): 3.05

pH: 6.93

Visual/Odor Observations: Cloudy; No Odor

During Development

06/07/2016

Time: 7:50 a.m.

Depth to Water: 25.42 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.2

Turbidity (NTU): 527

Specific Conductance (mS/cm): 2.82

pH: 6.53

Visual/Odor Observations: Opaque; No odor

During Development

Time: 10:15 a.m.

Depth to Water: 25.70 ft TOR

Development/Collection Method: Pump

Temp (°F): 66.9

Turbidity (NTU): 139

Specific Conductance (mS/cm): 2.87

pH: 6.69

Visual/Odor Observations: Cloudy; No Odor

Stantec

Well Development Form

During Development 93-4 P. 6

Time: 10:00 a.m.
Depth to Water: 25.70 ft TOR
Development/Collection Method: Pump
Temp (°F): 71.80
Turbidity (NTU): 235
Specific Conductance (mS/cm): 2.81
pH: 6.46
Visual/Odor Observations: Opaque; No odor

During Development

Time: 11:38 a.m.
Depth to Water: 25.8 ft TOR
Development/Collection Method: Pump
Temp (°F): 71.1
Turbidity (NTU): 278
Specific Conductance (mS/cm): 2.98
pH: 6.46
Visual/Odor Observations: Opaque; No odor

During Development

6/9/2016
Time: 9:00 a.m.
Depth to Water: 23.4 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.3
Turbidity (NTU): 84.7
Specific Conductance (mS/cm): 2.07
pH: 6.57
Visual/Odor Observations: Cloudy; No Odor

During Development

Time: 11:01 a.m.
Depth to Water: 26.1 ft TOR
Development/Collection Method: Pump
Temp (°F): 71.2
Turbidity (NTU): 112
Specific Conductance (mS/cm): 2. 80
pH: 7.11
Visual/Odor Observations: Very Cloudy; No Odor

Stantec

Well Development Form

During Development 93-4 P. 7

6/10/2016 Time: 7:20 a.m. Depth to Water: 25.54 ft TOR

Development/Collection Method: Pump

Temp (°F): 66.4

Turbidity (NTU): 327

Specific Conductance (mS/cm): 2.83

pH: 7.08

Visual/Odor Observations: Cloudy; Opaque; No odor

During Development

Time: 9:40 a.m. Depth to Water: 26.30 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.2

Turbidity (NTU): 166

Specific Conductance (mS/cm): 2.76

pH: 7.21

Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development

Time: 12:03 p.m. Depth to Water: 26.3 ft TOR

Development/Collection Method: Bail

Temp (°F): 71.4

Turbidity (NTU): 116

Specific Conductance (mS/cm): 2.90

pH: 6.96

Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development

Time: 1:25 p.m. Depth to Water: 26.95 ft TOR

Development/Collection Method: Bail

Temp (°F): 69.3

Turbidity (NTU): 108

Specific Conductance (mS/cm): 3.03

pH: 6.98

Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

Stantec

Well Development Form

During Development 93-4 P. 8

Time: 3:30 p.m. Depth to Water: 26.25 ft TOR

Development/Collection Method: Bail Temp (°F): 70.1

Turbidity (NTU): 94 Specific Conductance (mS/cm): 3.10

pH: 6.99 Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development Well allowed to re-charge

6/13/2016 Time: 2:50 p.m. Depth to Water: 26.42 ft TOR

Development/Collection Method: Bail Temp (°F): 70.6

Turbidity (NTU): 17.64 Specific Conductance (mµS/cm): 3.01

pH: 7.01 Visual/Odor Observations: Clear; No Odor

During Development Well bailed nearly dry; Allowed to re-charge

Time: 4:15 p.m. Depth to Water: 27.23 ft TOR

Development/Collection Method: Bail Temp (°F): 77.7

Turbidity (NTU): 87.4 Specific Conductance (mS/cm): 2.93

pH: 7.03 Visual/Odor Observations: Cloudy; Sl. Translucent; No Odor

During Development Well surged and pumped dry after readings collected; Allowed to re-charge

6/14/2016 Time: 7:30 a.m. Depth to Water: 27.45 ft TOR

Development/Collection Method: Surge and Pump Temp (°F): 77.1

Turbidity (NTU): 257 Specific Conductance (µS/cm): 1943

pH: 6.56 Visual/Odor Observations: Cloudy

Stantec

Well Development Form

During Development Low flow purge at 120 mL/min 93-4 P. 9

Time: 10:10 a.m.
Depth to Water: 26.62 ft TOR
Development/Collection Method: Pump
Temp (°F): 81.7
Turbidity (NTU): 149
Specific Conductance (mS/cm): 2.09
pH: 6.53
Visual/Odor Observations: Sl. Cloudy

During Development Low flow purge at100-120 mL/min

Time: 10:20 a.m.
Depth to Water: 28.00 ft TOR
Development/Collection Method: Pump
Temp (°F): 82.2
Turbidity (NTU): 111
Specific Conductance (mS/cm): 2.08
pH: 6.51
Visual/Odor Observations: Sl. Cloudy

During Development Low flow purge at100-120 mL/min

Time: 10:30 a.m.
Depth to Water: 27.14 ft TOR
Development/Collection Method: Pump
Temp (°F): 83.2
Turbidity (NTU): 90
Specific Conductance (mS/cm): 2.04
pH: 6.48
Visual/Odor Observations: Sl. Cloudy

During Development Low flow purge at100-120 mL/min

Time: 12:00 p.m.
Depth to Water: 28.83 ft TOR
Development/Collection Method: Pump
Temp (°F): 79.6
Turbidity (NTU): 95.1
Specific Conductance (mS/cm): 2.04
pH: 6.46
Visual/Odor Observations: Sl. Cloudy

Stantec

Well Development Form

During Development Purge at100-120 mL/min 93-4 P. 10

Time: 12:15 p.m.
Depth to Water: 28.95 ft TOR
Development/Collection Method: Pump
Temp (°F): 79.6
Turbidity (NTU): 96.8
Specific Conductance (mS/cm): 2.03
pH: 6.39
Visual/Odor Observations: Sl. Cloudy

During Development Purge at100-120 mL/min

Time: 12:30 p.m.
Depth to Water: 29.03 ft TOR
Development/Collection Method: Pump
Temp (°F): 79.4
Turbidity (NTU): 98.3
Specific Conductance (mS/cm): 2.14
pH: 6.39
Visual/Odor Observations: Sl. Cloudy

During Development Low flow purge at100-120 mL/min

Time: 12:45 p.m.
Depth to Water: 29.19 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.0
Turbidity (NTU): 107
Specific Conductance (mS/cm): 2.24
pH: 6.40
Visual/Odor Observations: Sl. Cloudy

During Development Low flow purge at100-120 mL/min

Time: 1:00 p.m.
Depth to Water: 29.31 ft TOR
Development/Collection Method: Pump
Temp (°F): 77.8
Turbidity (NTU): 72.6
Specific Conductance (mS/cm): 2.21
pH: 6.41
Visual/Odor Observations: Very Sl. Cloudy

Stantec

Well Development Form

During Development Low flow purge at100-120 mL/min 93-4 P. 11

Time: 1:10 p.m.
Depth to Water: 29.35 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.1
Turbidity (NTU): 34.4
Specific Conductance (mS/cm): 2.23
pH: 6.41
Visual/Odor Observations: Sl. Cloudy

During Development Low flow purge at100-120 mL/min

Time: 1:15 p.m.
Depth to Water: 29. 39 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.2
Turbidity (NTU): 49.9
Specific Conductance (mS/cm): 2.20
pH: 6.40
Visual/Odor Observations: Very Sl. Cloudy

During Development Low flow purge at100-120 mL/min

Time: 1:20 p.m.
Depth to Water: 29.44 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.3
Turbidity (NTU): 40.4
Specific Conductance (mS/cm): 2.23
pH: 6.41
Visual/Odor Observations: Clear

During Development Low flow purge at100-120 mL/min

Time: 1:25 p.m.
Depth to Water: 29.50 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.2
Turbidity (NTU): 39.5
Specific Conductance (mS/cm): 2.23
pH: 6.40
Visual/Odor Observations: Clear

Stantec

Well Development Form

During Development Low flow purge at100-120 mL/min 93-4 P. 12

Time: 1:30 p.m. Depth to Water: 29.56 ft TOR

Development/Collection Method: Pump Temp (°F): 78.2

Turbidity (NTU): 41.7 Specific Conductance (mS/cm): 2.22

pH: 6.40 Visual/Odor Observations: Clear

During Development

Time: 1:35 p.m. Depth to Water: 29. 60 ft TOR

Development/Collection Method: Pump Temp (°F): 78.3

Turbidity (NTU): 39.2 Specific Conductance (mS/cm): 2.23

pH: 6.40 Visual/Odor Observations: Clear

During Development Low flow purge at100-120 mL/min

Time: 1:40 p.m. Depth to Water: 29.59 ft TOR

Development/Collection Method: Pump Temp (°F): 78.3

Turbidity (NTU): 28.6 Specific Conductance (mS/cm): 2.22

pH: 6.41 Visual/Odor Observations: Clear

During Development Low flow purge at100-120 mL/min

Time: 1:45 p.m. Depth to Water: 29.64 ft TOR

Development/Collection Method: Pump Temp (°F): 78.2

Turbidity (NTU): 25 Specific Conductance (mS/cm): 2.22

pH: 6.41 Visual/Odor Observations: Clear

Stantec

Well Development Form

During Development Low   93-4 P. 13

Time: 1:50 p.m.
Depth to Water: 29.69 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.2
Turbidity (NTU): 26.8
Specific Conductance (mS/cm): 2.22
pH: 6.41
Visual/Odor Observations: Clear

Final Measurements Low flow purge at100-120 mL/min

Time: 1:55 p.m.
Depth to Water: 29.75 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.3
Turbidity (NTU): 25.45
Specific Conductance (mS/cm): 2.23
pH: 6.41
Visual/Odor Observations: Clear

Failed to reach target turbidity of 5 NTUs; refer to RFI 609389-014.

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 96-9 P. 1

Date: 06/14/2016

Well ID: 96-9

Facility: TVA-CUF

Well Depth: 31.35 ft TOR

Developed By: Stantec

Water Quality Meter: Oakton T-100/PCSTestr 35

Oversight Oversight By: Stantec

Well Condition: OK

Initial Measurements (Before Development)

Time: 9:20 a.m.

Depth to Water: 18.08 ft TOR

Development/Collection Method: Surge and Pump

Temp (°F): 71.9

Turbidity (NTU): > 1000

Specific Conductance (µS/cm): 1977

pH: 6.37

Visual/Odor Observations: Dark Black

During Development Well surged and pumped dry

Time: 9:50 a.m.

Depth to Water: 28.05 ft TOR

Development/Collection Method: Pump and Surge

Temp (°F): 70.9

Turbidity (NTU): > 1000

Specific Conductance (µS/cm): 1456

pH: 6.56

Visual/Odor Observations: Dark Black

During Development Well pumped dry

Time: 1:00 p.m.

Depth to Water: 28.10 ft TOR

Development/Collection Method: Pump

Temp (°F): N/A

Turbidity (NTU): 386

Specific Conductance (mS/cm): 2.45

pH: 6.31

Visual/Odor Observations: Cloudy; Gray

Stantec

Well Development Form

During Development Pump at 400 mL/min

96-9 P. 2

6/16/2016

Time: 11:37 a.m.

Depth to Water: 21.95 ft TOR

Development/Collection Method: Pump

Temp (°F): 75.2

Turbidity (NTU): 210

Specific Conductance (mS/cm): 2.75

pH: 6.33

Visual/Odor Observations: Sl. Cloudy

During Development Pump at 300 mL/min

Time: 11:42 a.m.

Depth to Water: 24.94 ft TOR

Development/Collection Method: Pump

Temp (°F): 70.2

Turbidity (NTU): 76.4

Specific Conductance (mS/cm): 2.51

pH: 6.36

Visual/Odor Observations: Sl. Cloudy

During Development Pump at 300 mL/min

Time: 11:47 a.m.

Depth to Water: 26.14 ft TOR

Development/Collection Method: Pump

Temp (°F): 70.1

Turbidity (NTU): 85.4

Specific Conductance (mS/cm): 2.36

pH: 6.28

Visual/Odor Observations:

Final Measurements Pump at 300 mL/min

Time: 11:52 a.m.

Depth to Water: 27.15 ft TOR

Development/Collection Method: Pump

Temp (°F): 70.6

Turbidity (NTU): 80

Specific Conductance (mS/cm): 2.31

pH: 6.32

Visual/Odor Observations: Sl. Cloudy

Stantec

Well Development Form

During Development Pump at 200 mL/min 96-9 P. 3

Time: 11:57 a.m.
Depth to Water: 28.10 ft TOR
Development/Collection Method: Pump
Temp (°F): 71.4
Turbidity (NTU): 73.8
Specific Conductance (mS/cm): 2.30
pH: 6.25
Visual/Odor Observations: Sl. Cloudy

During Development Pump at 140 mL/min

Time: 12:02 p.m.
Depth to Water: 28.73 ft TOR
Development/Collection Method: Pump
Temp (°F): 72.3
Turbidity (NTU): 66.3
Specific Conductance (mS/cm): 2.28
pH: 6.26
Visual/Odor Observations: Sl. Cloudy

During Development Pump at 150 mL/min

Time: 12:07 p.m.
Depth to Water: 29.37 ft TOR
Development/Collection Method: Pump
Temp (°F): 72.6
Turbidity (NTU): 59.7
Specific Conductance (mS/cm): 2.29
pH: 6.26
Visual/Odor Observations: Sl. Cloudy

Final Measurements Pump at 150 mL/min; Well pumped dry

Time: 12:12 p.m.
Depth to Water: 30.12 ft TOR
Development/Collection Method: Pump
Temp (°F): 73.3
Turbidity (NTU): 52.3
Specific Conductance (mS/cm): 2.26
pH: 6.26
Visual/Odor Observations: Sl. Cloudy

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-101 P. 1

Date: 06/14/2016	Well ID: CUF-101
Facility: TVA-CUF	Well Depth: 17.61 ft TOR
Developed By: Thompson	Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight Oversight By: Matthews	Well Condition: Fair

Initial Measurements (Before Development)

Time: 4:38 p.m.	Depth to Water: 2.15 ft TOR
Development/Collection Method: Compressed Nitrogen	Temp (°F): 82.9
Turbidity (NTU): 794	Specific Conductance (µS/cm): 374
pH: 8.27	Visual/Odor Observations: Muddy; Opaque; No Odor

During Development Well flushed with potable water (20 gal); Cleaned with compressed nitrogen

Time: 5:14 p.m.	Depth to Water: Surface ft TOR
Development/Collection Method: Compressed Nitrogen	Temp (°F): 82.4
Turbidity (NTU): 460	Specific Conductance (µS/cm): 322
pH: 8.44	Visual/Odor Observations: Muddy; Opaque; No Odor

During Development

Time: 5:30 p.m.	Depth to Water: Surface ft TOR
Development/Collection Method: Compressed Nitrogen	Temp (°F): 82.4
Turbidity (NTU): 110	Specific Conductance (µS/cm): 305
pH: 8.39	Visual/Odor Observations: Sl. Cloudy; Translucent; No Odor

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Well Development Form

During Development CUF-101 P. 2

6/15/2016 Time: 8:50 a.m. Depth to Water: Surface ft TOR

Development/Collection Method: Compressed Nitrogen

Temp (°F): 76.8

Turbidity (NTU): 60.8

Specific Conductance (µS/cm): 302

pH: 8.45

Visual/Odor Observations: Sl. Cloudy; Translucent; No Odor

During Development

Time: 8:59 a.m. Depth to Water: Surface ft TOR

Development/Collection Method: Compressed Nitrogen

Temp (°F): 78.2

Turbidity (NTU): 43.2

Specific Conductance (µS/cm): 302

pH: 8.42

Visual/Odor Observations: Clear; No Odor

Final Measurements

Time: 9:08 a.m. Depth to Water: Surface ft TOR

Development/Collection Method: Compressed Nitrogen

Temp (°F): 78.2

Turbidity (NTU): 38.6

Specific Conductance (µS/cm): 296

pH: 8.39

Visual/Odor Observations: Clear; No Odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 B-103 P. 1

Date: 06/02/2016
Well ID: B-103
Facility: TVA-CUF
Well Depth: 80.21 ft TOR
Developed By: Thompson
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Andrew
Well Condition: Good

Initial Measurements (Before Development)

Time: 11:45 a.m.
Depth to Water: 27.16 ft TOR
Development/Collection Method: Pumped
Temp (°F): 64.9
Turbidity (NTU): 177
Specific Conductance (mS/cm): 2.28
pH: 6.65
Visual/Odor Observations: Cloudy; No odor

During Development Surged; Pumped and allowed to re-charge

Time: 1:00 p.m.
Depth to Water: 27.55 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.7
Turbidity (NTU): 765
Specific Conductance (mS/cm): 2.34
pH: 6.47
Visual/Odor Observations: Opaque; No Odor

During Development

Time: 3:20 p.m.
Depth to Water: 57.90 ft TOR
Development/Collection Method: Pump
Temp (°F): 65.8
Turbidity (NTU): 467
Specific Conductance (mS/cm): 2.27
pH: 6.43
Visual/Odor Observations: Opaque; No Odor

Stantec

Well Development Form

During Development

B-103 P. 2

Time: 4:30 p.m.

Depth to Water: 32.05 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.6

Turbidity (NTU): 65.0

Specific Conductance (mS/cm): 2.42

pH: 6.54

Visual/Odor Observations: Cloudy; No odor

During Development

Time: 5:40 p.m.

Depth to Water: 34.45 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.4

Turbidity (NTU): 58.1

Specific Conductance (mS/cm): 2.34

pH: 6.56

Visual/Odor Observations: Cloudy; No odor

During Development

06/09/2016

Time: 9:45 a.m.

Depth to Water: 29.35 ft TOR

Development/Collection Method: Pump

Temp (°F): 64.5

Turbidity (NTU): 186

Specific Conductance (mS/cm): 2.46

pH: 6.68

Visual/Odor Observations: Opaque; No Odor

During Development

Time: 10:05 a.m.

Depth to Water: 44.26 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.2

Turbidity (NTU): 138

Specific Conductance (mS/cm): 2.27

pH: 6.72

Visual/Odor Observations: Cloudy; No odor

Well Development Form

During Development

B-103 P. 3

Time: 10:35 a.m.

Depth to Water: 49.02 ft TOR

Development/Collection Method: Pump

Temp (°F): 64.4

Turbidity (NTU): 28.6

Specific Conductance (mS/cm): 2.21

pH: 6.65

Visual/Odor Observations: Cloudy; No odor

During Development

06/09/2016

Time: 4:50 p.m.

Depth to Water: 29.68 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.8

Turbidity (NTU): 101

Specific Conductance (mS/cm): 2.30

pH: 7.14

Visual/Odor Observations: Cloudy; Sl. Sulfur Odor

During Development

Time: 5:02 p.m.

Depth to Water: 30.12 ft TOR

Development/Collection Method: Pump

Temp (°F): 66.2

Turbidity (NTU): 87.2

Specific Conductance (mS/cm): 2.34

pH: 7.16

Visual/Odor Observations: Cloudy; No odor

During Development

Time: 5:15 p.m.

Depth to Water: 31.20 ft TOR

Development/Collection Method: Pump

Temp (°F): 67.0

Turbidity (NTU): 55.7

Specific Conductance (mS/cm): 1.63

pH: 7.14

Visual/Odor Observations: Sl. Cloudy; Sulfur Odor

Stantec

Well Development Form

Final Measurements B-103 P. 4

Time: 5:25 p.m.

Depth to Water: 30.80 ft TOR

Development/Collection Method: Pump

Temp (°F): 66.0

Turbidity (NTU): 28.6

Specific Conductance (mS/cm): 1.60

pH: 7.20

Visual/Odor Observations: Clear; Sl. Sulfur Odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 B-110 P. 1

Date: 06/15/2016
Well ID: B-110
Facility: TVA-CUF
Well Depth: 51.9 ft TOR
Developed By: Thompson
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Matthews
Well Condition: Fair

Initial Measurements (Before Development)

Time: 9:23 a.m.
Depth to Water: 31.6 ft TOR
Development/Collection Method: Compressed Nitrogen
Temp (°F): 71.6
Turbidity (NTU): 810
Specific Conductance (µS/cm): 310
pH: 8.30
Visual/Odor Observations: Cloudy; Sl. Black; Opaque; Sulfur Odor; Trace Fly Ash

During Development Well flushed with ~ 30 gal. potable water; Cleaned with compressed nitrogen

Time: 9:31 a.m.
Depth to Water: Surface ft TOR
Development/Collection Method: Compressed Nitrogen
Temp (°F): 74.3
Turbidity (NTU): 457
Specific Conductance (µS/cm): 290
pH: 8.15
Visual/Odor Observations: Cloudy; Sl. Black; Opaque; Sulfur Odor

During Development

Time: 9:40 a.m.
Depth to Water: Surface ft TOR
Development/Collection Method: Compressed Nitrogen
Temp (°F): 74.9
Turbidity (NTU): 235
Specific Conductance (µS/cm): 308
pH: 8.05
Visual/Odor Observations: Cloudy; Sl. Translucent; Sl. Sulfur Odor

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Well Development Form

During Development B-110 P. 2

Time: 9:45 a.m.
Depth to Water: Surface ft TOR

Development/Collection Method: Compressed Nitrogen
Temp (°F): 75.4

Turbidity (NTU): 33.3
Specific Conductance (µS/cm): 302

pH: 7.95
Visual/Odor Observations: Clear; Sl. Sulfur Odor

Final Measurements

Time: 9:52 a.m.
Depth to Water: Surface ft TOR

Development/Collection Method: Compressed Nitrogen
Temp (°F): 75.2

Turbidity (NTU): 30.8
Specific Conductance (µS/cm): 300

pH: 7.92
Visual/Odor Observations: Clear; Sl. Sulfur Odor

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-120 P. 1

Date: 06/14/2016
Well ID: CUF-120
Facility: TVA-CUF
Well Depth: 14.75 ft TOR
Developed By: Thompson
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight Oversight By: Matthews
Well Condition: New

Initial Measurements (Before Development)

Time: 1:05 p.m.
Depth to Water: 5.92 ft TOR
Development/Collection Method: Compressed Nitrogen
Temp (°F): 71.2
Turbidity (NTU): 249
Specific Conductance (µS/cm): 323
pH: 8.51
Visual/Odor Observations: Cloudy; Opaque; No odor

During Development Added 40 gal potable water; Cleaned out with compressed nitrogen

Time: 1:20 p.m.
Depth to Water: Surface ft TOR
Development/Collection Method: Compressed Nitrogen
Temp (°F): 70.8
Turbidity (NTU): 123
Specific Conductance (µS/cm): 319
pH: 8.59
Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development

Time: 1:50 p.m.
Depth to Water: Surface ft TOR
Development/Collection Method: Compressed Nitrogen
Temp (°F): 71.5
Turbidity (NTU): 22
Specific Conductance (µS/cm): 316
pH: 8.61
Visual/Odor Observations: Clear; No Odor

Stantec

Well Development Form

Final Measurements CUF-120 P. 2

Time:	2:23 p.m.	Depth to Water:	Surface ft TOR
Development/Collection Method:	Compressed Nitrogen	Temp (°F):	71.6
Turbidity (NTU):	23.4	Specific Conductance (µS/cm):	316
pH:	8.54	Visual/Odor Observations:	Clear; No Odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-201 P. 1

Date: 05/23/2016
Well ID: CUF-201
Facility: TVA-CUF
Well Depth: 28.05 ft TOR
Developed By: Thompson
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight Oversight By: Andrew
Well Condition: New

Initial Measurements (Before Development)

Time: 2:10 p.m.
Depth to Water: 12.25 ft TOR
Development/Collection Method: pump
Temp (°F): 69.7
Turbidity (NTU): 15.41
Specific Conductance (µS/cm): 323
pH: 7.92
Visual/Odor Observations: Clear; no odor

During Development Surged

Time: 2:57 p.m.
Depth to Water: 24.78 ft TOR
Development/Collection Method: Pump
Temp (°F): 67.0
Turbidity (NTU): 409
Specific Conductance (µS/cm): 303
pH: 7.70
Visual/Odor Observations: Opaque; No odor

During Development

Time: 5:15 p.m.
Depth to Water: 22.45 ft TOR
Development/Collection Method: Pump
Temp (°F): 62.4
Turbidity (NTU): 277
Specific Conductance (µS/cm): 262
pH: 7.71
Visual/Odor Observations: Cloudy; No odor

Stantec

Well Development Form

During Development Surged — CUF-201 P. 2

5/24/2016 Time: 7:45 a.m. Depth to Water: 12.90 ft TOR

Development/Collection Method: pump

Temp (°F): 62.8

Turbidity (NTU): 748

Specific Conductance (µS/cm): 221

pH: 7.56

Visual/Odor Observations: Cloudy; opaque; no odor

During Development Well Allowed to Re-charge

Time: 1:50 p.m. Depth to Water: 13.00 ft TOR

Development/Collection Method: Pump

Temp (°F): 62.9

Turbidity (NTU): 402

Specific Conductance (µS/cm): 212

pH: 7.50

Visual/Odor Observations: Cloudy; Opaque; No odor

During Development

Time: 2:05 p.m. Depth to Water: 21.72 ft TOR

Development/Collection Method: Pump

Temp (°F): 62.5

Turbidity (NTU): 153

Specific Conductance (µS/cm): 216

pH: 7.37

Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development Pumped Nearly Dry; Well Allowed to Re-charge

Time: 4:00 p.m. Depth to Water: 16.20 ft TOR

Development/Collection Method: Pump

Temp (°F): 63.2

Turbidity (NTU): 134

Specific Conductance (µS/cm): 209

pH: 7.42

Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

Stantec

Well Development Form

During Development

CUF-201 P. 3

5/25/2016 Time: 7:30 a.m.

Depth to Water: 12.25 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.3

Turbidity (NTU): 109

Specific Conductance (µS/cm): 204

pH: 7.47

Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development

Time: 11:15 a.m.

Depth to Water: 14.70 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.8

Turbidity (NTU): 51.0

Specific Conductance (µS/cm): 211

pH: 7.51

Visual/Odor Observations: Sl. Cloudy; Translucent; No odor

During Development

Surged on 05/26/2016

5/27/2016 Time: 7:30 a.m.

Depth to Water: 12.22 ft TOR

Development/Collection Method: Pump

Temp (°F): 64.7

Turbidity (NTU): 29.3

Specific Conductance (µS/cm): 192.9

pH: 7.19

Visual/Odor Observations: Clear; No Odor

Final Measurements

Time: 8:25 a.m.

Depth to Water: 20.59 ft TOR

Development/Collection Method: Pump

Temp (°F): 64.5

Turbidity (NTU): 4.72

Specific Conductance (µS/cm): 194.7

pH: 7.24

Visual/Odor Observations: Clear; No Odor

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-202 P. 1

Date: 06/06/2016
Well ID: CUF-202
Facility: TVA-CUF
Well Depth: 19.95 ft TOR
Developed By: Jessie
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Matthews
Well Condition: New

Initial Measurements (Before Development)

Time: 1:20 p.m.
Depth to Water: 4.90 ft TOR
Development/Collection Method: Pumped
Temp (°F): 67.1
Turbidity (NTU): 887
Specific Conductance (µS/cm): 378
pH: 7.65
Visual/Odor Observations: Brown; Opaque; No Odor

During Development Surged; Pumped; Allowed to re-charge

Time: 3:05 p.m.
Depth to Water: 5.30 ft TOR
Development/Collection Method: Pumped
Temp (°F): 66.3
Turbidity (NTU): > 1000 (OR)
Specific Conductance (µS/cm): 388
pH: 7.80
Visual/Odor Observations: Muddy; Opaque; No Odor

During Development

06/07/2016 Time: 7:40 a.m.
Depth to Water: 4.90 ft TOR
Development/Collection Method: Pump
Temp (°F): 61.8
Turbidity (NTU): 294
Specific Conductance (µS/cm): 385
pH: 7.99
Visual/Odor Observations: Opaque; No Odor

Stantec

Well Development Form

During Development CUF-202 P. 2

Time: 7:55 a.m.
Depth to Water: 11.80 ft TOR
Development/Collection Method: Pump
Temp (°F): 61.9
Turbidity (NTU): 285
Specific Conductance (µS/cm): 370
pH: 7.89
Visual/Odor Observations: Opaque; No Odor

During Development

Time: 11:15 a.m.
Depth to Water: 8.40 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.4
Turbidity (NTU): 338
Specific Conductance (µS/cm): 284
pH: 7.46
Visual/Odor Observations: Opaque; No Odor

During Development

6/9/2016
Time: 7:49 a.m.
Depth to Water: 5.0 ft TOR
Development/Collection Method: Pump
Temp (°F): 64.0
Turbidity (NTU): 145
Specific Conductance (µS/cm): 353
pH: 7.86
Visual/Odor Observations: Transparent; No Odor

During Development

Time: 11:17 a.m.
Depth to Water: 8.4 ft TOR
Development/Collection Method: Pump
Temp (°F): 66.4
Turbidity (NTU): 36.1
Specific Conductance (µS/cm): 366
pH: 8.01
Visual/Odor Observations: Clear; No Odor

Stantec

Well Development Form

During Development CUF-202 P. 3

6/10/2016 Time: 8:05 a.m. Depth to Water: 5.42 ft TOR

Development/Collection Method: Pump

Temp (°F): 61.4

Turbidity (NTU): 75.1

Specific Conductance (µS/cm): 373

pH: 8.10

Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development

Time: 8:28 a.m. Depth to Water: 11.30 ft TOR

Development/Collection Method: Pump

Temp (°F): 60.5

Turbidity (NTU): 36.5

Specific Conductance (µS/cm): 364

pH: 8.14

Visual/Odor Observations: Sl. Cloudy; Translucent; No odor

During Development

Time: 8:35 a.m. Depth to Water: 14.16 ft TOR

Development/Collection Method: Pump

Temp (°F): 60.2

Turbidity (NTU): 27.1

Specific Conductance (µS/cm): 364

pH: 8.12

Visual/Odor Observations: Clear; No Odor

During Development

Time: 8:43 a.m. Depth to Water: 11.54 ft TOR

Development/Collection Method: Pump

Temp (°F): 61.2

Turbidity (NTU): 19.13

Specific Conductance (µS/cm): 362

pH: 7.92

Visual/Odor Observations: Clear; No Odor

Stantec

Well Development Form

Final Measurements CUF-202 P. 4

Time:	8:50 a.m.	Depth to Water:	13.0 ft TOR
Development/Collection Method:	Pump	Temp (°F):	61.3
Turbidity (NTU):	14.11	Specific Conductance (µS/cm):	360
pH:	7.98	Visual/Odor Observations:	Clear; No Odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-204 P. 1

Date: 06/02/2016

Well ID: CUF-204

Facility: TVA-CUF

Well Depth: 48.8 ft TOR

Developed By: Jessie

Water Quality Meter: Oakton T-100/PCSTestr 35

Oversight By: Matthews

Well Condition: New

Initial Measurements (Before Development)

Time: 11:20 a.m.

Depth to Water: 28.2 ft TOR

Development/Collection Method: Pumped

Temp (°F): 66.3

Turbidity (NTU): 266

Specific Conductance (µS/cm): 606

pH: 7.76

Visual/Odor Observations: Cloudy; Opaque; No odor

During Development Surged

Time: 1:00 p.m.

Depth to Water: 39.1 ft TOR

Development/Collection Method: Pump

Temp (°F): 63.4

Turbidity (NTU): 708

Specific Conductance (µS/cm): 505

pH: 7.78

Visual/Odor Observations: Muddy; Opaque; No Odor

During Development

06/03/2016 Time: 10:45 a.m.

Depth to Water: 30.7 ft TOR

Development/Collection Method: Pump

Temp (°F): 64.5

Turbidity (NTU): 421

Specific Conductance (µS/cm): 498

pH: 7.69

Visual/Odor Observations: Cloudy; No Odor

Stantec

Well Development Form

During Development CUF-204 P. 2

06/06/2016 Time: 12:50 p.m. Depth to Water: 48.20 ft TOR

Development/Collection Method: Pump Temp (°F): 66.3

Turbidity (NTU): 118 Specific Conductance (µS/cm): 504

pH: 7.68 Visual/Odor Observations: Cloudy; No Odor

During Development

Time: 3:30 p.m. Depth to Water: 36.50 ft TOR

Development/Collection Method: Pump Temp (°F): 65.1

Turbidity (NTU): 73.2 Specific Conductance (µS/cm): 502

pH: 7.63 Visual/Odor Observations: Translucent; No Odor

During Development

06/06/2016 Time: 8:10 a.m. Depth to Water: 29.3 ft TOR

Development/Collection Method: Pump Temp (°F): 62.6

Turbidity (NTU): 13.50 Specific Conductance (µS/cm): 566

pH: 7.68 Visual/Odor Observations: Clear; No Odor

During Development

Time: 8:25 a.m. Depth to Water: 45.85 ft TOR

Development/Collection Method: Pump Temp (°F): 62.8

Turbidity (NTU): 339 Specific Conductance (µS/cm): 524

pH: 7.70 Visual/Odor Observations: Cloudy; No Odor

Well Development Form

Stantec

During Development

CUF-204 P. 3

Time: 10:05 a.m.
Depth to Water: 46.72 ft TOR

Development/Collection Method: Pump
Temp (°F): 63.4

Turbidity (NTU): 18.81
Specific Conductance (µS/cm): 502

pH: 7.72
Visual/Odor Observations: Clear; No Odor

During Development

Time: 12:20 p.m.
Depth to Water: 47.12 ft TOR

Development/Collection Method: Pump
Temp (°F): 65.2

Turbidity (NTU): 22.4
Specific Conductance (µS/cm): 500

pH: 7.69
Visual/Odor Observations: Clear; No Odor

During Development

6/9/2016
Time: 10:00 a.m.
Depth to Water: 30.30 ft TOR

Development/Collection Method: Pump
Temp (°F): 67.5

Turbidity (NTU): 15.28
Specific Conductance (µS/cm): 483

pH: 7.03
Visual/Odor Observations: Clear; No Odor

Final Measurements

Time: 10:35 a.m.
Depth to Water: 29.80 ft TOR

Development/Collection Method: Pump
Temp (°F): 70.5

Turbidity (NTU): 11.78
Specific Conductance (µS/cm): 472

pH: 7.23
Visual/Odor Observations: Clear; No Odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-205 P. 1

Date: 05/24/2016

Well ID: CUF-205

Facility: TVA-CUF

Well Depth: 27.49 ft TOR

Developed By: Jessie

Water Quality Meter: Oakton T-100/PCSTestr 35

Oversight By: Matthews

Well Condition: New

Initial Measurements (Before Development) Surged

Time: 8:30 a.m.

Depth to Water: 17.45 ft TOR

Development/Collection Method: Pumped

Temp (°F): 63.6

Turbidity (NTU): > 1000

Specific Conductance (µS/cm): 473

pH: 7.91

Visual/Odor Observations: Muddy; Opaque; No odor

During Development

Time: 10:30 a.m.

Depth to Water: 20.60 ft TOR

Development/Collection Method: Pump

Temp (°F): 63.4

Turbidity (NTU): 821

Specific Conductance (µS/cm): 552

pH: 7.72

Visual/Odor Observations: Cloudy; Opaque; No Odor

During Development Well Allowed to Re-charge

Time: 1:15 p.m.

Depth to Water: 17.50 ft TOR

Development/Collection Method: Pump

Temp (°F): 63.4

Turbidity (NTU): 234

Specific Conductance (µS/cm): 567

pH: 7.69

Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

Stantec

Well Development Form

During Development Pumped Nearly Dry; Well Allowed to Re-charge CUF-205 P. 2

Time: 4:40 p.m.
Depth to Water: 17.45 ft TOR
Development/Collection Method: Pump
Temp (°F): 64.7
Turbidity (NTU): 129
Specific Conductance (µS/cm): 585
pH: 7.57
Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development

05/25/2016 Time: 7:20 a.m.
Depth to Water: 17.45 ft TOR
Development/Collection Method: Pump
Temp (°F): 66.1
Turbidity (NTU): 90.0
Specific Conductance (µS/cm): 630
pH: 7.59
Visual/Odor Observations: Sl. Cloudy; Translucent; No odor

During Development

Time: 12:00 noon
Depth to Water: 18.2 ft TOR
Development/Collection Method: Pump
Temp (°F): 66.3
Turbidity (NTU): 56.5
Specific Conductance (µS/cm): 58.7
pH: 7.52
Visual/Odor Observations: Sl. Cloudy; Translucent; No odor

During Development Surged

05/26/2016 Time: 1:45 p.m.
Depth to Water: 15.95 ft TOR
Development/Collection Method: Pump
Temp (°F): 65.6
Turbidity (NTU): 232
Specific Conductance (µS/cm): 645
pH: 7.56
Visual/Odor Observations: Cloudy; No Odor

Stantec

Well Development Form

During Development

CUF-205 P. 3

Time: 2:55 p.m.

Depth to Water: 19.38 ft TOR

Development/Collection Method: Pump

Temp (°F): 71.2

Turbidity (NTU): 22.1

Specific Conductance (µS/cm): 619

pH: 7.26

Visual/Odor Observations: Clear; No odor

Final Measurements

Time: 3:30 p.m.

Depth to Water: 19.97 ft TOR

Development/Collection Method: Pump

Temp (°F): 70.1

Turbidity (NTU): 3.87

Specific Conductance (µS/cm): 601

pH: 7.12

Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-206 P. 1

Date: 06/07/2016
Well ID: CUF-206
Facility: TVA-CUF
Well Depth: 94.0 ft TOR
Developed By: Caudill
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Matthews
Well Condition: New

Initial Measurements (Before Development)

Time: 4:45 p.m.
Depth to Water: 33.17 ft TOR
Development/Collection Method: Bailed
Temp (°F): 64.9
Turbidity (NTU): >1000 (OR)
Specific Conductance (µS/cm): 1697
pH: 7.28
Visual/Odor Observations: Muddy; Opaque; No Odor

During Development

6/8/2016
Time: 11:50 a.m.
Depth to Water: 33.55 ft TOR
Development/Collection Method: Bailed
Temp (°F): 67.2
Turbidity (NTU): 920
Specific Conductance (mS/cm): 2.86
pH: 7.33
Visual/Odor Observations: Muddy; Opaque; No Odor

During Development Bailed and surged

Time: 3:15 p.m.
Depth to Water: 33.68 ft TOR
Development/Collection Method: Pump
Temp (°F): 64.2
Turbidity (NTU): 229
Specific Conductance (mS/cm): 3.04
pH: 6.94
Visual/Odor Observations: Opaque; No Odor

Stantec

Well Development Form

During Development

CUF-206 P. 2

Time: 4:05 p.m.
Depth to Water: 34.40 ft TOR

Development/Collection Method: Pump
Temp (°F): 65.1

Turbidity (NTU): 181
Specific Conductance (mS/cm): 3.08

pH: 6.98
Visual/Odor Observations: Translucent; No Odor

During Development

Time: 5:25 p.m.
Depth to Water: 34.58 ft TOR

Development/Collection Method: Pump
Temp (°F): 67.2

Turbidity (NTU): 106
Specific Conductance (mS/cm): 3.08

pH: 6.83
Visual/Odor Observations: Translucent; No Odor

During Development

6/9/2016
Time: 10:15 a.m.
Depth to Water: 33.22 ft TOR

Development/Collection Method: Pump
Temp (°F): 66.5

Turbidity (NTU): 19.72
Specific Conductance (mS/cm): 3.09

pH: 6.92
Visual/Odor Observations: Clear; Sl. Sulfur Odor

Final Measurements

Time: 10:30 a.m.
Depth to Water: 33.22 ft TOR

Development/Collection Method: Pump
Temp (°F): 66.5

Turbidity (NTU): 18.76
Specific Conductance (mS/cm): 3.09

pH: 6.98
Visual/Odor Observations: Clear; Sl. Sulfur Odor

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-207 P. 1

Date: 06/03/2016
Well ID: CUF-207
Facility: TVA-CUF
Well Depth: 85.7 ft TOR
Developed By: Matthews
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Andrew
Well Condition: New

Initial Measurements (Before Development)

Time: 8:50 a.m.
Depth to Water: 31.13 ft TOR
Development/Collection Method: Pumped
Temp (°F): 65.7
Turbidity (NTU): 963
Specific Conductance (mS/cm): 2.87
pH: 6.99
Visual/Odor Observations: Muddy; Opaque; Odorless

During Development Surged

Time: 9:35 a.m.
Depth to Water: 53.65 ft TOR
Development/Collection Method: Pumped
Temp (°F): 65.7
Turbidity (NTU): 948
Specific Conductance (mS/cm): 2.78
pH: 6.97
Visual/Odor Observations: Muddy; Opaque; Odorless

During Development

Time: 11:45 a.m.
Depth to Water: 41.85 ft TOR
Development/Collection Method: Pump
Temp (°F): 66.9
Turbidity (NTU): 47.0
Specific Conductance (mS/cm): 3.09
pH: 7.11
Visual/Odor Observations: Sl. Cloudy; Translucent; No Odor

Stantec Well Development Form

During Development — CUF-207 P. 2

06/06/2016 Time: 3:20 p.m. Depth to Water: 31.70 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.5

Turbidity (NTU): 378

Specific Conductance (mS/cm): 3.35

pH: 6.42

Visual/Odor Observations: Very Cloudy; Sl. Sulfur Odor

During Development

Time: 5:20 p.m. Depth to Water: 42.30 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.5

Turbidity (NTU): 2.36

Specific Conductance (mS/cm): 3.36

pH: 6.98

Visual/Odor Observations: Clear; Sl. Sulfur Odor

During Development Bailed and surged well

6/8/2016 Time: 1:50 p.m. Depth to Water: 32.60 ft TOR

Development/Collection Method: Bailed

Temp (°F): 67.5

Turbidity (NTU): 98.0

Specific Conductance (mS/cm): 2.49

pH: 7.04

Visual/Odor Observations: Translucent; No Odor

During Development

Time: 2:25 p.m. Depth to Water: 34.80 ft TOR

Development/Collection Method: Bailed

Temp (°F): 67.8

Turbidity (NTU): 348

Specific Conductance (mS/cm): 2.52

pH: 7.05

Visual/Odor Observations: Opaque; Odorless

Stantec

Well Development Form

During Development

CUF-207 P. 3

06/9/2016 Time: 11:00 a.m.

Depth to Water: 32.51 ft TOR

Development/Collection Method: Pump

Temp (°F): 62.1

Turbidity (NTU): 18.58

Specific Conductance (mS/cm): 3.20

pH: 6.97

Visual/Odor Observations: Clear; Sl. Sulfur Odor

During Development

Time: 11:20 a.m.

Depth to Water: 33.05 ft TOR

Development/Collection Method: Pump

Temp (°F): 62.8

Turbidity (NTU): 5.66

Specific Conductance (mS/cm): 3.16

pH: 7.02

Visual/Odor Observations: Clear; Sl. Sulfur Odor

Final Measurements

Time: 11:47 a.m.

Depth to Water: 32.58 ft TOR

Development/Collection Method: Pump

Temp (°F): 63.9

Turbidity (NTU): 4.71

Specific Conductance (mS/cm): 3.08

pH: 7.08

Visual/Odor Observations: Clear; Sl. Sulfur Odor

Well Development Form

Stantec

General Information TVA CUF GWMW Installations 175565299 CUF-208 P. 1

Date: 05/24/2016

Well ID: CUF-208

Facility: TVA-CUF

Well Depth: 58.4 ft TOR

Developed By: Jessie

Water Quality Meter: Oakton T-100/PCSTestr 35

Oversight By: Matthews

Well Condition: New

Initial Measurements (Before Development) Surged, Pumped Dry, Well Recharged

05/25/2016 Time: 7:30 a.m.

Depth to Water: 34.8 ft TOR

Development/Collection Method: Pumped

Temp (°F): 66.2

Turbidity (NTU): 683

Specific Conductance (mS/cm): 2.75

pH: 6.99

Visual/Odor Observations: Cloudy; opaque; no odor

During Development

06/6/2016 Time: 4:20 p.m.

Depth to Water: 35.25 ft TOR

Development/Collection Method: Pumped

Temp (°F): 68.7

Turbidity (NTU): 155

Specific Conductance (mS/cm): 2.84

pH: 6.45

Visual/Odor Observations: Very Cloudy; No Odor

During Development

06/8/2016 Time: 8:05 a.m.

Depth to Water: 35.50 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.4

Turbidity (NTU): 631

Specific Conductance (mS/cm): 2.85

pH: 6.50

Visual/Odor Observations: Opaque; No odor

Stantec

Well Development Form

During Development CUF-208 P. 2

Time: 2:15 p.m. Depth to Water: 35.60 ft TOR

Development/Collection Method: Pump Temp (°F): 66.8

Turbidity (NTU): 224 Specific Conductance (mS/cm): 2.85

pH: 6.63 Visual/Odor Observations: Cloudy; No odor

During Development

Time: 4:50 p.m. Depth to Water: 36.75 ft TOR

Development/Collection Method: Pump Temp (°F): 65.4

Turbidity (NTU): 121 Specific Conductance (mS/cm): 2.77

pH: 6.60 Visual/Odor Observations: Cloudy; No odor

During Development

06/6/2016 Time: 9:48 a.m. Depth to Water: 35.30 ft TOR

Development/Collection Method: Pump Temp (°F): 72.5

Turbidity (NTU): 64.1 Specific Conductance (mS/cm): 2.66

pH: 6.52 Visual/Odor Observations: Cloudy; No odor

During Development

Time: 12:20 p.m. Depth to Water: 39.60 ft TOR

Development/Collection Method: Pump Temp (°F): 71.2

Turbidity (NTU): 603 Specific Conductance (mS/cm): 2.75

pH: 6.47 Visual/Odor Observations: Opaque; No odor

Stantec

Well Development Form

During Development

CUF-208 P. 3

Time: 1:58 p.m.
Depth to Water: 38.57 ft TOR
Development/Collection Method: Pump
Temp (°F): 67.5
Turbidity (NTU): 334
Specific Conductance (mS/cm): 2.71
pH: 6.43
Visual/Odor Observations: Opaque; No odor

During Development

Time: 2:25 p.m.
Depth to Water: 39.77 ft TOR
Development/Collection Method: Pump
Temp (°F): 72.4
Turbidity (NTU): 266
Specific Conductance (mS/cm): 2.71
pH: 6.68
Visual/Odor Observations: Opaque; No odor

During Development

Time: 3:02 p.m.
Depth to Water: 39.95 ft TOR
Development/Collection Method: Pump
Temp (°F): 69.9
Turbidity (NTU): 48.4
Specific Conductance (mS/cm): 2.55
pH: 6.75
Visual/Odor Observations: Cloudy; No odor

During Development

Time: 3:30 p.m.
Depth to Water: 38.78 ft TOR
Development/Collection Method: Pump
Temp (°F): 73.7
Turbidity (NTU): 30.3
Specific Conductance (mS/cm): 2.53
pH: 6.80
Visual/Odor Observations: Transparent; No odor

Stantec

Well Development Form

During Development

CUF-208 P. 4

Time: 3:50 p.m.

Depth to Water: 40.81 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.7

Turbidity (NTU): 14.08

Specific Conductance (mS/cm): 2.55

pH: 6.74

Visual/Odor Observations: Clear; No odor

During Development

Time: 4:15 p.m.

Depth to Water: 39.50 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.3

Turbidity (NTU): 16.02

Specific Conductance (mS/cm): 2.56

pH: 6.79

Visual/Odor Observations: Clear; No odor

Final Measurements

Time: 4:53 p.m.

Depth to Water: 40.08 ft TOR

Development/Collection Method: Pump

Temp (°F): 66.8

Turbidity (NTU): 11.73

Specific Conductance (mS/cm): 2.55

pH: 6.60

Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-209 P. 1

Date: 05/25/2016

Well ID: CUF-209

Facility: TVA-CUF

Well Depth: 63.83 ft TOR

Developed By: Jessie

Water Quality Meter: Oakton T-100/PCSTestr 35

Oversight By: Matthews

Well Condition: New

Initial Measurements (Before Development)

Time: 9:00 a.m.

Depth to Water: 34.73 ft TOR

Development/Collection Method: Pumped

Temp (°F): 68.7

Turbidity (NTU): 259

Specific Conductance (mS/cm): 2.47

pH: 7.23

Visual/Odor Observations: Cloudy; Opaque; No odor

During Development

Time: 9:40 a.m.

Depth to Water: 46.60 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.1

Turbidity (NTU): 381

Specific Conductance (mS/cm): 2.01

pH: 7.26

Visual/Odor Observations: Cloudy; Opaque; No odor

During Development

Time: 10:40 a.m.

Depth to Water: 52.24 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.8

Turbidity (NTU): 102

Specific Conductance (µS/cm): 1843

pH: 7.37

Visual/Odor Observations: Sl. Cloudy; Translucent; No Odor

Stantec

Well Development Form

During Development

CUF-209 P. 2

5/26/16 Time: 8:25 a.m. Depth to Water: 34.25 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.7

Turbidity (NTU): 47.3

Specific Conductance (µS/cm): 1904

pH: 7.54

Visual/Odor Observations: Clear; No Odor

During Development

Time: 8:35 a.m. Depth to Water: 38.53 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.1

Turbidity (NTU): 19.81

Specific Conductance (µS/cm): 1853

pH: 7.43

Visual/Odor Observations: Clear; No odor

During Development

Time: 8:46 a.m. Depth to Water: 42.82 ft TOR

Development/Collection Method: Pump

Temp (°F): 65.7

Turbidity (NTU): 58.5

Specific Conductance (µS/cm): 1825

pH: 7.50

Visual/Odor Observations: Clear; No odor

During Development

Time: 12:45 p.m. Depth to Water: 52.31 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.6

Turbidity (NTU): 12.71

Specific Conductance (µS/cm): 1807

pH: 7.62

Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

During Development CUF-209 P. 3

Time: 1:15 p.m.
Depth to Water: 52.20 ft TOR
Development/Collection Method: Pump
Temp (°F): 67.7
Turbidity (NTU): 5.44
Specific Conductance (µS/cm): 1825
pH: 7.58
Visual/Odor Observations: Clear; No odor

Final Measurements

Time: 1:42 p.m.
Depth to Water: 52.35 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.2
Turbidity (NTU): 3.61
Specific Conductance (µS/cm): 1810
pH: 7.61
Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-210 P. 1

Date: 06/10/2016
Well ID: CUF-210
Facility: TVA-CUF
Well Depth: 69.0 ft TOR
Developed By: Matthews
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Matthews
Well Condition: New

Initial Measurements (Before Development) Initial sample bailed from bottom

Time: 10:50 a.m.
Depth to Water: 26.55 ft TOR
Development/Collection Method: Bail
Temp (°F): 65.9
Turbidity (NTU): 962
Specific Conductance (µS/cm): 2970
pH: 8.41
Visual/Odor Observations: Muddy; Opaque; No Odor

During Development Surged

Time: 11:20 a.m.
Depth to Water: 38.89 ft TOR
Development/Collection Method: Pumped
Temp (°F): 70.0
Turbidity (NTU): 706
Specific Conductance (µS/cm): 3470
pH: 8.49
Visual/Odor Observations: Muddy; Opaque; No Odor

During Development

Time: 12:20 p.m.
Depth to Water: 60.35 ft TOR
Development/Collection Method: Pump
Temp (°F): 66.3
Turbidity (NTU): 332
Specific Conductance (µS/cm): 413
pH: 8.59
Visual/Odor Observations: Cloudy; Opaque; No Odor

Stantec

Well Development Form

During Development CUF-210 P. 2

6/13/2016 Time: 12:07 p.m. Depth to Water: 28.60 ft TOR

Development/Collection Method: Bail

Temp (°F): 69.7

Turbidity (NTU): 24.0

Specific Conductance (µS/cm): 730

pH: 7.69

Visual/Odor Observations: Clear; No Odor

During Development Bailing Well

Time: 12:25 p.m. Depth to Water: 32.40 ft TOR

Development/Collection Method: Bail

Temp (°F): 67.5

Turbidity (NTU): 913

Specific Conductance (µS/cm): 789

pH: 7.62

Visual/Odor Observations: Muddy; Opaque; No Odor

During Development Bailed nearly dry; Re-charging (slow re-charge rate); Surged

6/14/2016 Time: 10:15 a.m. Depth to Water: 63.20 ft TOR

Development/Collection Method: Pump

Temp (°F): 70.2

Turbidity (NTU): > 1000

Specific Conductance (µS/cm): 585

pH: 7.80

Visual/Odor Observations: Muddy; Opaque; No Odor

During Development Re-charged overnight; Pump rate fluctuating between 200 and 300 mL/min

6/15/2016 Time: 8:30 a.m. Depth to Water: 45.25 ft TOR

Development/Collection Method: Pump

Temp (°F): 72.9

Turbidity (NTU): > 1000

Specific Conductance (µS/cm): 642

pH: 7.85

Visual/Odor Observations: Muddy; Opaque; No Odor

Stantec

Well Development Form

During Development Pump rate 200-250 mL/min CUF-210 P. 3

Time: 8:50 a.m.
Depth to Water: 47.90 ft TOR
Development/Collection Method: Pump
Temp (°F): 75.5
Turbidity (NTU): 293
Specific Conductance (µS/cm): 575
pH: 7.72
Visual/Odor Observations: Cloudy; Sl. Translucent; No Odor

During Development Pump rate 200-250 mL/min

Time: 9:10 a.m.
Depth to Water: 48.83 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.1
Turbidity (NTU): 79.7
Specific Conductance (µS/cm): 553
pH: 7.68
Visual/Odor Observations: Sl. Cloudy; Translucent; No Odor

During Development Pump rate 200-250 mL/min

Time: 9:30 a.m.
Depth to Water: 50.33 ft TOR
Development/Collection Method: Pump
Temp (°F): 76.7
Turbidity (NTU): 32.0
Specific Conductance (µS/cm): 548
pH: 7.92
Visual/Odor Observations: Becoming Clear; No Odor

During Development Pump rate 200-250 mL/min

Time: 9:50 a.m.
Depth to Water: 51.86 ft TOR
Development/Collection Method: Pump
Temp (°F): 77.5
Turbidity (NTU): 30.1
Specific Conductance (µS/cm): 547
pH: 7.88
Visual/Odor Observations: Clear; No Odor

Well Development Form

During Development Pump rate 200 mL/min CUF-210 P. 4

Time: 10:10 a.m.
Depth to Water: 52.95 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.3
Turbidity (NTU): 33.4
Specific Conductance (µS/cm): 541
pH: 7.85
Visual/Odor Observations: Clear

During Development Pump rate 100-150 mL/min

Time: 10:30 a.m.
Depth to Water: 53.47 ft TOR
Development/Collection Method: Pump
Temp (°F): 79.3
Turbidity (NTU): 31.1
Specific Conductance (µS/cm): 538
pH: 7.85
Visual/Odor Observations: Clear

During Development Pump rate 100-120 mL/min

Time: 10:50 a.m.
Depth to Water: 53.75 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.7
Turbidity (NTU): 29.3
Specific Conductance (µS/cm): 544
pH: 7.84
Visual/Odor Observations: Clear

During Development Pump rate 100 mL/min

Time: 11:10 a.m.
Depth to Water: 54.13 ft TOR
Development/Collection Method: Pump
Temp (°F): 78.7
Turbidity (NTU): 30.1
Specific Conductance (µS/cm): 539
pH: 7.84
Visual/Odor Observations: Clear

Well Development Form

During Development Pump rate 100 -120 mL/min CUF-210 P. 5

Time: 11:30 a.m.
Depth to Water: 54.47 ft TOR

Development/Collection Method: Pump
Temp (°F): 78.8

Turbidity (NTU): 30.9
Specific Conductance (µS/cm): 538

pH: 7.85
Visual/Odor Observations: Clear

Final Measurements Pump rate 100 -120 mL/min

Time: 11:50 a.m.
Depth to Water: 54.70 ft TOR

Development/Collection Method: Pump
Temp (°F): 78.8

Turbidity (NTU): 29.3
Specific Conductance (µS/cm): 536

pH: 7.84
Visual/Odor Observations: Clear

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-211 P. 1

Date: 05/26/2016
Well ID: CUF-211
Facility: TVA-CUF
Well Depth: 68.56 ft TOR
Developed By: Jessie
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Matthews
Well Condition: New

Initial Measurements (Before Development)

Time: 2:10 p.m.
Depth to Water: 35.8 ft TOR
Development/Collection Method: Pumped
Temp (°F): 71.2
Turbidity (NTU): 574
Specific Conductance (µS/cm): 854
pH: 7.03
Visual/Odor Observations: Cloudy; opaque; no odor

During Development

Time: 2:40 p.m.
Depth to Water: 44.21 ft TOR
Development/Collection Method: Pumped
Temp (°F): 72.0
Turbidity (NTU): 84.5
Specific Conductance (µS/cm): 1349
pH: 6.95
Visual/Odor Observations: Sl. Cloudy; Translucent; No Odor

During Development Surged

06/6/2016 Time: 3:45 p.m.
Depth to Water: 35.40 ft TOR
Development/Collection Method: Pumped
Temp (°F): 69.5
Turbidity (NTU): 108
Specific Conductance (µS/cm): 1345
pH: 6.27
Visual/Odor Observations: Opaque; No Odor

Stantec

Well Development Form

During Development CUF-211 P. 2

06/6/2016 Time: 5:25 p.m. Depth to Water: 39.30 ft TOR

Development/Collection Method: pump

Temp (°F): 68.8

Turbidity (NTU): 66.0

Specific Conductance (µS/cm): 1352

pH: 6.54

Visual/Odor Observations: Cloudy; No Odor

During Development

06/8/2016 Time: 8:47 a.m. Depth to Water: 36.72 ft TOR

Development/Collection Method: Pump

Temp (°F): 66.0

Turbidity (NTU): 204

Specific Conductance (µS/cm): 1295

pH: 6.46

Visual/Odor Observations: Opaque; No Odor

Final Measurements

Time: 11:39 a.m. Depth to Water: 35.50 ft TOR

Development/Collection Method: Pump

Temp (°F): 69.3

Turbidity (NTU): 108

Specific Conductance (µS/cm): 1425

pH: 6.90

Visual/Odor Observations: Cloudy; No Odor

Failed to reach target turbidity of 5 NTUs; refer to RFI 609389-014.

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-212 P. 1

Date: 05/26/2016
Well ID: CUF-212
Facility: TVA-CUF
Well Depth: 75.2 ft TOR
Developed By: Jessie
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Matthews
Well Condition: New

Initial Measurements (Before Development)

Time: 7:45 a.m.
Depth to Water: 38.5 ft TOR
Development/Collection Method: Pump
Temp (°F): 67.2
Turbidity (NTU): 181
Specific Conductance (mS/cm): 3.14
pH: 7.46
Visual/Odor Observations: Cloudy; Sl. Translucent; No odor

During Development

05/26/2016 Time: 8:45 a.m.
Depth to Water: 43.49 ft TOR
Development/Collection Method: Pump
Temp (°F): 67.8
Turbidity (NTU): 59.5
Specific Conductance (mS/cm): 3.42
pH: 7.18
Visual/Odor Observations: Sl. Cloudy; Translucent; No odor

During Development

Time: 9:08 a.m.
Depth to Water: 45.60 ft TOR
Development/Collection Method: Pump
Temp (°F): 67.5
Turbidity (NTU): 22.9
Specific Conductance (mS/cm): 3.32
pH: 7.25
Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

During Development

CUF-212 P. 2

Time: 9:40 a.m.
Depth to Water: 48.24 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.2
Turbidity (NTU): 14.68
Specific Conductance (mS/cm): 3.42
pH: 7.19
Visual/Odor Observations: Clear; No odor

During Development

Time: 10:05 a.m.
Depth to Water: 52.09 ft TOR
Development/Collection Method: Pump
Temp (°F): 67.9
Turbidity (NTU): 16.79
Specific Conductance (mS/cm): 3.27
pH: 7.23
Visual/Odor Observations: Clear; No odor

During Development

Time: 10:20 a.m.
Depth to Water: 48.60 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.1
Turbidity (NTU): 12.91
Specific Conductance (mS/cm): 3.33
pH: 7.31
Visual/Odor Observations: Clear; No odor

During Development

Time: 10:30 a.m.
Depth to Water: 49.20 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.5
Turbidity (NTU): 9.69
Specific Conductance (mS/cm): 3.30
pH: 7.27
Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

During Development CUF-212 P. 3

Time: 10:40 a.m. Depth to Water: 49.31 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.4

Turbidity (NTU): 7.90

Specific Conductance (mS/cm): 3.31

pH: 7.23

Visual/Odor Observations: Clear; No odor

During Development

Time: 10:52 a.m. Depth to Water: 49.62 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.7

Turbidity (NTU): 4.76

Specific Conductance (mS/cm): 3.31

pH: 7.18

Visual/Odor Observations: Clear; No odor

Final Measurements

Time: 11:05 a.m. Depth to Water: 49.85 ft TOR

Development/Collection Method: Pump

Temp (°F): 68.5

Turbidity (NTU): 3.81

Specific Conductance (mS/cm): 3.30

pH: 7.20

Visual/Odor Observations: Clear; No odor

Stantec

Well Development Form

General Information TVA CUF GWMW Installations 175565299 CUF-213 P. 1

Date: 05/26/2016
Well ID: CUF-213
Facility: TVA-CUF
Well Depth: 45.63 ft TOR
Developed By: Jessie
Water Quality Meter: Oakton T-100/PCSTestr 35
Oversight By: Matthews
Well Condition: New

Initial Measurements (Before Development) Pump, surged, pump

Time: 10:55 a.m.
Depth to Water: 13.9 ft TOR
Development/Collection Method: Pumped
Temp (°F): 70.3
Turbidity (NTU): 69.4
Specific Conductance (mS/cm): 3.23
pH: 9.93
Visual/Odor Observations: Sl. Cloudy; Translucent; Sl. Sulfur odor

During Development

Time: 11:45 a.m.
Depth to Water: 32.7 ft TOR
Development/Collection Method: Pump
Temp (°F): 70.7
Turbidity (NTU): 16.57
Specific Conductance (mS/cm): 3.32
pH: 9.70
Visual/Odor Observations: Clear; Sl. Sulfur Odor

During Development

Time: 12:33 p.m.
Depth to Water: 31.3 ft TOR
Development/Collection Method: Pump
Temp (°F): 68.9
Turbidity (NTU): 11.26
Specific Conductance (mS/cm): 3.18
pH: 9.86
Visual/Odor Observations: Clear; Sl. Sulfur Odor

Stantec

Well Development Form

Final Measurements CUF-213 P. 2

Time: 1:05 p.m.

Depth to Water: 32.4 ft TOR

Development/Collection Method: Pump

Temp (°F): 70.3

Turbidity (NTU): 3.02

Specific Conductance (mS/cm): 3.27

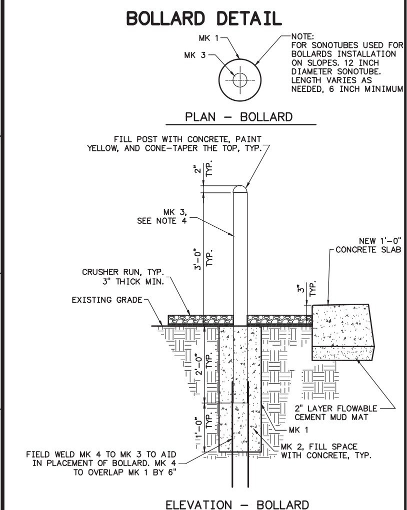
pH: 9.94

Visual/Odor Observations: Clear; Sl. Sulfur Odor

APPENDIX E
TVA WELLHEAD DESIGN DRAWINGS

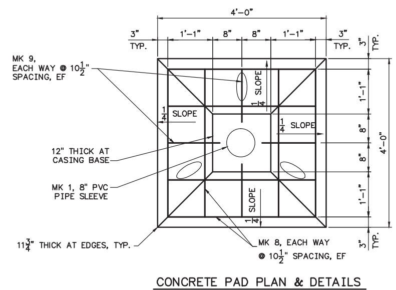
46 C 10W858-02

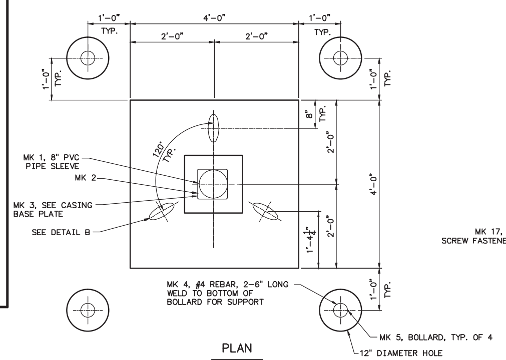
BOLLARD DETAIL

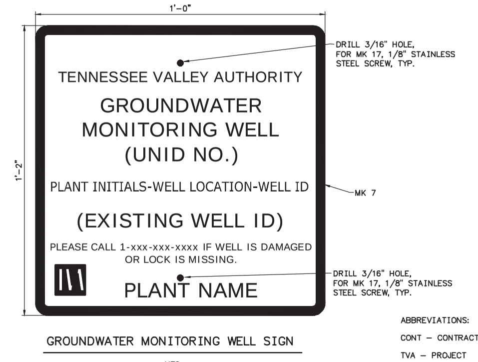


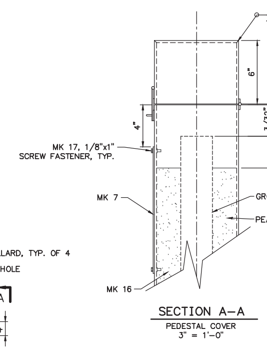
BOLLARD DETAIL — MARK NUMBERS AND MATERIAL LIST

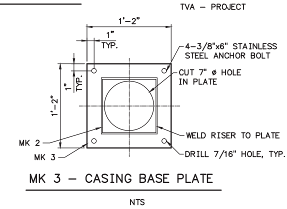
MARK NO.	QUANTITY	DESCRIPTION	PROCURE
1	1 EA	12" SONOTUBE CONCRETE FORM	CONT
2	AS-REQ	CONCRETE, 3000PSI	CONT
3	1 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
4	2 EA	#4 REBAR, 2'-6" LONG	CONT











MARK NUMBERS AND MATERIAL LIST

MARK NO.	QUANTITY	DESCRIPTION	PROCURE
1	1 EA	8"DIA.X1'-0"L. PVC PIPE SLEEVE	CONT
2	1 EA	TS 3/16"T8"X8"X5'L, GALVANIZED A500, SEE SECT A-A.	CONT
3	1 EA	14"X14"X3/4" STEEL PLATE WITH 4-3/8"x6" STAINLESS STEEL ANCHOR BOLTS	CONT
4	8 EA	#4 REBAR, 2-6" LONG	CONT
5	4 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
6	AS-REQ	CONCRETE, 3000PSI	CONT
7	1 EA	3/16"X14"HX12"L WITH 1/2" RADIUS CORNERS INSTRUMENT SIGN	TVA
8	16 EA	#5 REBAR, 3'-6" LONG	CONT
9	8 EA	#5 REBAR, 1'-3" LONG	CONT
10	AS-REQ	GEOTEXTILE, EASY GARDNER CONTRACTOR GRADE LANDSCAPE FABRIC, MODEL 30109 OR EASY GARDNER COMMERCIAL LANDSCAPE FABRIC, MODEL 2508R OR AN APPROVED EQUAL	CONT
11	3 EA	E LIFT FORM, PEIKKO, PRODUCT #E-670F, OR APPROVED EQUAL	CONT
12	3 EA	E LIFT ANCHOR, PEIKKO, PRODUCT #E-670-375G, OR APPROVED EQUAL	CONT
13	3 EA	FILL WITH SAND THEN ADD 1/2" LAYER OF EXTERIOR SILICONE CAULK	CONT
14	AS-REQ	FLOWABLE CEMENT MUD MAT	CONT
15	AS-REQ	GRANDULAR BENTONITE	CONT
16	AS-REQ	3/8" SIZE WASHED PEA GRAVEL	CONT
17	AS-REQ	2-1/8"x1" STAINLESS STEEL SCREW	CONT

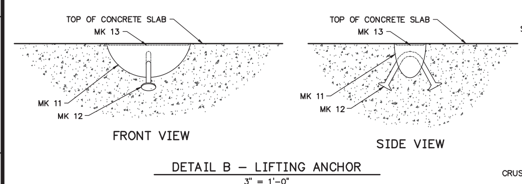
ABBREVIATIONS:

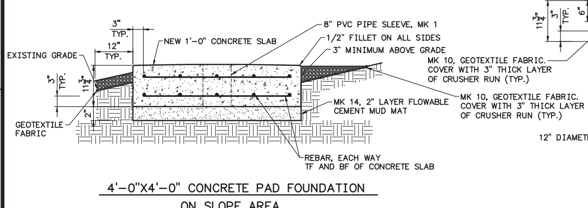
CONT – CONTRACTOR

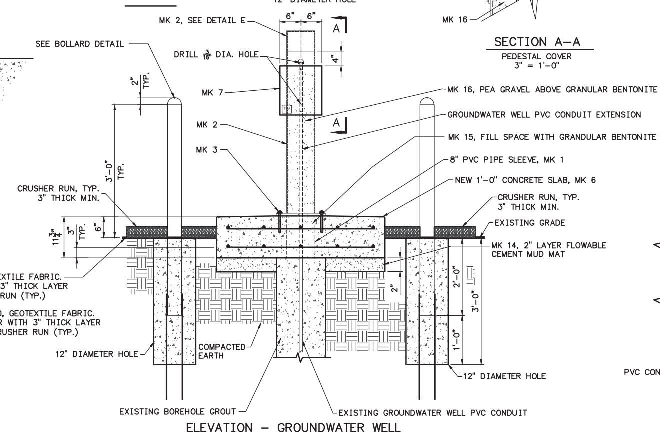
TVA – PROJECT

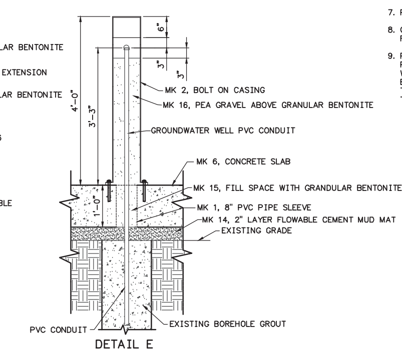
NOTES:

1. ALL STAINLESS STEEL TO BE GRADE 303 UNLESS NOTED OTHERWISE.
2. IMPLEMENT BEST MANAGEMENT PRACTICES PRIOR TO STARTING WORK.
3. PROVIDE TEMPORARY SPILL CONTAINMENT DEVICES IF CONTRACTOR WILL REFUEL EQUIPMENT ONSITE.
4. BOLLARDS PAINTING REQUIREMENTS:
   A. SURFACE PREPARATION:
      CLEAN SURFACES PRIOR TO APPLYING THE PAINT IN ACCORDANCE WITH THE STEEL STRUCTURES PAINTING COUNCIL (SSPC) SP-2 & -3 STANDARDS, "HAND AND POWER TOOL CLEANING". ALL LOSE RUST, LOOSE PAINT, AND OTHER LOOSE DETRIMENTAL FOREIGN MATTER SHALL BE REMOVED. FEATHER THE EDGES OF ANY REMAINING OLD PAINT SO THAT THE REPAINTED SURFACES CAN HAVE A REASONABLY SMOOTH APPEARANCE.
   B. PAINT AND PRIMER – SHERWIN WILLIAMS COATINGS SYSTEM OR AN APPROVED EQUEAL:
      PRIMER
      SHERWIN WILLIAMS DURA PLATE 235 @ 3-5 MILS DFT FOR BARE STEEL OR RUST.
      SHERWIN WILLIAMS POLYSILOXANE 1K @ 1.5-2.5 MILS DFT PER COAT FOR THE PREVIOUSLY PRIMED OR PAINTED SURFACES.
      FINISH COLOR
      SHERWIN WILLIAMS SUNSPOT YELLOW (SW) 1672.
   C. BOLLARDS SHALL RECEIVE ONE COAT OF PRIMER AND TWO COATS OF PAINT.
5. CONCRETE PAD TO HAVE A BROOM FINISH.
6. BENTONITE SHALL BE CETCO C/S OR AN APPROVED EQUAL.
7. PEA GRAVEL SHALL BE WASHED 3/8" SIZE OR AN APPROVED EQUAL.
8. GROUNDWATER MONITORING WELL SIGN SHALL BE PAINTED BLUE, FEDERAL STANDARD NO. 15187.
9. PROVIDE A MASTER LOCK ON THE GROUND WATER MONITORING WELL PROTECTIVE COVER THAT WILL ACCEPT TVA GROUND WATER MONITORING WELL KEY NUMBER 0896 ONLY. LOCKS NOT ACCEPTING KEY 0896 WILL NOT BE ALLOWED UNLESS PRIOR APPROVAL IS OBTAINED FROM TVA. CONTACT THE PLANT'S ENVIRONMENTAL SCIENTIST FOR ASSISTANCE IN OBTAINING THE PROPER LOCK.









R	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD
0	06-20-2016	JLG	CWH	JLG		SEB	MST	

INITIAL ISSUE

SCALE: 1" = 1'-0" EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

TYPICAL GROUNDWATER MONITORING WELL CONCRETE PAD & BOLLARDS PLAN ELEVATION & CONSTRUCTION DETAILS

DESIGNED BY: J.L. GRAY · DRAWN BY: C.W. HENSLEY · CHECKED BY: J.L. GRAY · REVIEWED BY: · APPROVED BY: S.E. BENNETT · ISSUED BY: M.S. TURNBOW

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2008 | 46 | C | 10W858-02 | R 0

PLOT FACTOR: W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.

APPENDIX F
FIELD SURVEY RESULTS

TVA Cumberland Fossil Plant
Cumberland City, Tennessee

Survey Data for Wells and Borings

WELL	ELEV A	ELEV B	ELEV C	ELEV D	GS ELEV	BM ELEV	BM NOTE	NORTHING(27)	EASTING(27)	Latitude(27)	Longitude(27)	NORTHING(83)	EASTING(83)	Latitude(83)	Longitude(83)
93-1	397.79	397.17	395.23	395.24	394.9	395.25	PK NAIL	730,034.86	1,509,989.90	N36°23'09.90"	W87°39'52.89"	751,418.07	1,478,497.06	N36°23'10.14"	W87°39'52.95"
93-2R	398.21	397.88	395.36	395.37	395.3	395.37	PK NAIL	728,859.59	1,510,842.10	N36°22'58.42"	W87°39'42.23"	750,242.78	1,479,349.19	N36°22'58.67"	W87°39'42.29"
93-3	398.20	397.50	395.64	395.71	395.2	395.70	PK NAIL	728,035.37	1,513,325.36	N36°22'50.69"	W87°39'11.69"	749,418.47	1,481,832.36	N36°22'50.93"	W87°39'11.76"
93-4	397.52	397.34	394.60	394.62	394.6	394.63	PK NAIL	732,258.75	1,511,362.72	N36°23'32.12"	W87°39'36.57"	753,641.85	1,479,869.95	N36°23'32.36"	W87°39'36.63"
96-9	392.86	392.59	392.86	392.73	392.7	392.75	PK NAIL	731,388.41	1,515,397.29	N36°23'24.19"	W87°38'47.05"	752,771.34	1,483,904.39	N36°23'24.43"	W87°38'47.11"
B103	396.42	395.97	394.35	394.44	394.4	394.45	PK NAIL	732,854.52	1,509,708.25	N36°23'37.73"	W87°39'56.92"	754,237.68	1,478,215.54	N36°23'37.97"	W87°39'56.98"
B110	398.68	398.27	395.76	395.73	395.7	395.76	PK NAIL	727,929.15	1,513,716.59	N36°22'49.70"	W87°39'06.89"	749,312.23	1,482,223.57	N36°22'49.95"	W87°39'06.95"
CUF-101	386.15	385.68	386.15	386.12	385.9	386.15	PK NAIL	731,687.01	1,513,777.18	N36°23'26.87"	W87°39'06.92"	753,070.02	1,482,284.33	N36°23'27.11"	W87°39'06.98"
CUF-102	403.19	402.93	403.19	403.15	403.2	403.18	PK NAIL	730,912.45	1,513,919.62	N36°23'19.24"	W87°39'05.02"	752,295.47	1,482,426.74	N36°23'19.48"	W87°39'05.08"
CUF-120	394.27	393.19	390.26	390.24	389.4	390.25	PK NAIL	730,384.17	1,513,540.26	N36°23'13.95"	W87°39'09.55"	751,767.21	1,482,047.36	N36°23'14.19"	W87°39'09.61"
CUF-201	401.27	400.41	397.18	397.21	396.7	397.25	PK NAIL	730,765.35	1,505,625.26	N36°23'16.39"	W87°40'46.42"	752,148.73	1,474,132.54	N36°23'16.63"	W87°40'46.48"
CUF-202	384.17	383.28	380.09	380.04	379.5	380.07	PK NAIL	730,347.74	1,506,636.70	N36°23'12.43"	W87°40'33.96"	751,731.09	1,475,143.95	N36°23'12.67"	W87°40'34.02"
CUF-204	440.91	439.66	436.84	436.87	435.9	436.89	PK NAIL	726,557.28	1,506,364.04	N36°22'34.90"	W87°40'36.50"	747,940.72	1,474,871.13	N36°22'35.15"	W87°40'36.56"
CUF-205	385.46	384.51	381.36	381.39	380.8	381.41	PK NAIL	733,581.23	1,511,258.33	N36°23'45.18"	W87°39'38.12"	754,964.30	1,479,765.62	N36°23'45.42"	W87°39'38.18"
CUF-206	399.68	398.67	395.57	395.57	394.9	395.60	PK NAIL	733,499.10	1,510,518.16	N36°23'44.24"	W87°39'47.15"	754,882.21	1,479,025.46	N36°23'44.48"	W87°39'47.21"
CUF-207	399.03	398.19	394.94	394.98	394.4	395.00	PK NAIL	733,146.70	1,510,018.97	N36°23'40.67"	W87°39'53.18"	754,529.84	1,478,526.27	N36°23'40.91"	W87°39'53.24"
CUF-208	399.48	398.38	395.38	395.32	394.6	395.34	PK NAIL	732,242.48	1,509,462.75	N36°23'31.64"	W87°39'59.80"	753,625.65	1,477,970.02	N36°23'31.88"	W87°39'59.86"
CUF-209	399.19	398.23	395.11	395.05	394.5	395.07	PK NAIL	731,074.78	1,509,317.09	N36°23'20.07"	W87°40'01.34"	752,457.99	1,477,824.31	N36°23'20.31"	W87°40'01.40"
CUF-210	399.23	398.20	395.12	395.04	394.5	395.07	PK NAIL	730,478.75	1,509,519.11	N36°23'14.21"	W87°39'58.74"	751,861.96	1,478,026.30	N36°23'14.45"	W87°39'58.80"
CUF-211	399.77	398.76	395.72	395.65	395.0	395.67	PK NAIL	729,830.15	1,510,203.78	N36°23'07.91"	W87°39'50.23"	751,213.35	1,478,710.93	N36°23'08.15"	W87°39'50.30"
CUF-212	399.61	398.71	395.58	395.50	395.0	395.51	PK NAIL	728,016.94	1,511,935.77	N36°22'50.27"	W87°39'28.68"	749,400.10	1,480,442.80	N36°22'50.52"	W87°39'28.74"
CUF-213	400.09	399.05	396.04	395.99	395.3	396.02	PK NAIL	727,951.80	1,513,737.18	N36°22'49.93"	W87°39'06.64"	749,334.89	1,482,244.17	N36°22'50.17"	W87°39'06.70"
CUF-120A	Soil Boring				388.0	NA	NA	730,379.26	1,513,536.18	N36°23'13.90"	W87°39'09.60"	751,762.30	1,482,043.27	N36°23'14.14"	W87°39'09.66"
CUF-202A	Soil Boring				412.3	NA	NA	729,833.21	1,506,809.10	N36°23'07.37"	W87°40'31.74"	751,216.55	1,475,316.32	N36°23'07.61"	W87°40'31.81"
CUF-202B	Soil Boring				390.7	NA	NA	730,302.00	1,506,772.64	N36°23'12.00"	W87°40'32.29"	751,685.34	1,475,279.89	N36°23'12.24"	W87°40'32.35"
CUF-203A	Soil Boring				409.5	NA	NA	727,192.01	1,509,863.93	N36°22'41.77"	W87°39'53.84"	748,575.28	1,478,370.97	N36°22'42.01"	W87°39'53.90"
CUF-203B	Soil Boring				378.0	NA	NA	727,398.56	1,509,388.20	N36°22'43.73"	W87°39'59.70"	748,781.85	1,477,895.26	N36°22'43.98"	W87°39'59.76"
CUF-204A	Soil Boring				458.3	NA	NA	726,274.53	1,506,340.23	N36°22'32.10"	W87°40'36.73"	747,657.98	1,474,847.30	N36°22'32.35"	W87°40'36.80"
CUF-214	Soil Boring				395.3	NA	NA	727,943.74	1,513,730.37	N36°22'49.85"	W87°39'06.72"	749,326.83	1,482,237.36	N36°22'50.09"	W87°39'06.79"

ELEV A	TOP OF COVER
ELEV B	TOP OF RISER NEXT TO NOTCH
ELEV C	CONC PAD ELEV NEXT TO RISER
ELEV D	CONC PAD ELEV AT EDGE OF PAD
GS ELEV	NATURAL GROUND ELEVATION

***ELEVATIONS ARE IN NGVD'29**

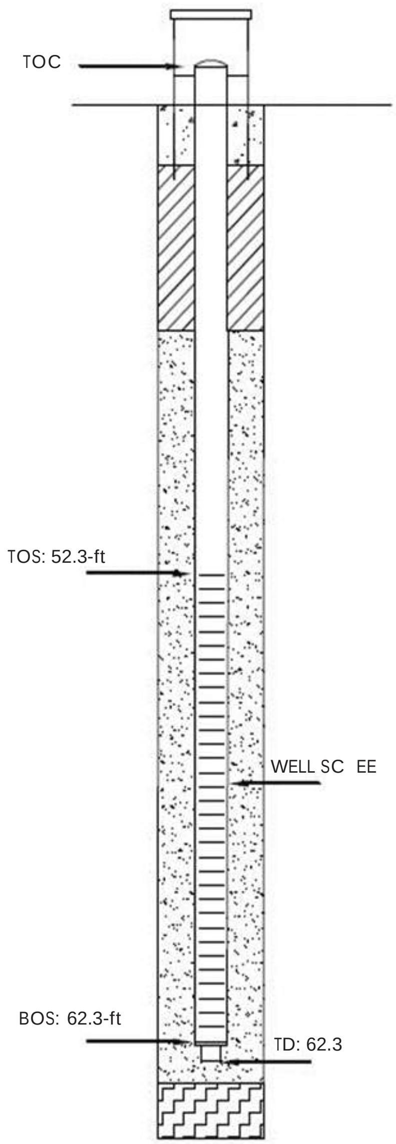
APPENDIX G
DOWNHOLE VIDEO LOGGING OF WELLS

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 06 09 2016 13:20	**SURFACE CON ITIONS:** Conc. Pad, clear, accessible
WELL NO.: CUF-93-1	**WEAT ER CON ITIONS:** Sunny, 59°F	**EPT TO WATER FT :** 39.30
PUMP NO. PUI : ED-061602-001	**CAMERA MO EL:** Well-Vu DVCC15	**TOTAL WELL EPT FT :** 62.0
UNI NO.: CUF-00-GW-43-001	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 2.0
LOGGE B : T. Shirah	**OTSPOT SIGNAL STRENGT :** 3 bars	**OUTSI E WELL IA. IN** 2.4

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

At 12.3-ft below top of casing (BTOC) there was discoloration inside pipe.

At 17.2-ft: eavy brown scaling to 17.7-ft BTOC

At 33.5-ft BTOC: Pitting and scaling inside pipe.

Scaling and cloudy water made it hard to determine the top of the screen and top of the screen joint.

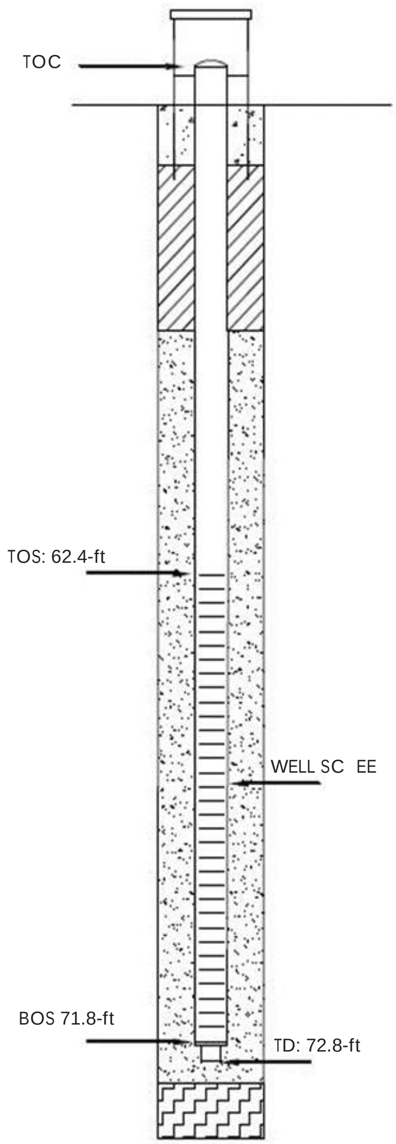
VI EO FILE NAME: 20161109_152323.AVI

WELL VI EO LOG

FACILIT NAME:	ATE TIME:	SURFACE CON ITIONS:
CUF	10 07 2016 10:00	Good
WELL NO.:	**WEAT ER CON ITIONS:**	**EPT TO WATER FT :**
CUF-93-2	Sunny, 75°F	42.90
PUMP NO. PUI :	**CAMERA MO EL:**	**TOTAL WELL EPT FT :**
ED-061602-002	Geovision	72.8
UNI NO.:	**OTSPOT SIGNAL PROVI ER:**	**INSI E WELL IA. IN :**
CUF-00-GW-43-002	Veri on	2.0
LOGGE B :	**OTSPOT SIGNAL STRENGT :**	**OUTSI E WELL IA. IN**
F. Thaxton, D. Smith	2 bars	2.4

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

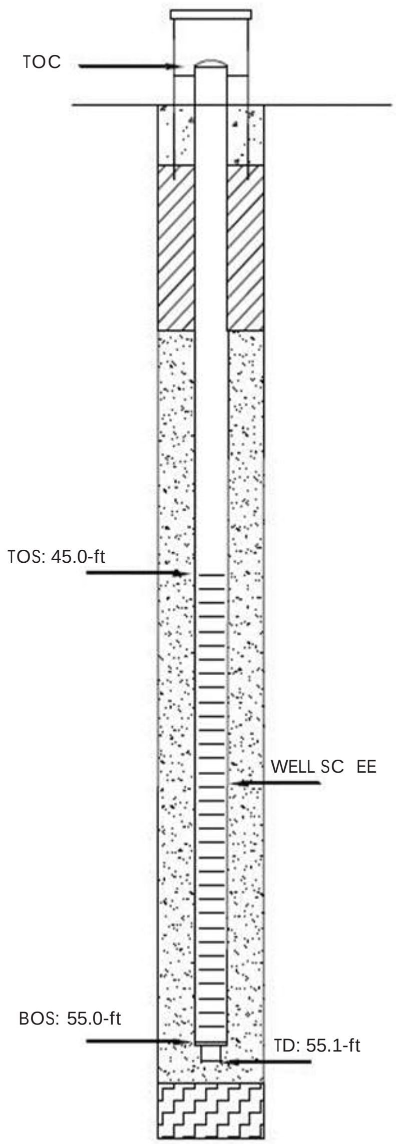
VI EO FILE NAME: TVA_CUF_93-2 _234552.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 11 09 2016 12:21	**SURFACE CON ITIONS:** Conc. Pad, clear, accessible
WELL NO.: CUF-93-3	**WEAT ER CON ITIONS:** Sunny, 58°F	**EPT TO WATER FT :** 31.65
PUMP NO. PUI : ED-061602-003	**CAMERA MO EL:** Well-Vu DVCC15	**TOTAL WELL EPT FT :** 55.1
UNI NO.: CUF-00-GW-43-003	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 2.0
LOGGE B : T. Shirah	**OTSPOT SIGNAL STRENGT :** 3 bars	**OUTSI E WELL IA. IN** 2.3

Well Layout

Depth (Feet below top of casing)



E :
TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

At 35-ft below top of casing (BTOC) - heavy black scaling to 35.6-ft. Gray scaling continues to 46.3-ft BTOC.

At 40.7-ft BTOC object in pipe.

PVC floaters in water column knocked down to 41.2-ft BTOC.

PVC shavings in bottom of pipe.

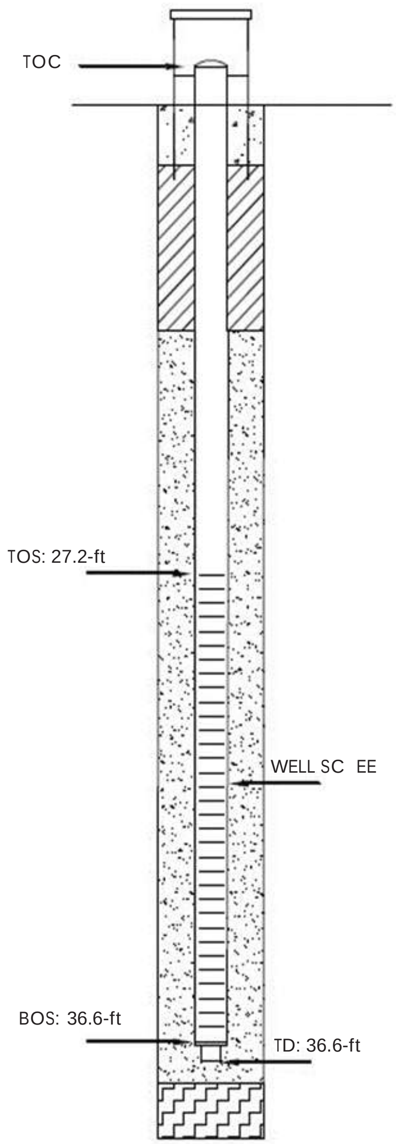
VI EO FILE NAME: 20161109_142729.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 11 09 2016 14:05	**SURFACE CON ITIONS:** Conc. Pad, clear, accessible
WELL NO.: CUF-93-4	**WEAT ER CON ITIONS:** Sunny, 60°F	**EPT TO WATER FT :** 29.91
PUMP NO. PUI : ED-061602-004	**CAMERA MO EL:** Well-Vu DVCC15	**TOTAL WELL EPT FT :** 36.6
UNI NO.: CUF-00-GW-43-004	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 2.0
LOGGE B : T. Shirah	**OTSPOT SIGNAL STRENGT :** 3 bars	**OUTSI E WELL IA. IN** 2.4

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

Brown Black scaling from 26.4-ft to 32.0-ft below top of casing

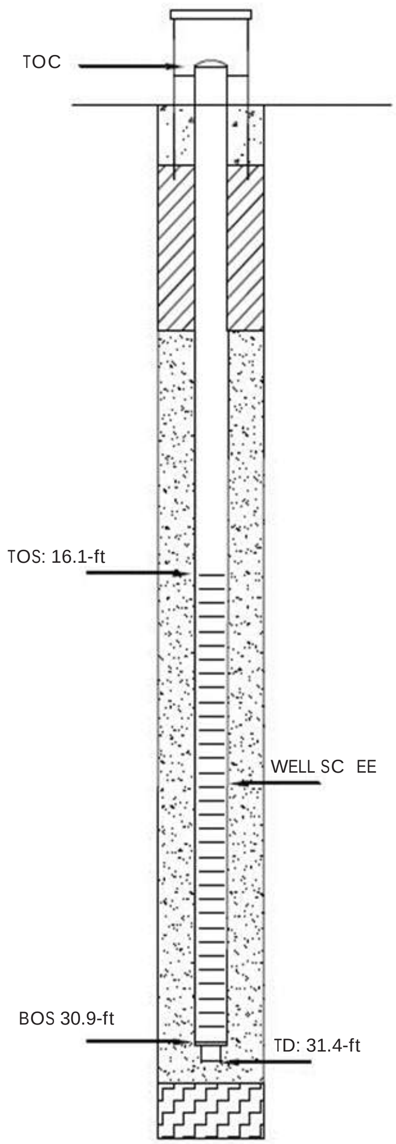
VI EO FILE NAME: 20161109_161539.AVI

WELL VI EO LOG

FACILIT NAME:	ATE TIME:	SURFACE CON ITIONS:
CUF	10 07 2016 11:20	Good
WELL NO.:	**WEAT ER CON ITIONS:**	**EPT TO WATER FT :**
CUF-96-9	Sunny, 79°F	20.34
PUMP NO. PUI :	**CAMERA MO EL:**	**TOTAL WELL EPT FT :**
A	Geovision	31.4
UNI NO.:	**OTSPOT SIGNAL PROVI ER:**	**INSI E WELL IA. IN :**
CUF-00-GW-43-005	Veri on	2.0
LOGGE B :	**OTSPOT SIGNAL STRENGT :**	**OUTSI E WELL IA. IN**
F. Thaxton, D. Smith	5 bars	2.4

Well Layout

Depth (Feet below top of casing)



E :
TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

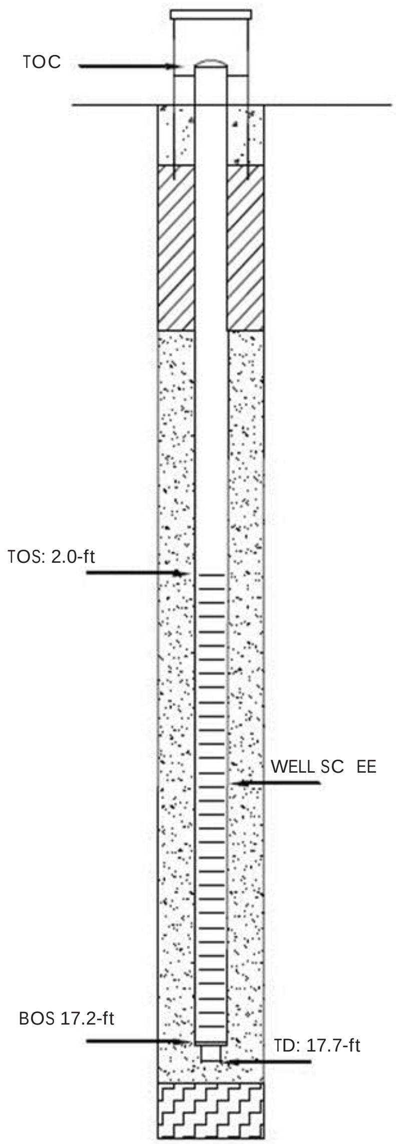
VI EO FILE NAME: TVA_CUF_96-9_005608.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 10 2016 11:25	**SURFACE CON ITIONS:** Good (overgrown vegetation)
WELL NO.: CUF-101	**WEAT ER CON ITIONS:** Mostly Sunny, 72°F	**EPT TO WATER FT :** 2.70
PUMP NO. PUI : A	**CAMERA MO EL:** Medit	**TOTAL WELL EPT FT :** 17.7
UNI NO.: CUF-00-GW-43-008	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 1.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 4 bars	**OUTSI E WELL IA. IN** 1.3

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

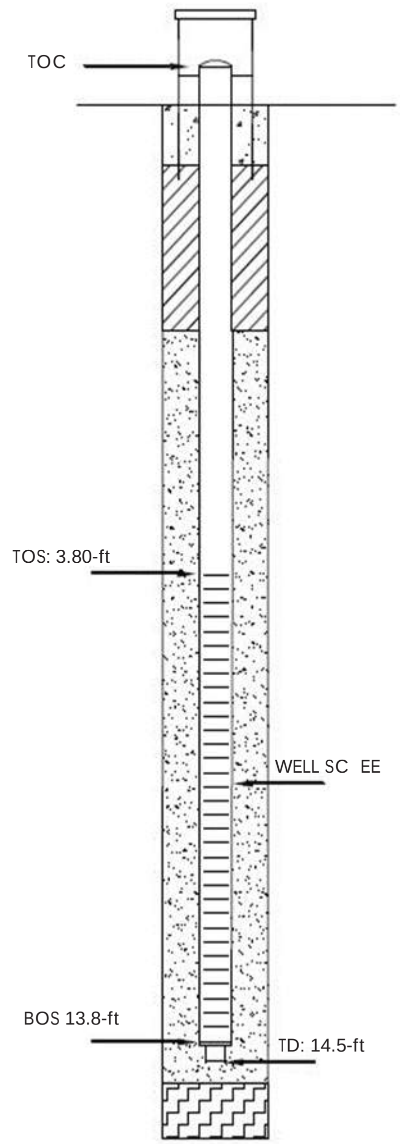
VI EO FILE NAME: TVA_CUF-101_20161011_000101.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 07 2016 08:55	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-102	**WEAT ER CON ITIONS:** Sunny, 66°F	**EPT TO WATER FT :** 12.86
PUMP NO. PUI : A	**CAMERA MO EL:** Medit	**TOTAL WELL EPT FT :** 14.5
UNI NO.: CUF-00-GW-43-009	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 1.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 4 bars	**OUTSI E WELL IA. IN** 1.3

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

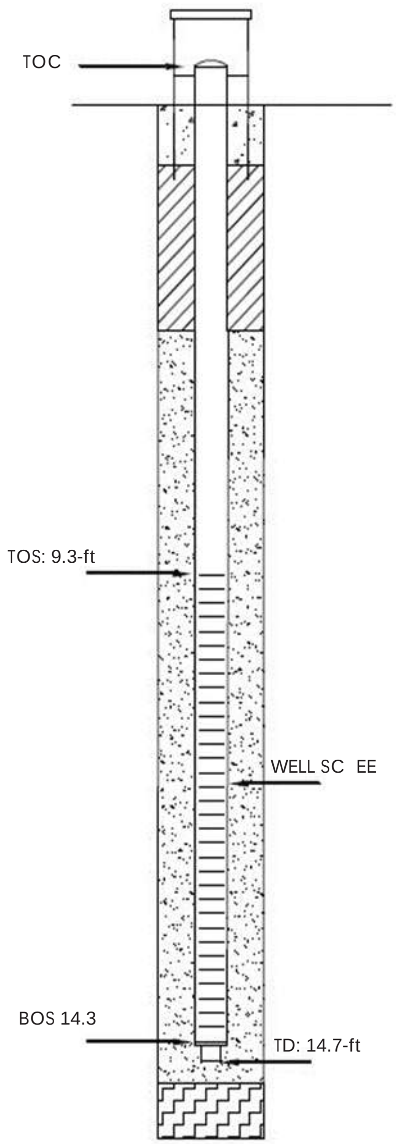
VI EO FILE NAME: TVA_CUF-120_20161007_214507.AVI

WELL VI EO LOG

FACILIT NAME:	ATE TIME:	SURFACE CON ITIONS:
CUF	10 10 2016 10:30	Good
WELL NO.:	**WEAT ER CON ITIONS:**	**EPT TO WATER FT :**
CUF-120	Partly Cloudy, 68°F	11.16
PUMP NO. PUI :	**CAMERA MO EL:**	**TOTAL WELL EPT FT :**
A	Medit	14.7
UNI NO.:	**OTSPOT SIGNAL PROVI ER:**	**INSI E WELL IA. IN :**
CUF-00-GW-43-010	Veri on	1.0
LOGGE B :	**OTSPOT SIGNAL STRENGT :**	**OUTSI E WELL IA. IN**
F. Thaxton, D. Smith	4 bars	1.3

Well Layout

Depth (Feet below top of casing)



E :
TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

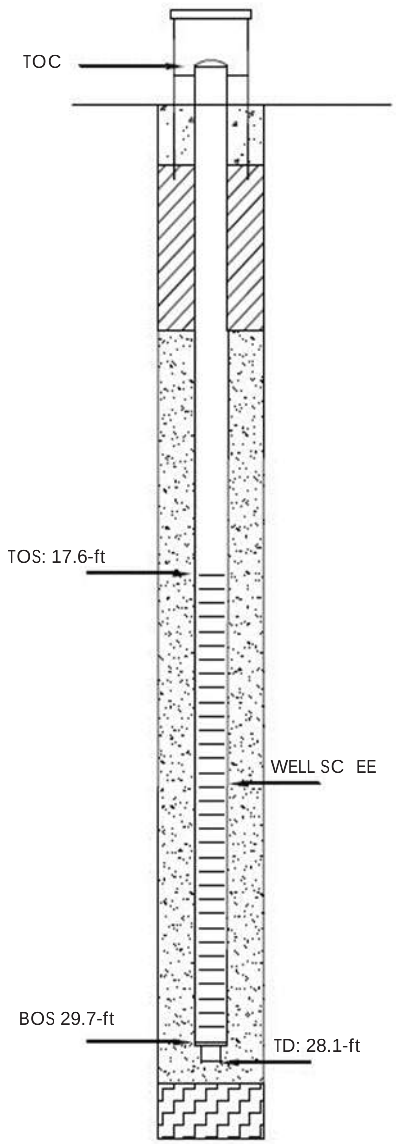
VI EO FILE NAME: A

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 10 2016 12:20	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-201	**WEAT ER CON ITIONS:** Mostly Sunny, 72°F	**EPT TO WATER FT :** 12.56
PUMP NO. PUI : ED-061602-011	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 28.1
UNI NO.: CUF-00-GW-43-011	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 1 bar	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

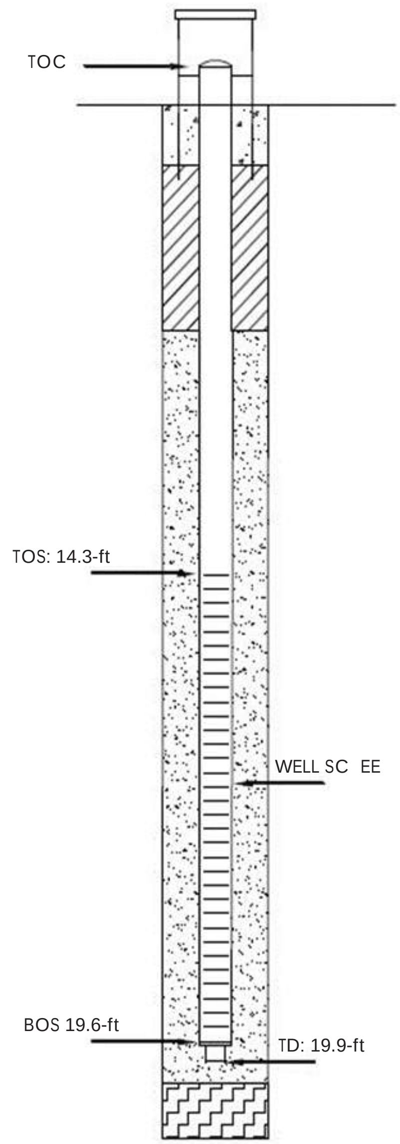
VI EO FILE NAME: TVA_CUF-201_020406.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 10 2016 13:15	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-202	**WEAT ER CON ITIONS:** Sunny, 73°F	**EPT TO WATER FT :** 6.64
PUMP NO. PUI : ED-061602-012	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 19.9
UNI NO.: CUF-00-GW-43-012	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 2 bars LTE	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC   Top of Casing
TOS   Top of Screen
BOS   Bottom of Screen
TD   Total Depth

Observations

STRUCTURAL   AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

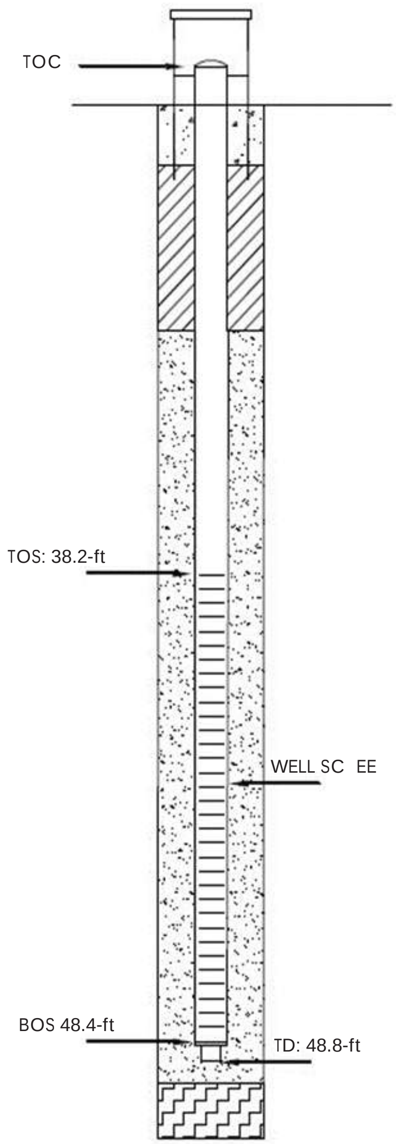
VI EO FILE NAME: TVA_CUF-202_025403.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 10 2016 14:10	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-204	**WEAT ER CON ITIONS:** Sunny, 75°F	**EPT TO WATER FT :** 31.92
PUMP NO. PUI : ED-061602-013	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 48.8
UNI NO.: CUF-00-GW-43-013	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 2 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC   Top of Casing
TOS   Top of Screen
BOS   Bottom of Screen
TD   Total Depth

Observations

STRUCTURAL   AMAGE OBSTRUCTION:

o structural damage or obstructions.

NOTES:

All depths measured from top of casing (TOC).

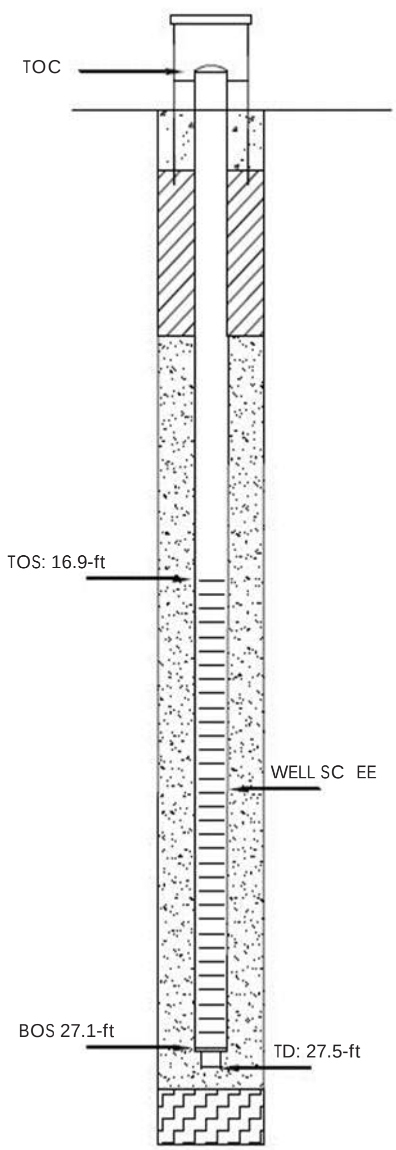
VI   EO FILE NAME: TVA_CUF-204_034633.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 07 2016 07:15	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-205	**WEAT ER CON ITIONS:** Foggy, 61°F	**EPT TO WATER FT :** 20.87
PUMP NO. PUI : ED-061601-014	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 27.5
UNI NO.: CUF-00-GW-43-014	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 5 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL   AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

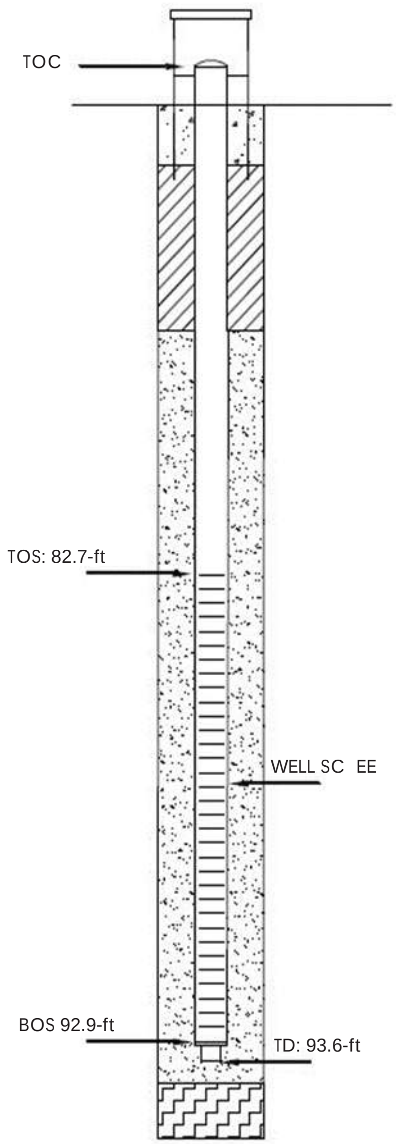
VI   EO FILE NAME: TVA_CUF-205_210134.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 06 2016 17:00	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-206	**WEAT ER CON ITIONS:** Sunny, 84°F	**EPT TO WATER FT :** 35.92
PUMP NO. PUI : ED-061602-015	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 93.6
UNI NO.: CUF-00-GW-43-015	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 5 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL   AMAGE OBSTRUCTION:
Crack in casing at 92.3-ft to 92.6-ft. running across slots and down to the bottom of slots around approximately   of the circumference of the casing.

NOTES:
All depths measured from top of casing (TOC).

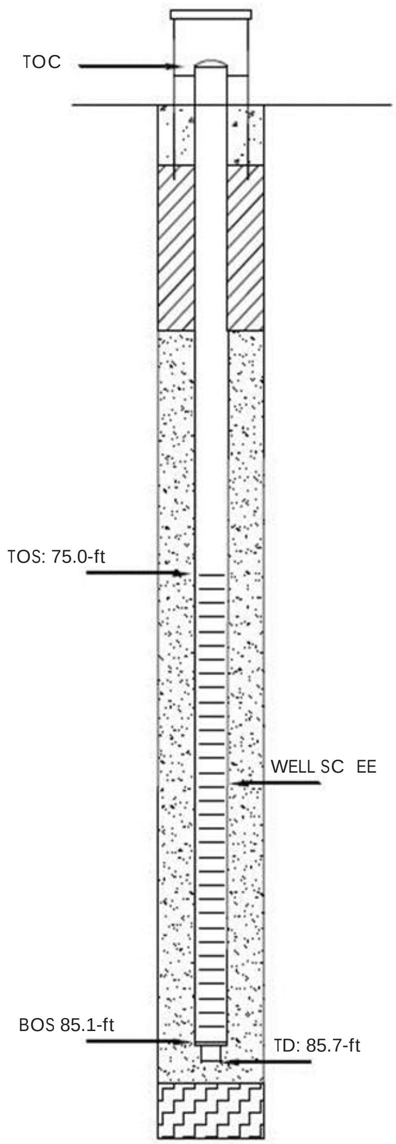
VI   EO FILE NAME: TVA_CUF-206_063845.AVI

WELL VI EO LOG

FACILIT NAME:	ATE TIME:	SURFACE CON ITIONS:
CUF	10 06 2016 15:45	Good
WELL NO.:	**WEAT ER CON ITIONS:**	**EPT TO WATER FT :**
CUF-207	Sunny, 84°F	34.43
PUMP NO. PUI :	**CAMERA MO EL:**	**TOTAL WELL EPT FT :**
ED-061602-016	Geovision	85.7
UNI NO.:	**OTSPOT SIGNAL PROVI ER:**	**INSI E WELL IA. IN :**
CUF-00-GW-43-016	Veri on	4.0
LOGGE B :	**OTSPOT SIGNAL STRENGT :**	**OUTSI E WELL IA. IN**
F. Thaxton, D. Smith	4 bars	4.5

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

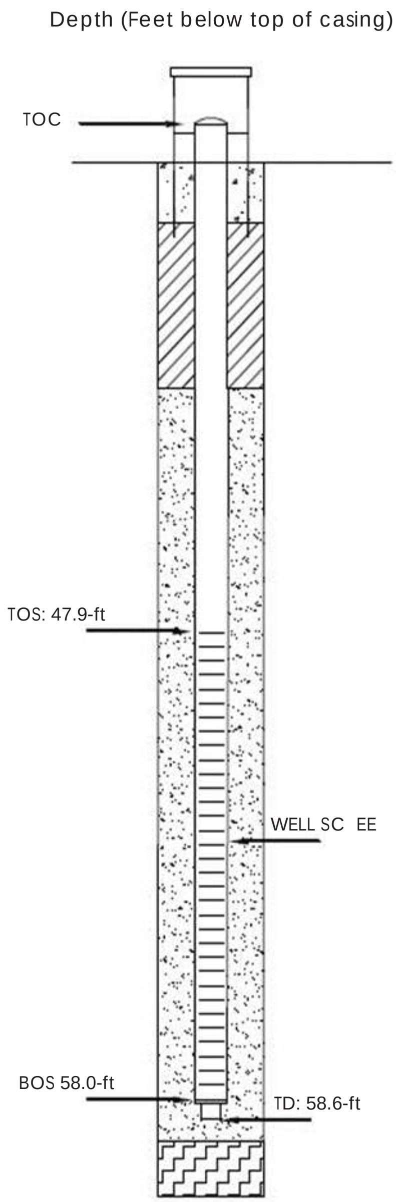
NOTES:
All depths measured from top of casing (TOC).

VI EO FILE NAME: TVA_CUF-207_052452.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 06 2016 14:50	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-208	**WEAT ER CON ITIONS:** Sunny, 86°F	**EPT TO WATER FT :** 39.00
PUMP NO. PUI : ED-061602-017	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 58.6
UNI NO.: CUF-00-GW-43-017	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 4 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout



E :
TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

VI EO FILE NAME: TVA_CUF-208_042438.AVI

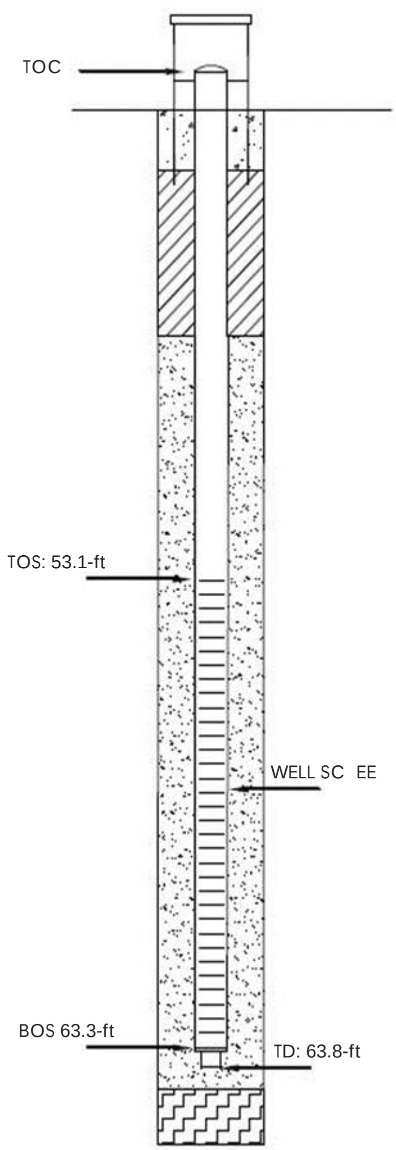
Stantec

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 06 2016 13:50	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-209	**WEAT ER CON ITIONS:** Sunny, 80°F	**EPT TO WATER FT :** 36.94
PUMP NO. PUI : ED-061602-018	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 63.8
UNI NO.: CUF-00-GW-43-018	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 3 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

Cloudy screen from 61.4-ft. to 62.6-ft.

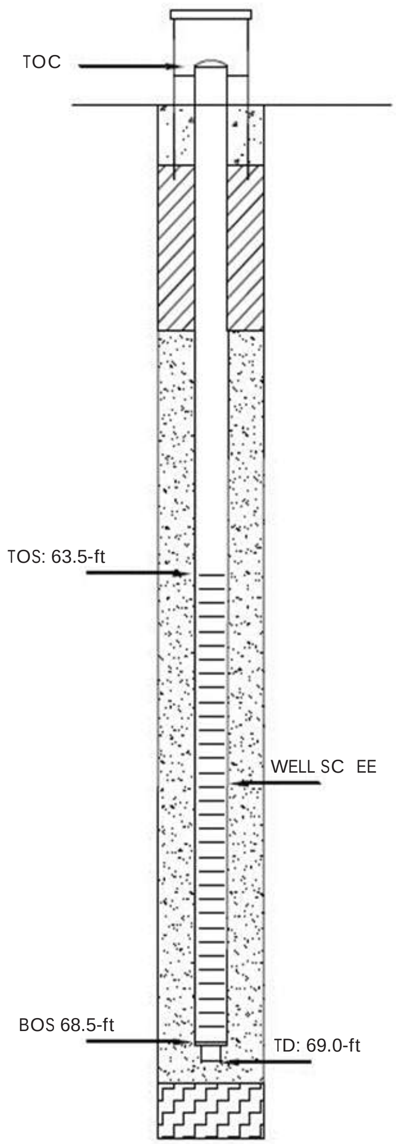
VI EO FILE NAME: TVA_CUF-209_032555.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 06 2016 12:30	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-210	**WEAT ER CON ITIONS:** Sunny, 77°F	**EPT TO WATER FT :** 28.45
PUMP NO. PUI : ED-061602-019	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 69.0
UNI NO.: CUF-00-GW-43-019	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 3 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

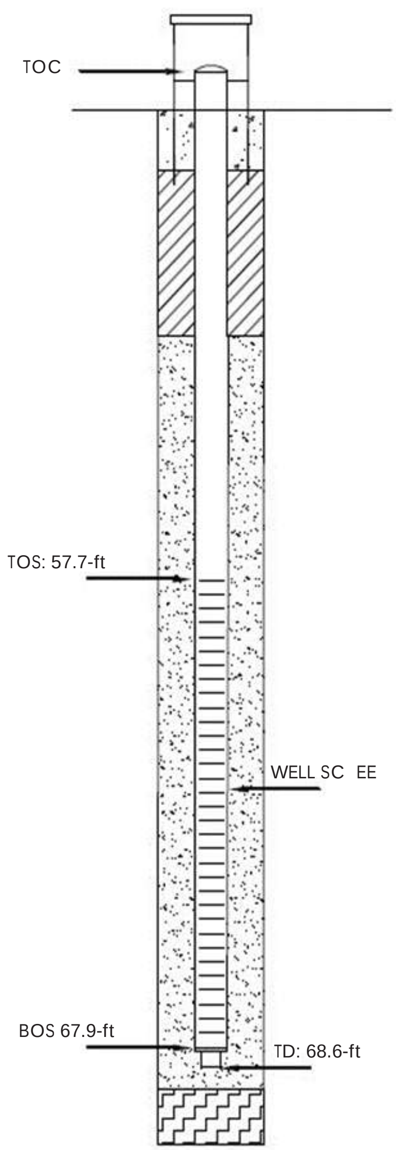
VI EO FILE NAME: TVA_CUF-210_022527.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 06 2016	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-211	**WEAT ER CON ITIONS:** Sunny, 77°F	**EPT TO WATER FT :** 39.59
PUMP NO. PUI : ED-061602-020	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 68.6
UNI NO.: CUF-00-GW-43-020	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 3 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

VI EO FILE NAME: TVA_CUF-211_000934.AVI

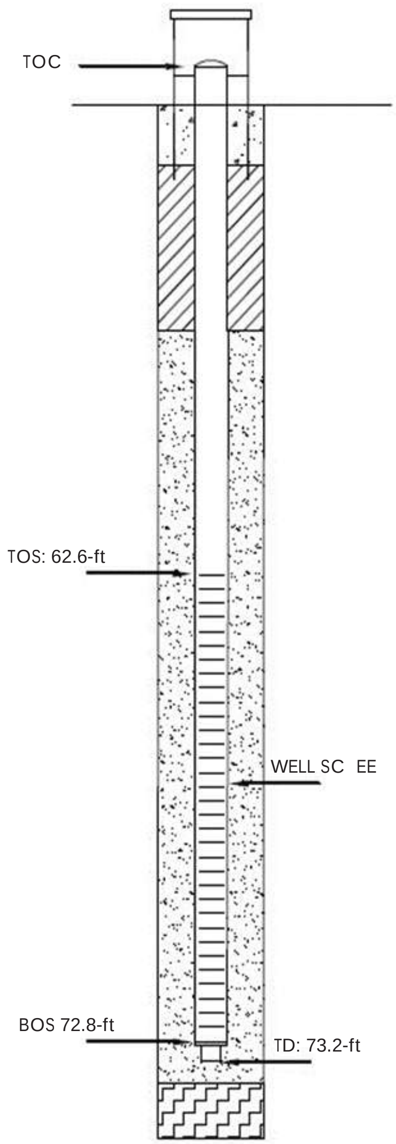
Stantec

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 06 2016 09:20	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-212	**WEAT ER CON ITIONS:** Sunny, 70°F	**EPT TO WATER FT :** 43.90
PUMP NO. PUI : ED-061602-021	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 73.2
UNI NO.: CUF-00-GW-43-021	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 3 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E :
TOC Top of Casing
TOS Top of Screen
BOS Bottom of Screen
TD Total Depth

Observations

STRUCTURAL AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

Dirty black screen at 62.9-ft.

Debris (metal nut) in bottom of well.

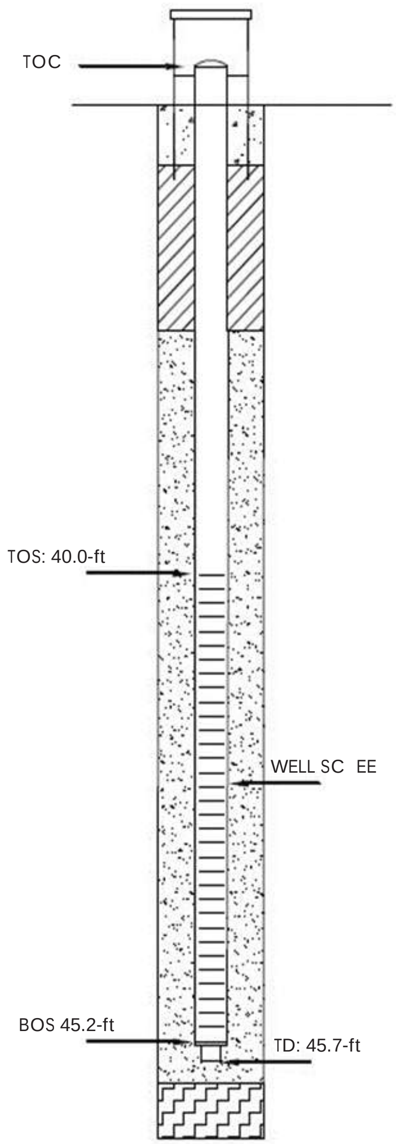
VI EO FILE NAME: TVA_CUF-212_230456.AVI

WELL VI EO LOG

FACILIT NAME: CUF	**ATE TIME:** 10 06 2016 07:15	**SURFACE CON ITIONS:** Good
WELL NO.: CUF-213	**WEAT ER CON ITIONS:** Sunny, 63°F	**EPT TO WATER FT :** 21.37
PUMP NO. PUI : ED-061602-022	**CAMERA MO EL:** Geovision	**TOTAL WELL EPT FT :** 45.7
UNI NO.: CUF-00-GW-43-022	**OTSPOT SIGNAL PROVI ER:** Veri on	**INSI E WELL IA. IN :** 4.0
LOGGE B : F. Thaxton, D. Smith	**OTSPOT SIGNAL STRENGT :** 5 bars	**OUTSI E WELL IA. IN** 4.5

Well Layout

Depth (Feet below top of casing)



E : TOC   Top of Casing
TOS   Top of Screen
BOS   Bottom of Screen
TD   Total Depth

Observations

STRUCTURAL   AMAGE OBSTRUCTION:
o structural damage or obstructions.

NOTES:
All depths measured from top of casing (TOC).

VI EO FILE NAME: TVA_CUF-213_214315.AVI

APPENDIX H
ANALYTICAL TEST RESULTS

ANALYTICAL REPORT

June 24, 2016

Stantec Consulting Corp - TN

Sample Delivery Group:	L838637
Samples Received:	05/31/2016
Project Number:	175565299
Description:	TVA-CUF GWMW Installations - CCP
Site:	TVA-CUF
Report To:	Mr. Briggs Evans 601 Grassmere Park Road; Ste 22 Nashville, TN 37211

Entire Report Reviewed By: Terrie Fudge

Terrie Fudge
Technical Service Representative

TABLE OF CONTENTS

	Collected by	Collected date/time	Received date/time
CUF-201 15-24FT L838637-01 Solid	Jim Andrew	05/11/16 00:00	05/31/16 14:25

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Mercury by Method 7471A	WG876967	1	06/01/16 14:40	06/02/16 08:33	NJB
Metals (ICP) by Method 6010B	WG876953	1	06/01/16 13:55	06/02/16 03:00	CCE
Metals (ICPMS) by Method 6020	WG880755	5	06/16/16 10:42	06/17/16 13:17	RDS
Wet Chemistry by Method 4500NOrg C-2011	WG881893	1	06/21/16 12:49	06/21/16 18:39	JER
Wet Chemistry by Method 9045D	WG881088	1	06/20/16 09:36	06/20/16 09:36	MHM
Wet Chemistry by Method 9056A	WG881686	1	06/20/16 13:30	06/20/16 19:36	CM
Wet Chemistry by Method USDA LOI	WG881779	1	06/21/16 11:00	06/22/16 16:12	MMF

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Terrie Fudge

Terrie Fudge
Technical Service Representative

Sample Handling and Receiving

The following samples were prepared and/or analyzed past recommended holding time. Concentrations should be considered minimum values.

ESC Sample ID	Project Sample ID	Method
L838637-01	CUF-201 15-24FT	9045D, USDA LOI

Wet Chemistry by Method 4500NOrg C-2011

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Kjeldahl Nitrogen, TKN	302		20.0	1	06/21/2016 18:39	WG881893

Wet Chemistry by Method 9045D

Analyte	Result su	Qualifier	Dilution	Analysis date / time	Batch
pH	6.47		1	06/20/2016 09:36	WG881088

Sample Narrative:

9045D L838637-01 WG881088: 6.47 at 21.1c

Wet Chemistry by Method 9056A

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Chloride	91.3		10.0	1	06/20/2016 19:36	WG881686
Fluoride	2.19		1.00	1	06/20/2016 19:36	WG881686
Nitrate-Nitrite	ND		2.00	1	06/20/2016 19:36	WG881686
Phosphate as P	3.55		1.00	1	06/20/2016 19:36	WG881686

Wet Chemistry by Method USDA LOI

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
TOC (Total Organic Carbon)	8190		10.0	1	06/22/2016 16:12	WG881779

Mercury by Method 7471A

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Mercury	0.0332	B	0.0200	1	06/02/2016 08:33	WG876967

Metals (ICP) by Method 6010B

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Aluminum	3320		10.0	1	06/02/2016 03:00	WG876953
Antimony	ND		2.00	1	06/02/2016 03:00	WG876953
Arsenic	ND		2.00	1	06/02/2016 03:00	WG876953
Barium	46.0		0.500	1	06/02/2016 03:00	WG876953
Beryllium	0.379		0.200	1	06/02/2016 03:00	WG876953
Boron	ND		10.0	1	06/02/2016 03:00	WG876953
Cadmium	ND		0.500	1	06/02/2016 03:00	WG876953
Calcium	1030		100	1	06/02/2016 03:00	WG876953
Chromium	10.1		1.00	1	06/02/2016 03:00	WG876953
Cobalt	5.38		1.00	1	06/02/2016 03:00	WG876953
Copper	5.70		2.00	1	06/02/2016 03:00	WG876953
Iron	6300		10.0	1	06/02/2016 03:00	WG876953
Lead	11.5		0.500	1	06/02/2016 03:00	WG876953
Lithium	ND		5.00	1	06/02/2016 03:00	WG876953
Manganese	117		1.00	1	06/02/2016 03:00	WG876953
Molybdenum	ND		0.500	1	06/02/2016 03:00	WG876953
Nickel	7.41		2.00	1	06/02/2016 03:00	WG876953
Selenium	ND		2.00	1	06/02/2016 03:00	WG876953
Silver	ND		1.00	1	06/02/2016 03:00	WG876953
Strontium	4.85		1.00	1	06/02/2016 03:00	WG876953
Sulfur	ND		100	1	06/02/2016 03:00	WG876953
Thallium	ND		2.00	1	06/02/2016 03:00	WG876953

Metals (ICP) by Method 6010B

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Tin	ND		5.00	1	06/02/2016 03:00	WG876953
Vanadium	12.7		2.00	1	06/02/2016 03:00	WG876953
Zinc	35.2		5.00	1	06/02/2016 03:00	WG876953

Metals (ICPMS) by Method 6020

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Uranium	ND		5.00	5	06/17/2016 13:17	WG880755

1 Cp | 2 Tc | 3 Ss | 4 Cn | 5 Sr | 6 Qc | 7 Gl | 8 Al | 9 Sc

Method Blank (MB)

(MB) R3145001-1 06/21/16 18:34

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Kjeldahl Nitrogen, TKN	4.88	B J	4.48	20.0

L841520-01 Original Sample (OS) • Duplicate (DUP)

(OS) L841520-01 06/21/16 18:43 • (DUP) R3145001-6 06/21/16 18:44

Analyte	Original Result mg/kg	DUP Result mg/kg	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Kjeldahl Nitrogen, TKN	6420	6860	50	7.00		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3145001-2 06/21/16 18:35 • (LCSD) R3145001-3 06/21/16 18:37

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Kjeldahl Nitrogen, TKN	882	832	928	94.0	105	50.0-150			11.0	20

L838637-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L838637-01 06/21/16 18:39 • (MS) R3145001-4 06/21/16 18:40 • (MSD) R3145001-5 06/21/16 18:41

Analyte	Spike Amount mg/kg	Original Result mg/kg	MS Result mg/kg	MSD Result mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Kjeldahl Nitrogen, TKN	400	302	680	720	95.0	105	1	90.0-110			6.00	20

L841779-01 Original Sample (OS) • Duplicate (DUP)

(OS) L841779-01 06/20/16 09:36 • (DUP) WG881088-3 06/20/16 09:36

	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
Analyte	su	su		%		%
pH	8.23	8.28	1	0.606		1

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG881088-1 06/20/16 09:36 • (LCSD) WG881088-2 06/20/16 09:36

	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
Analyte	su	su	su	%	%	%			%	%
pH	6.12	6.16	6.21	101	101	98.4-102			0.808	1

Method Blank (MB)

(MB) R3144747-2 06/20/16 15:00

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Chloride	U		0.795	10.0
Fluoride	U		0.261	1.00
Nitrate-Nitrite	U		0.107	2.00
Phosphate as P	U		0.0769	1.00

L842421-03 Original Sample (OS) • Duplicate (DUP)

(OS) L842421-03 06/21/16 01:59 • (DUP) R3144747-7 06/21/16 02:23

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Chloride	975	967	1	1		15
Fluoride	5.57	7.04	1	23	J3	15
Nitrate-Nitrite	4.17	4.19	1	0		15
Phosphate as P	2.34	2.96	1	23	P1	15

L842421-01 Original Sample (OS) • Duplicate (DUP)

(OS) L842421-01 06/21/16 07:30 • (DUP) R3144747-8 06/21/16 07:54

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Chloride	185	158	1	16	J3	15
Fluoride	4.88	6.56	1	29	J3	15
Nitrate-Nitrite	U	0.000	1	0		15
Phosphate as P	U	0.000	1	0		15

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3144747-3 06/20/16 15:24 • (LCSD) R3144747-4 06/20/16 15:48

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Chloride	200	199	199	99	100	80-120			0	15
Fluoride	20.0	20.2	20.3	101	101	80-120			0	15
Nitrate-Nitrite	40.0	40.0	40.2	100	100	80-120			0	15
Phosphate as P	20.0	19.4	19.5	97	98	80-120			1	15

L842421-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L842421-02 06/21/16 00:00 • (MS) R3144747-5 06/21/16 00:24 • (MSD) R3144747-6 06/21/16 00:47

	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
Analyte	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Chloride	500	129	681	663	110	107	1	80-120			3	15
Fluoride	50.0	5.54	43.5	41.8	76	73	1	80-120	J6	J6	4	15
Nitrate-Nitrite	100	2.18	111	108	109	106	1	80-120			3	15
Phosphate as P	50.0	U	20.5	20.4	41	41	1	80-120	J6	J6	0	15

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3145162-1 06/22/16 16:40

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
TOC (Total Organic Carbon)	U		3.33	10.0

L841374-04 Original Sample (OS) • Duplicate (DUP)

(OS) L841374-04 06/22/16 16:12 • (DUP) R3145162-4 06/22/16 16:12

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
TOC (Total Organic Carbon)	958	801	1	17.9		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3145162-2 06/22/16 16:11 • (LCSD) R3145162-3 06/22/16 16:10

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
TOC (Total Organic Carbon)	5820	6060	6120	104	105	50.0-150			0.983	20

Method Blank (MB)

(MB) R3141071-1 06/02/16 07:50

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Mercury	0.00373	J	0.0028	0.0200

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3141071-2 06/02/16 07:52 • (LCSD) R3141071-3 06/02/16 07:55

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Mercury	0.300	0.277	0.276	92	92	80-120			0	20

L838520-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L838520-01 06/02/16 07:57 • (MS) R3141071-4 06/02/16 08:00 • (MSD) R3141071-5 06/02/16 08:03

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Mercury	0.300	0.0250	0.303	0.294	93	90	1	75-125			3	20

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3141037-1 06/02/16 02:28

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Aluminum	U		3.5	10.0
Antimony	U		0.75	2.00
Arsenic	U		0.65	2.00
Barium	U		0.17	0.500
Beryllium	U		0.07	0.200
Boron	U		1.26	10.0
Cadmium	U		0.07	0.500
Calcium	U		4.63	100
Chromium	U		0.14	1.00
Cobalt	U		0.23	1.00
Copper	U		0.53	2.00
Iron	U		1.41	10.0
Lead	U		0.19	0.500
Lithium	U		0.53	5.00
Manganese	U		0.12	1.00
Molybdenum	U		0.16	0.500
Nickel	U		0.49	2.00
Selenium	U		0.74	2.00
Silver	U		0.28	1.00
Strontium	U		0.17	1.00
Sulfur	U		22	100
Thallium	U		0.65	2.00
Tin	U		0.44	5.00
Vanadium	U		0.24	2.00
Zinc	U		0.59	5.00

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3141037-2 06/02/16 02:30 • (LCSD) R3141037-3 06/02/16 02:33

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Aluminum	1000	975	1010	97	101	80-120			3	20
Antimony	100	98.3	100	98	100	80-120			2	20
Arsenic	100	98.6	101	99	101	80-120			3	20
Barium	100	99.0	101	99	101	80-120			2	20
Beryllium	100	94.9	98.0	95	98	80-120			3	20
Boron	100	97.7	98.5	98	98	80-120			1	20
Cadmium	100	97.8	99.8	98	100	80-120			2	20
Calcium	1000	944	970	94	97	80-120			3	20

1 Cp 2 Tc 3 Ss 4 Cn 5 Sr 6 Qc 7 Gl 8 Al 9 Sc

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3141037-2 06/02/16 02:30 • (LCSD) R3141037-3 06/02/16 02:33

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Chromium	100	97.6	98.9	98	99	80-120			1	20
Cobalt	100	97.2	99.5	97	100	80-120			2	20
Copper	100	97.6	100	98	100	80-120			2	20
Iron	1000	977	1010	98	101	80-120			3	20
Lead	100	95.1	97.7	95	98	80-120			3	20
Lithium	100	96.8	99.0	97	99	80-120			2	20
Manganese	100	94.3	96.6	94	97	80-120			2	20
Molybdenum	100	103	104	103	104	80-120			1	20
Nickel	100	97.2	100	97	100	80-120			3	20
Selenium	100	101	102	101	102	80-120			2	20
Silver	100	95.0	95.9	95	96	80-120			1	20
Strontium	100	96.2	99.5	96	100	80-120			3	20
Sulfur	1000	900	943	90	94	80-120			5	20
Thallium	100	92.1	95.4	92	95	80-120			3	20
Tin	100	95.5	97.8	96	98	80-120			2	20
Vanadium	100	96.0	98.4	96	98	80-120			2	20
Zinc	100	93.1	95.4	93	95	80-120			2	20

L838721-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L838721-01 06/02/16 02:36 • (MS) R3141037-6 06/02/16 02:44 • (MSD) R3141037-7 06/02/16 02:46

Analyte	Spike Amount mg/kg	Original Result mg/kg	MS Result mg/kg	MSD Result mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Aluminum	1000	3240	3800	4060	56	82	1	75-125	J6		7	20
Antimony	100	ND	81.7	80.4	82	80	1	75-125			2	20
Arsenic	100	2.34	92.6	96.2	90	94	1	75-125			4	20
Barium	100	95.5	163	177	68	82	1	75-125	J6		8	20
Beryllium	100	0.795	89.3	92.7	88	92	1	75-125			4	20
Boron	100	ND	92.7	95.9	90	94	1	75-125			3	20
Cadmium	100	ND	92.1	95.3	92	95	1	75-125			3	20
Calcium	1000	3720	3380	4030	0	31	1	75-125	J6	J6	17	20
Chromium	100	3.51	92.8	96.4	89	93	1	75-125			4	20
Cobalt	100	3.48	97.0	101	94	97	1	75-125			4	20
Copper	100	7.44	98.1	103	91	96	1	75-125			5	20
Iron	1000	4830	5610	5800	77	96	1	75-125			3	20
Lead	100	31.0	115	115	84	84	1	75-125			0	20
Lithium	100	ND	95.8	99.0	93	97	1	75-125			3	20
Manganese	100	231	271	303	40	72	1	75-125	E J6	E J6	11	20
Molybdenum	100	ND	90.2	90.5	90	91	1	75-125			0	20

L838721-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L838721-01 06/02/16 02:36 • (MS) R3141037-6 06/02/16 02:44 • (MSD) R3141037-7 06/02/16 02:46

Analyte	Spike Amount mg/kg	Original Result mg/kg	MS Result mg/kg	MSD Result mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Nickel	100	4.49	104	102	100	98	1	75-125			2	20
Selenium	100	ND	91.4	93.5	91	94	1	75-125			2	20
Silver	100	ND	87.2	90.9	87	91	1	75-125			4	20
Strontium	100	41.1	118	127	77	86	1	75-125			7	20
Sulfur	1000	ND	886	986	84	94	1	75-125			11	20
Thallium	100	ND	88.4	91.6	88	92	1	75-125			4	20
Tin	100	ND	88.3	90.6	88	90	1	75-125			3	20
Vanadium	100	10.7	97.3	102	87	91	1	75-125			4	20
Zinc	100	52.3	122	127	70	74	1	75-125	J6	J6	4	20

Method Blank (MB)

(MB) R3144284-9 06/17/16 14:21

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Uranium	U		0.08	5.00

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3144284-10 06/17/16 14:24 • (LCSD) R3144284-15 06/17/16 14:49

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Uranium	100	105	108	105	108	80-120			3	20

L841423-05 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L841423-05 06/17/16 14:32 • (MS) R3144284-13 06/17/16 14:40 • (MSD) R3144284-14 06/17/16 14:43

Analyte	Spike Amount (dry)	Original Result (dry)	MS Result (dry)	MSD Result (dry)	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Uranium	24.0	0.956	126	126	104	104	5	75-125			0	20

Abbreviations and Definitions

SDG	Sample Delivery Group.
MDL	Method Detection Limit.
RDL	Reported Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
U	Not detected at the Reporting Limit (or MDL where applicable).
RPD	Relative Percent Difference.
(dry)	Results are reported based on the dry weight of the sample. [this will only be present on a dry report basis for soils].
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Rec.	Recovery.

Qualifier	Description
B	The same analyte is found in the associated blank.
E	The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration (ICAL).
J	The identification of the analyte is acceptable; the reported value is an estimate.
J3	The associated batch QC was outside the established quality control range for precision.
J6	The sample matrix interfered with the ability to make any accurate determination; spike value is low.
P1	RPD value not applicable for sample concentrations less than 5 times the reporting limit.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Conneticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

1. Drinking Water 2. Underground Storage Tanks 3. Aquatic Toxicity 4. Chemical/Microbiological 5. Mold n/a Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**

Company Name/Address:
Stantec
601 Grassmere Park Road; Ste 22
Nashville, TN 37211

Billing Information:
attn: Chardonne Dixon
601 Grassmere Park Rd; Ste 22
Nashville, TN 37211

Chain of Custody Page 1 of 1

ESC L·A·B S·C·I·E·N·C·E·S
YOUR LAB OF CHOICE
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to: Briggs Evans

Email To: briggs.evans@stantec.com

Project Description: TVA-CUF GWMW Installations - CCP

City/State Collected: Cumberland City, TN

Phone: 615-885-1144
Fax: 615-885-1102

Client Project #: 175565299

Lab Project #:

Collected by (print): Jim Andrew

Site/Facility ID #: TVA-CUF

P.O. #: 175565299

Collected by (signature): Jim W. Andrew

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%
___ Three Day 25%

Date Results Needed
Email? ___No ✓ Yes
FAX? ___No ___Yes

Immediately Packed on Ice N ___ Y ✓

L #: L838037

Table #:

Acctnum: SECOR
Template:
Prelogin:
TSR: 064 T. Fudge
PB:
Shipped Via: Courier

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	See Attached TAL	See Attached TAL	See Attached TAL	See Attached TAL						Rem./Contaminant	Sample # (lab only)
CUF-201 15' - 24'	Comp	SS	15-24	5/11/2016		4	X	X	X	X							-01

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

pH ________ Temp ________

Flow ________ Other ________

Remarks: **Please note the sample date in regards to hold times for Cl/FL No2/No**

Hold #

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☑ Courier ☐ ____	Condition: (lab use only)
[signature]	5-31-16	1000	Johnny Fisher		OK TO4
Relinquished by: (Signature)	**Date:**	**Time:**	**Received by: (Signature)**	**Temp: °C / Bottles Received:**	**COC Seal Intact: ___Y ___N ✓ NA**
Johnny Fisher	5/31/16	14:25	[signature]	2.4°C / 4	
Relinquished by: (Signature)	**Date:**	**Time:**	**Received for lab by: (Signature)**	**Date: / Time:**	**pH Checked: / NCF:**
			[signature]	5-31-16 / 1425	

L838637

ANALYTE LIST, ANALYTICAL METHODS, AND REPORTING LIMIT OBJECTIVES FOR BACKGROUND SOIL SAMPLING CCP GROUNDWATER PROGRAM

Parameter	Analytical Method	Residential Soil Screening Level[1] (mg/Kg)	Industrial Soil Screening Level[1] (mg/Kg)
Metals			
Aluminum	USEPA Method 6010	77,000	1,100,000
Antimony	USEPA Method 6010	31	470
Arsenic	USEPA Method 6010	0.68	3.0
Barium	USEPA Method 6010	15,000	220,000
Beryllium	USEPA Method 6010	160	2,300
Boron	USEPA Method 6010	16,000	230,000
Cadmium	USEPA Method 6010	71	980
Calcium	USEPA Method 6010	NE	NE
Chromium	USEPA Method 6010	120,000[2]	1,800,000[2]
Cobalt	USEPA Method 6010	23	350
Copper	USEPA Method 6010	3,100	47,000
Iron	USEPA Method 6010	55,000	820,000
Lead	USEPA Method 6010	400	800
Lithium	USEPA Method 6010	160	2,300
Manganese	USEPA Method 6010	1,800	26,000
Mercury	USEPA Method 7470	9.4	40
Molybdenum	USEPA Method 6010	390	5,800
Nickel	USEPA Method 6010	1,500	22,000
Selenium	USEPA Method 6010	390	5,800
Silver	USEPA Method 6010	390	5,800
Strontium	USEPA Method 6010	47,000	700,000
Sulfur	USEPA Method 6010	NE	NE
Thallium	USEPA Method 6010	0.78	12
Tin	USEPA Method 6010	47,000	700,000
Uranium	USEPA Method 6010	230	3,500
Vanadium	USEPA Method 6010	390	5,800
Zinc	USEPA Method 6010	23,000	350,000
General Chemistry			
Chloride	ASTM D3987/ USEPA Method 9056	NE	NE
Fluoride	ASTM D3987/USEPA Method 9056	3,100	47,000
Nitrate-Nitrite	ASTM D3987/USEPA Method 353.2	NE	NE
Phosphorus	USEPA Method 365.4	NE	NE
pH	ASTM D3987/USEPA Method 9040	NE	NE
Radium -226[3]	EPA 600/Method 903.1	NE	NE
Radium -228[4]	EPA 600/Method 904.1	NE	NE
Total Kjeldahl Nitrogen	ASTM D3987/USEPA Method 351.2	NE	NE
Total Organic Carbon	EPA Method 9060	NE	NE

NE – Not established
mg/kg – Milligram per kilogram

Notes:

[1] Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites for Residential and Industrial Soils with target hazard quotient of 1.0 (June 2015)

[2] Preliminary SRG for total chromium has not been established; values provided are for insoluable salts chromium (III) PSRGs.

[3] Radium -226 samples are subjected to a minimum 21 day ingrowth period.

[4] Radium -228 samples are subjected to an ingrowth period of approximately 30 hours.

ANALYTICAL REPORT

June 27, 2016

Stantec Consulting Corp - TN

Sample Delivery Group:	L842508
Samples Received:	06/20/2016
Project Number:	175565299
Description:	TVA-CUF GW/MW Installations
Site:	TVA-CUF
Report To:	Mr. Briggs Evans 601 Grassmere Park Road; Ste 22 Nashville, TN 37211

Entire Report Reviewed By:

Terrie Fudge

Technical Service Representative

TABLE OF CONTENTS

	Collected by	Collected date/time	Received date/time
CUF-202 11-16FT L842508-01 Solid	Jim Andrew	06/01/16 00:00	06/20/16 15:15

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Mercury by Method 7471A	WG882438	1	06/22/16 13:19	06/23/16 09:34	NJB
Metals (ICP) by Method 6010B	WG882068	1	06/21/16 13:55	06/22/16 03:54	LTB
Metals (ICP) by Method 6010B	WG882068	1	06/21/16 13:55	06/22/16 08:14	LTB
Metals (ICP) by Method 6010B	WG882068	1	06/21/16 13:55	06/22/16 10:22	CCE
Metals (ICPMS) by Method 6020	WG882292	5	06/22/16 07:14	06/22/16 12:39	JDG
Wet Chemistry by Method 4500NOrg C-2011	WG883209	1	06/25/16 12:00	06/27/16 12:51	JER
Wet Chemistry by Method 9045D	WG882129	1	06/23/16 10:01	06/23/16 10:01	MHM
Wet Chemistry by Method 9056A	WG882844	1	06/24/16 10:45	06/24/16 14:53	SAM
Wet Chemistry by Method USDA LOI	WG881779	1	06/21/16 11:00	06/22/16 16:12	MMF

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Terrie Fudge

Terrie Fudge
Technical Service Representative

Sample Handling and Receiving

The following samples were prepared and/or analyzed past recommended holding time. Concentrations should be considered minimum values.

ESC Sample ID	Project Sample ID	Method
L842508-01	CUF-202 11-16FT	9045D

Wet Chemistry by Method 4500NOrg C-2011

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Kjeldahl Nitrogen, TKN	210		20.0	1	06/27/2016 12:51	WG883209

Wet Chemistry by Method 9045D

Analyte	Result su	Qualifier	Dilution	Analysis date / time	Batch
pH	6.99		1	06/23/2016 10:01	WG882129

Sample Narrative:

9045D L842508-01 WG882129: 6.99 at 22.4c

Wet Chemistry by Method 9056A

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Chloride	ND		10.0	1	06/24/2016 14:53	WG882844
Fluoride	ND		1.00	1	06/24/2016 14:53	WG882844
Nitrate-Nitrite	ND		2.00	1	06/24/2016 14:53	WG882844
Phosphate as P	1.08		1.00	1	06/24/2016 14:53	WG882844

Wet Chemistry by Method USDA LOI

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
TOC (Total Organic Carbon)	6230		10.0	1	06/22/2016 16:12	WG881779

Mercury by Method 7471A

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Mercury	0.0222		0.0200	1	06/23/2016 09:34	WG882438

Metals (ICP) by Method 6010B

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Aluminum	12500		10.0	1	06/22/2016 03:54	WG882068
Antimony	ND		2.00	1	06/22/2016 03:54	WG882068
Arsenic	27.8		2.00	1	06/22/2016 03:54	WG882068
Barium	85.8		0.500	1	06/22/2016 03:54	WG882068
Beryllium	1.94		0.200	1	06/22/2016 03:54	WG882068
Cadmium	0.526		0.500	1	06/22/2016 03:54	WG882068
Calcium	1810		100	1	06/22/2016 03:54	WG882068
Chromium	14.3		1.00	1	06/22/2016 03:54	WG882068
Cobalt	60.6		1.00	1	06/22/2016 03:54	WG882068
Copper	28.2		2.00	1	06/22/2016 03:54	WG882068
Iron	29000		10.0	1	06/22/2016 03:54	WG882068
Lead	13.4		0.500	1	06/22/2016 08:14	WG882068
Lithium	13.4		5.00	1	06/22/2016 03:54	WG882068
Magnesium	759		100	1	06/22/2016 03:54	WG882068
Manganese	657		1.00	1	06/22/2016 03:54	WG882068
Molybdenum	4.93		0.500	1	06/22/2016 03:54	WG882068
Nickel	191		2.00	1	06/22/2016 03:54	WG882068
Potassium	1060		100	1	06/22/2016 03:54	WG882068
Selenium	ND		2.00	1	06/22/2016 03:54	WG882068
Silver	ND		1.00	1	06/22/2016 03:54	WG882068
Sodium	ND		100	1	06/22/2016 03:54	WG882068
Strontium	35.9		1.00	1	06/22/2016 03:54	WG882068

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Metals (ICP) by Method 6010B

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Sulfur	ND		100	1	06/22/2016 03:54	WG882068
Thallium	ND		2.00	1	06/22/2016 10:22	WG882068
Tin	ND		5.00	1	06/22/2016 03:54	WG882068
Vanadium	30.1		2.00	1	06/22/2016 03:54	WG882068
Zinc	217		5.00	1	06/22/2016 03:54	WG882068

Metals (ICPMS) by Method 6020

Analyte	Result mg/kg	Qualifier	RDL mg/kg	Dilution	Analysis date / time	Batch
Uranium	ND		5.00	5	06/22/2016 12:39	WG882292

Method Blank (MB)

(MB) R3146034-2 06/27/16 12:11

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Kjeldahl Nitrogen, TKN	U		4.48	20.0

L842508-01 Original Sample (OS) • Duplicate (DUP)

(OS) L842508-01 06/27/16 12:51 • (DUP) R3146034-6 06/27/16 12:52

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Kjeldahl Nitrogen, TKN	210	253	1	18.0		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3146034-3 06/27/16 12:12 • (LCSD) R3146034-4 06/27/16 12:14

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Kjeldahl Nitrogen, TKN	882	984	920	112	104	50.0-150			7.00	20

L841779-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L841779-01 06/27/16 12:16 • (MS) R3146034-5 06/27/16 12:17

Analyte	Spike Amount	Original Result	MS Result	MS Rec.	Dilution	Rec. Limits	MS Qualifier
	mg/kg	mg/kg	mg/kg	%		%	
Kjeldahl Nitrogen, TKN	400	600	932	83.0	1	90.0-110	E J6

L842323-04 Original Sample (OS) • Duplicate (DUP)

(OS) L842323-04 06/23/16 10:01 • (DUP) WG882129-3 06/23/16 10:01

	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
Analyte	su	su		%		%
pH	5.00	4.96	1	0.803		1

L842970-02 Original Sample (OS) • Duplicate (DUP)

(OS) L842970-02 06/23/16 10:01 • (DUP) WG882129-4 06/23/16 10:01

	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
Analyte	su	su		%		%
pH	6.08	6.08	1	0.000		1

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG882129-1 06/23/16 10:01 • (LCSD) WG882129-2 06/23/16 10:01

	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
Analyte	su	su	su	%	%	%			%	%
pH	6.12	6.02	6.03	98.4	98.5	98.4-102			0.166	1

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3145839-1 06/24/16 11:22

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Chloride	U		0.795	10.0
Fluoride	U		0.261	1.00
Nitrate-Nitrite	U		0.107	2.00
Phosphate as P	U		0.0769	1.00

L842830-01 Original Sample (OS) • Duplicate (DUP)

(OS) L842830-01 06/24/16 19:16 • (DUP) R3145839-4 06/24/16 19:40

Analyte	Original Result mg/kg	DUP Result mg/kg	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Chloride	85.8	98.6	1	14		15
Fluoride	5.82	0.645	1	160	J3	15
Nitrate-Nitrite	ND	2.84	1	200	P1	15
Phosphate as P	ND	10.7	1	200	J3	15

L842989-05 Original Sample (OS) • Duplicate (DUP)

(OS) L842989-05 06/25/16 00:27 • (DUP) R3145839-7 06/25/16 00:51

Analyte	Original Result mg/kg	DUP Result mg/kg	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Chloride	4000	4180	50	4		15
Fluoride	ND	0.000	50	0		15
Nitrate-Nitrite	ND	0.000	50	0		15
Phosphate as P	ND	0.000	50	0		15

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3145839-2 06/24/16 11:46 • (LCSD) R3145839-3 06/24/16 12:10

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Chloride	200	200	198	100	99	80-120			1	15
Fluoride	20.0	20.2	20.1	101	101	80-120			0	15
Nitrate-Nitrite	40.0	40.3	39.9	101	100	80-120			1	15
Phosphate as P	20.0	19.9	20.4	99	102	80-120			2	15

L842989-03 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L842989-03 06/24/16 22:51 • (MS) R3145839-5 06/24/16 23:15 • (MSD) R3145839-6 06/24/16 23:39

Analyte	Spike Amount mg/kg	Original Result mg/kg	MS Result mg/kg	MSD Result mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Chloride	10.0	2410	2820	2720	83	64	50	80-120		V	3	15
Fluoride	1.00	ND	19.4	19.9	39	40	50	80-120	J6	J6	0	15
Nitrate-Nitrite	2.00	ND	ND	ND	0	0	50	80-120	J6	J6	0	15
Phosphate as P	1.00	ND	49.5	44.8	99	90	50	80-120			0	15

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

QUALITY CONTROL SUMMARY

L842508-01

Method Blank (MB)

(MB) R3145162-1 06/22/16 16:40

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
TOC (Total Organic Carbon)	U		3.33	10.0

L841374-04 Original Sample (OS) • Duplicate (DUP)

(OS) L841374-04 06/22/16 16:12 • (DUP) R3145162-4 06/22/16 16:12

Analyte	Original Result mg/kg	DUP Result mg/kg	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
TOC (Total Organic Carbon)	958	801	1	17.9		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3145162-2 06/22/16 16:11 • (LCSD) R3145162-3 06/22/16 16:10

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
TOC (Total Organic Carbon)	5820	6060	6120	104	105	50.0-150			0.983	20

Method Blank (MB)

(MB) R3145314-1 06/23/16 08:48

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Mercury	U		0.0028	0.0200

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3145314-2 06/23/16 08:51 • (LCSD) R3145314-3 06/23/16 08:53

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Mercury	0.300	0.278	0.277	93	92	80-120			0	20

L842446-21 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L842446-21 06/23/16 08:56 • (MS) R3145314-4 06/23/16 08:58 • (MSD) R3145314-5 06/23/16 09:01

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Mercury	0.362	0.0665	0.388	0.396	89	91	1	75-125			2	20

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3144916-1 06/22/16 02:31

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Aluminum	U		3.5	10.0
Antimony	U		0.75	2.00
Arsenic	U		0.65	2.00
Barium	U		0.17	0.500
Beryllium	U		0.07	0.200
Cadmium	U		0.07	0.500
Calcium	U		4.63	100
Chromium	U		0.14	1.00
Cobalt	U		0.23	1.00
Copper	U		0.53	2.00
Iron	U		1.41	10.0
Lead	U		0.19	0.500
Lithium	U		0.53	5.00
Magnesium	1.14	J	1.11	100
Manganese	U		0.12	1.00
Molybdenum	U		0.16	0.500
Nickel	U		0.49	2.00
Potassium	U		10.2	100
Selenium	U		0.74	2.00
Silver	U		0.28	1.00
Sodium	41	J	9.85	100
Strontium	U		0.17	1.00
Sulfur	U		22	100
Thallium	U		0.65	2.00
Tin	0.845	J	0.44	5.00
Vanadium	U		0.24	2.00
Zinc	U		0.59	5.00

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3144916-2 06/22/16 02:34 • (LCSD) R3144916-3 06/22/16 02:36

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Aluminum	1000	1000	995	100	99	80-120			1	20
Antimony	100	100	93.1	100	93	80-120			8	20
Arsenic	100	99.4	92.1	99	92	80-120			8	20
Barium	100	102	95.4	102	95	80-120			7	20
Beryllium	100	101	94.4	101	94	80-120			7	20
Cadmium	100	100	93.1	100	93	80-120			7	20

1 Cp | 2 Tc | 3 Ss | 4 Cn | 5 Sr | 6 Qc | 7 Gl | 8 Al | 9 Sc

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3144916-2 06/22/16 02:34 • (LCSD) R3144916-3 06/22/16 02:36

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Calcium	1000	997	946	100	95	80-120			5	20
Chromium	100	100	93.4	100	93	80-120			7	20
Cobalt	100	102	95.0	102	95	80-120			7	20
Copper	100	101	94.1	101	94	80-120			7	20
Iron	1000	998	981	100	98	80-120			2	20
Lead	100	101	93.8	101	94	80-120			7	20
Lithium	100	102	94.8	102	95	80-120			7	20
Magnesium	1000	1010	951	101	95	80-120			6	20
Manganese	100	97.5	91.3	98	91	80-120			7	20
Molybdenum	100	102	94.9	102	95	80-120			7	20
Nickel	100	102	94.7	102	95	80-120			7	20
Potassium	1000	952	888	95	89	80-120			7	20
Selenium	100	101	94.0	101	94	80-120			7	20
Silver	100	97.6	91.0	98	91	80-120			7	20
Sodium	1000	1020	952	102	95	80-120			7	20
Strontium	100	99.7	93.0	100	93	80-120			7	20
Sulfur	1000	947	879	95	88	80-120			7	20
Thallium	100	99.4	92.4	99	92	80-120			7	20
Tin	100	99.8	93.0	100	93	80-120			7	20
Vanadium	100	99.9	93.1	100	93	80-120			7	20
Zinc	100	98.8	92.0	99	92	80-120			7	20

L842448-16 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L842448-16 06/22/16 02:39 • (MS) R3144916-6 06/22/16 02:47 • (MSD) R3144916-7 06/22/16 02:50

Analyte	Spike Amount mg/kg	Original Result mg/kg	MS Result mg/kg	MSD Result mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Aluminum	1000	21600	25500	25800	386	415	1	75-125	V	V	1	20
Antimony	100	U	42.0	40.9	42	41	1	75-125	J6	J6	3	20
Arsenic	100	4.45	99.7	101	95	96	1	75-125			1	20
Barium	100	134	248	250	114	116	1	75-125			1	20
Beryllium	100	0.632	96.6	97.9	96	97	1	75-125			1	20
Cadmium	100	0.106	97.9	98.7	98	99	1	75-125			1	20
Calcium	1000	4900	6120	6150	121	125	1	75-125			1	20
Chromium	100	18.0	114	115	96	97	1	75-125			1	20
Cobalt	100	11.5	121	125	109	114	1	75-125			3	20
Copper	100	18.6	118	120	99	102	1	75-125			2	20
Iron	1000	33200	34200	34600	102	144	1	75-125		V	1	20
Lead	100	5.47	108	109	102	103	1	75-125			1	20

L842448-16 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L842448-16 06/22/16 02:39 • (MS) R3144916-6 06/22/16 02:47 • (MSD) R3144916-7 06/22/16 02:50

Analyte	Spike Amount mg/kg	Original Result mg/kg	MS Result mg/kg	MSD Result mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Lithium	100	9.84	111	112	101	102	1	75-125			1	20
Magnesium	1000	5770	7080	7370	131	161	1	75-125	V	V	4	20
Manganese	100	545	623	713	78	168	1	75-125		V	14	20
Molybdenum	100	U	91.4	91.9	91	92	1	75-125			1	20
Nickel	100	25.7	137	142	111	117	1	75-125			4	20
Potassium	1000	1290	1990	2000	70	70	1	75-125	J6	J6	0	20
Selenium	100	U	96.7	97.5	97	98	1	75-125			1	20
Silver	100	U	98.0	99.0	98	99	1	75-125			1	20
Sodium	1000	458	1590	1590	113	113	1	75-125			0	20
Strontium	100	62.2	174	177	112	114	1	75-125			1	20
Sulfur	1000	27.2	945	947	92	92	1	75-125			0	20
Thallium	100	U	96.5	96.8	97	97	1	75-125			0	20
Tin	100	1.11	85.3	85.0	84	84	1	75-125			0	20
Vanadium	100	84.0	180	183	96	100	1	75-125			2	20
Zinc	100	55.5	145	147	90	91	1	75-125			1	20

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3145114-1 06/22/16 12:20

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Uranium	U		0.08	5.00

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3145114-2 06/22/16 12:23 • (LCSD) R3145114-3 06/22/16 12:25

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Uranium	100	105	101	105	101	80-120			3	20

L842580-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L842580-01 06/22/16 12:27 • (MS) R3145114-6 06/22/16 12:34 • (MSD) R3145114-7 06/22/16 12:37

Analyte	Spike Amount (dry)	Original Result (dry)	MS Result (dry)	MSD Result (dry)	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Uranium	20.4	0.850	112	112	109	109	5	75-125			0	20

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Abbreviations and Definitions

SDG	Sample Delivery Group.
MDL	Method Detection Limit.
RDL	Reported Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
U	Not detected at the Reporting Limit (or MDL where applicable).
RPD	Relative Percent Difference.
(dry)	Results are reported based on the dry weight of the sample. [this will only be present on a dry report basis for soils].
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Rec.	Recovery.

Qualifier	Description
E	The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration (ICAL).
J	The identification of the analyte is acceptable; the reported value is an estimate.
J3	The associated batch QC was outside the established quality control range for precision.
J6	The sample matrix interfered with the ability to make any accurate determination; spike value is low.
P1	RPD value not applicable for sample concentrations less than 5 times the reporting limit.
V	The sample concentration is too high to evaluate accurate spike recoveries.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Conneticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1.] Drinking Water [2.] Underground Storage Tanks [3.] Aquatic Toxicity [4.] Chemical/Microbiological [5.] Mold [n/a] Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**

Company Name/Address:
Stantec
601 Grassmere Park Road; Ste 22
Nashville, TN 37211

Billing Information:
attn: Chardonne Dixon
601 Grassmere Park Rd; Ste 22
Nashville, TN 37211

Report to: Briggs Evans

Email To: briggs.evans@stantec.com

Project Description: TVA-CUF GWMW Installations

City/State Collected: Cumberland City, TN

Phone: 615-885-1144
Fax: 615-885-1102

Client Project #: 175565299

Lab Project #:

Collected by (print): Jim Andrew

Site/Facility ID #: TVA-CUF

P.O. #:

Collected by (signature): Jim W. Andrew

Immediately Packed on Ice N ___ Y ✓

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%
___ Three Day 25%

Date Results Needed
Email? ___No ✓ Yes
FAX? ___No ___Yes

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	See Attached TAL	See Attached TAL	See Attached TAL	See Attached TAL							Rem./Contaminant	Sample # (lab only)
CUF-202 11' - 16'	Comp	SS		6-1-2016		4	X	X	X	X								-01

Chain of Custody Page ___ of ___

ESC L·A·B S·C·I·E·N·C·E·S
YOUR LAB OF CHOICE
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L # L842508
A189

Acctnum: SECOR
Template:
Prelogin:
TSR: 064 T. Fudge
PB:
Shipped Via: Courier

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

Remarks: **Please note the sample date in regards to hold times for Cl/FL No2/No**

pH ______ Temp ______
Flow ______ Other ______

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☒ Courier ☐ ____	Hold #
[signature]	6-20-16	1400	Johnny Fisher		Condition: (lab use only) ok
Relinquished by: (Signature)	**Date:**	**Time:**	**Received by: (Signature)**	Temp: 1.9 °C Bottles Received: 4	COC Seal Intact: ___Y ___N ___NA
Johnny Fisher	6/20/16	1515			
Relinquished by: (Signature)	**Date:**	**Time:**	**Received for lab by: (Signature)**	Date: 6-20-16 Time: 15:15	pH Checked: NCF:
			[signature]		

L842508

ANALYTE LIST, ANALYTICAL METHODS, AND REPORTING LIMIT OBJECTIVES FOR BACKGROUND SOIL SAMPLING CCP GROUNDWATER PROGRAM

Parameter	Analytical Method	Residential Soil Screening Level[1] (mg/Kg)	Industrial Soil Screening Level[1] (mg/Kg)
Metals			
Aluminum	USEPA Method 6010	77,000	1,100,000
Antimony	USEPA Method 6010	31	470
Arsenic	USEPA Method 6010	0.68	3.0
Barium	USEPA Method 6010	15,000	220,000
Beryllium	USEPA Method 6010	160	2,300
Boron	USEPA Method 6010	16,000	230,000
Cadmium	USEPA Method 6010	71	980
Calcium	USEPA Method 6010	NE	NE
Chromium	USEPA Method 6010	120,000[2]	1,800,000[2]
Cobalt	USEPA Method 6010	23	350
Copper	USEPA Method 6010	3,100	47,000
Iron	USEPA Method 6010	55,000	820,000
Lead	USEPA Method 6010	400	800
Lithium	USEPA Method 6010	160	2,300
Manganese	USEPA Method 6010	1,800	26,000
Mercury	USEPA Method 7470	9.4	40
Molybdenum	USEPA Method 6010	390	5,800
Nickel	USEPA Method 6010	1,500	22,000
Selenium	USEPA Method 6010	390	5,800
Silver	USEPA Method 6010	390	5,800
Strontium	USEPA Method 6010	47,000	700,000
Sulfur	USEPA Method 6010	NE	NE
Thallium	USEPA Method 6010	0.78	12
Tin	USEPA Method 6010	47,000	700,000
Uranium	USEPA Method 6010	230	3,500
Vanadium	USEPA Method 6010	390	5,800
Zinc	USEPA Method 6010	23,000	350,000
General Chemistry			
Chloride	ASTM D3987/ USEPA Method 9056	NE	NE
Fluoride	ASTM D3987/USEPA Method 9056	3,100	47,000
Nitrate-Nitrite	ASTM D3987/USEPA Method 353.2	NE	NE
Phosphorus	USEPA Method 365.4	NE	NE
pH	ASTM D3987/USEPA Method 9040	NE	NE
Radium -226[3]	EPA 600/Method 903.1	NE	NE
Radium -228[4]	EPA 600/Method 904.1	NE	NE
Total Kjeldahl Nitrogen	ASTM D3987/USEPA Method 351.2	NE	NE
Total Organic Carbon	EPA Method 9060	NE	NE

NE – Not established
mg/kg – Milligram per kilogram

Notes:

[1] Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites for Residential and Industrial Soils with target hazard quotient of 1.0 (June 2015)
[2] Preliminary SRG for total chromium has not been established; values provided are for insoluable salts chromium (III) PSRGs.
[3] Radium -226 samples are subjected to a minimum 21 day ingrowth period.
[4] Radium -228 samples are subjected to an ingrowth period of approximately 30 hours.

ANALYTICAL REPORT

July 21, 2016

Stantec Consulting Corp - TN

Sample Delivery Group:	L842509
Samples Received:	06/20/2016
Project Number:	175565299
Description:	TVA-CUF GW/MW Installations
Site:	TVA-CUF
Report To:	Mr. Briggs Evans 601 Grassmere Park Road; Ste 22 Nashville, TN 37211

Entire Report Reviewed By:

Terrie Fudge
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

TABLE OF CONTENTS

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Terrie Fudge
Technical Service Representative

Project Narrative

L842509 -01 contains subout data that is included after the chain of custody.

Abbreviations and Definitions

SDG	Sample Delivery Group.

Qualifier	Description
	The remainder of this page intentionally left blank, there are no qualifiers applied to this SDG.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Conneticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1,4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**

Company Name/Address:
Stantec
601 Grassmere Park Road; Ste 22
Nashville, TN 37211

Billing Information:
attn: Chardonne Dixon
601 Grassmere Park Rd; Ste 22
Nashville, TN 37211

Report to: Briggs Evans

Email To: briggs.evans@stantec.com

Project Description: TVA-CUF GWMW Installations

City/State Collected: Cumberland City, TN

Phone: 615-885-1144
Fax: 615-885-1102

Client Project # 175565299

Lab Project #

Collected by (print): Jim Andrew

Site/Facility ID # TVA-CUF

P.O. #

Collected by (signature): Jim W. Andrew

Immediately Packed on Ice N ___ Y ✓

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%
___ Three Day 25%

Date Results Needed
Email? ___ No ✓ Yes
FAX? ___ No ___ Yes

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
YOUR LAB OF CHOICE
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L # ~~E842508~~ L842509
A189

Acctnum: SECOR
Template:
Prelogin:
TSR: 064 T. Fudge
PB:
Shipped Via: Courier

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	See Attached TAL	See Attached TAL	See Attached TAL	See Attached TAL							Rem./Contaminant	Sample # (lab only)
CUF-202 11' - 16'	Comp	SS		6-1-2016		4	X	X	X	X								-01

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

Remarks: **Please note the sample date in regards to hold times for Cl/FL No2/No**

pH ______ Temp ______
Flow ______ Other ______

Hold #

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	
[signature]	6-20-16	1400	Johnny Fisher	Samples returned via: ☐ UPS ☐ FedEx ☒ Courier ☐ ____
Relinquished by: (Signature) Johnny Fisher	6/20/16	1545	Received by: (Signature)	Temp: 1.9 °C Bottles Received: 4
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature) [signature]	Date: 6-20-16 Time: 15:15

Condition: (lab use only) ok

COC Seal Intact: ___ Y ___ N ___ NA

pH Checked: NCF:

~~C842508~~
C842509

ANALYTE LIST, ANALYTICAL METHODS, AND REPORTING LIMIT OBJECTIVES FOR BACKGROUND SOIL SAMPLING CCP GROUNDWATER PROGRAM

Parameter	Analytical Method	Residential Soil Screening Level[1] (mg/Kg)	Industrial Soil Screening Level[1] (mg/Kg)
Metals			
Aluminum	USEPA Method 6010	77,000	1,100,000
Antimony	USEPA Method 6010	31	470
Arsenic	USEPA Method 6010	0.68	3.0
Barium	USEPA Method 6010	15,000	220,000
Beryllium	USEPA Method 6010	160	2,300
Boron	USEPA Method 6010	16,000	230,000
Cadmium	USEPA Method 6010	71	980
Calcium	USEPA Method 6010	NE	NE
Chromium	USEPA Method 6010	120,000[2]	1,800,000[2]
Cobalt	USEPA Method 6010	23	350
Copper	USEPA Method 6010	3,100	47,000
Iron	USEPA Method 6010	55,000	820,000
Lead	USEPA Method 6010	400	800
Lithium	USEPA Method 6010	160	2,300
Manganese	USEPA Method 6010	1,800	26,000
Mercury	USEPA Method 7470	9.4	40
Molybdenum	USEPA Method 6010	390	5,800
Nickel	USEPA Method 6010	1,500	22,000
Selenium	USEPA Method 6010	390	5,800
Silver	USEPA Method 6010	390	5,800
Strontium	USEPA Method 6010	47,000	700,000
Sulfur	USEPA Method 6010	NE	NE
Thallium	USEPA Method 6010	0.78	12
Tin	USEPA Method 6010	47,000	700,000
Uranium	USEPA Method 6010	230	3,500
Vanadium	USEPA Method 6010	390	5,800
Zinc	USEPA Method 6010	23,000	350,000
General Chemistry			
Chloride	ASTM D3987/ USEPA Method 9056	NE	NE
Fluoride	ASTM D3987/USEPA Method 9056	3,100	47,000
Nitrate-Nitrite	ASTM D3987/USEPA Method 353.2	NE	NE
Phosphorus	USEPA Method 365.4	NE	NE
pH	ASTM D3987/USEPA Method 9040	NE	NE
Radium -226[3]	EPA 600/Method 903.1	NE	NE
Radium -228[4]	EPA 600/Method 904.1	NE	NE
Total Kjeldahl Nitrogen	ASTM D3987/USEPA Method 351.2	NE	NE
Total Organic Carbon	EPA Method 9060	NE	NE

NE – Not established
mg/kg – Milligram per kilogram

Notes:

[1] Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites for Residential and Industrial Soils with target hazard quotient of 1.0 (June 2015)

[2] Preliminary SRG for total chromium has not been established; values provided are for insoluable salts chromium (III) PSRGs.

[3] Radium -226 samples are subjected to a minimum 21 day ingrowth period.

[4] Radium -228 samples are subjected to an ingrowth period of approximately 30 hours.

NJ OK001

Case Narrative

Lab No: 20160598

This report contains the analytical results for the 1 sample(s) received under chain of custody by ESC Lab Sciences on 6/22/2016 3:34:08 PM. These samples are associated with your TVA-CUF GWMW Installations project.

The analytical results included in this report meet all applicable quality control procedure requirements except as noted below:

The test results in this report meet all NELAC requirements unless noted below:

This report shall not be reproduced, except in full, without the written approval of ESC Lab Sciences.

All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client.

Results have been reviewed by the Director of Radiochemistry or their designees and is approved for release.

Observations / Nonconformances

*NELAC Certified Parameter   BDL = Below Detection Limit

OUTREACH LABORATORY, A Divsion of ESC Lab Sciences
Address: 311 North Aspen Avenue, Broken Arrow, OK, 74012 - EMail: outreach@esclabsciences.com - Tel: (918) 251-2515

Client	:	Stantec
Client Project	:	TVA-CUF GWMW Installations
Lab Number	:	20160598
Date Reported	:	07/20/16
Date Received	:	06/22/16
Page Number	:	2 of 2

Analytical Report

	Method	Result	DL	Units	Qual	Prep Date	Analysis Date	Analyst

Lab ID : **20160598-01**
Client ID : **CUF-202 11' - 16'**
Date Sampled : **6/1/2016**
Matrix : **SCM**

Radiochemical Analyses

	Method	Result	DL	Units	Qual	Prep Date	Analysis Date	Analyst
Radium-226	SM 7500 Ra B M*	2.18 +/- 0.166	0.054	pCi/g		07/01/16	07/06/16	AK
Radium-228	EPA 904*/9320*	0.400 +/- 0.328	0.585	pCi/g		07/11/16	07/18/16	JR

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	RER, NAD or DER	MS %REC	MSD %REC	MSD RPD	Batch ID
Radium-226	0.038	75.6			54.1	1.740	70.8			
Radium-228	-0.316	89.4			NC	0.674	77.2			R3828

Lab Approval:

*NELAC Certified Parameter BDL = Below Detection Limit

OUTREACH LABORATORY, A Divsion of ESC Lab Sciences
Address: 311 North Aspen Avenue, Broken Arrow, OK, 74012 - EMail: outreach@esclabsciences.com - Tel: (918) 251-2515

Company Name/Address:
Stantec
601 Grassmere Park Road; Ste 22
Nashville, TN 37211

Billing Information:
attn: Chardonne Dixon
601 Grassmere Park Rd; Ste 22
Nashville, TN 37211

Report to: Briggs Evans

Email To: briggs.evans@stantec.com

Project Description: TVA-CUF GWMW Installations

City/State Collected: Cumberland City, TN

Phone: 615-885-1144
Fax: 615-885-1102

Client Project # 175565299

Lab Project #

Collected by (print): Jim Andrew

Site/Facility ID # TVA-CUF

P.O. #

Collected by (signature): Jim W. Andrew

Immediately Packed on Ice N ___ Y ✓

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%
___ Three Day 25%

Date Results Needed

Email? ___No ✓ Yes
FAX? ___No ___Yes

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	See Attached TAL	See Attached TAL	See Attached TAL	See Attached TAL						Rem./Contaminant	Sample # (lab only)
CUF-202 11' - 16'	Comp	SS		6-1-2016		4	X	X	X	X							-01

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
YOUR LAB OF CHOICE
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# ~~E842508~~ A189 L842509

Acctnum: SECOR
Template:
Prelogin:
TSR: 064 T. Fudge
PB:
Shipped Via: Courier

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

Remarks: **Please note the sample date in regards to hold times for Cl/FL No2/No**

pH ______ Temp ______

Flow ______ Other ______

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☒ Courier ☐ ____	Hold #
Jim W. Andrew	6-20-16	1400	Johnny Fisher		
Relinquished by: (Signature)	**Date:**	**Time:**	**Received by: (Signature)**	**Temp: °C** / **Bottles Received:**	**Condition: (lab use only)**
Johnny Fisher	6/20/16	1515	[illegible] 3:54	1.9 / 4	ok
Relinquished by: (Signature)	**Date:**	**Time:**	**Received for lab by: (Signature)**	**Date:** / **Time:**	**COC Seal Intact: ___Y ___N ___NA** / **pH Checked:** / **NCF:**
			[illegible]	6-20-16 / 1515	

70E0598

~~C842508~~
C842509

ANALYTE LIST, ANALYTICAL METHODS, AND REPORTING LIMIT OBJECTIVES FOR BACKGROUND SOIL SAMPLING CCP GROUNDWATER PROGRAM

Parameter	Analytical Method	Residential Soil Screening Level[1] (mg/Kg)	Industrial Soil Screening Level[1] (mg/Kg)
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Antimony	USEPA Method 6010	31	470
Arsenic	USEPA Method 6010	0.68	3.0
Barium	USEPA Method 6010	15,000	220,000
Beryllium	USEPA Method 6010	160	2,300
Boron	USEPA Method 6010	16,000	230,000
Cadmium	USEPA Method 6010	71	980
Calcium	USEPA Method 6010	NE	NE
Chromium	USEPA Method 6010	120,000[2]	1,800,000[2]
Cobalt	USEPA Method 6010	23	350
Copper	USEPA Method 6010	3,100	47,000
Iron	USEPA Method 6010	55,000	820,000
Lead	USEPA Method 6010	400	800
Lithium	USEPA Method 6010	160	2,300
Manganese	USEPA Method 6010	1,800	26,000
Mercury	USEPA Method 7470	9.4	40
Molybdenum	USEPA Method 6010	390	5,800
Nickel	USEPA Method 6010	1,500	22,000
Selenium	USEPA Method 6010	390	5,800
Silver	USEPA Method 6010	390	5,800
Strontium	USEPA Method 6010	47,000	700,000
Sulfur	USEPA Method 6010	NE	NE
Thallium	USEPA Method 6010	0.78	12
Tin	USEPA Method 6010	47,000	700,000
Uranium	USEPA Method 6010	230	3,500
Vanadium	USEPA Method 6010	390	5,800
Zinc	USEPA Method 6010	23,000	350,000
General Chemistry			
Chloride	ASTM D3987/ USEPA Method 9056	NE	NE
Fluoride	ASTM D3987/USEPA Method 9056	3,100	47,000
Nitrate-Nitrite	ASTM D3987/USEPA Method 353.2	NE	NE
Phosphorus	USEPA Method 365.4	NE	NE
pH	ASTM D3987/USEPA Method 9040	NE	NE
Radium -226[3]	EPA 600/Method 903.1	NE	NE
Radium -228[4]	EPA 600/Method 904.1	NE	NE
Total Kjeldahl Nitrogen	ASTM D3987/USEPA Method 351.2	NE	NE
Total Organic Carbon	EPA Method 9060	NE	NE

NE – Not established
mg/kg – Milligram per kilogram

Notes:
[1] Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites for Residential and Industrial Soils with target hazard quotient of 1.0 (June 2015)
[2] Preliminary SRG for total chromium has not been established; values provided are for insoluable salts chromium (III) PSRGs.
[3] Radium -226 samples are subjected to a minimum 21 day ingrowth period.
[4] Radium -228 samples are subjected to an ingrowth period of approximately 30 hours.

SAMPLE LOGIN

Date Received: *6/22/2016 3:34:08* **Lab Number:** 20160598 **Due:** 7/20/2016

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Preserved Upon Receipt	Custody Seal	Seal Intact
20160598-01 C	CUF-202 11' - 16'	SCM	06/01/16	Plastic	20 ml	None	☐	No	No
20160598-01 B	CUF-202 11' - 16'	SCM	06/01/16	Glass	4 oz	None	☐	No	No
20160598-01 A	CUF-202 11' - 16'	SCM	06/01/16	Glass	4 oz	None	☑	No	No
Radium-226			SM 7500 Ra B M*						
Radium-228			EPA 904*/9320*						

CONTAINER INSPECTION

 # Coolers **Custody Seals Broken** ☐ **Temperature:** C Ice **Radiation Survey:** <300 cpm

SAMPLE INSPECTION

Sample Seal Broken **Chain of Custody Record** ☐ **Labels in Tact** ☐ **Radiation Survey Complete** ☐

Anomalles

Inspected By: [signature] **DATE** 6/22/16

QA or Designee Review: ____________ **DATE** ____________

Sample Custodian Review: [signature] **DATE** 6/22/16

Project Notes:

APPENDIX I
DEDICATED PUMP INSTALLATION CHECKLISTS AND MANUFACTURER DATA

TVA Cumberland Fossil Plant
Cumberland City, Tennessee
Groundwater Monitoring Network

Dedicated Pump Installations

Facility / Location	Well ID	Latitude NAD83 (D M S)	Longitude NAD83 (D M S)	Top of Casing Elevation (ft NGVD 29)	Ground Surface Elevation (ft NGVD 29)	Well Inside Diameter (inch)	Screened Interval (ft btoc)	Well Depth (ft btoc)	Bottom of Well Elevation (ft NGVD 29)	Existing Stickup Height (ft ags)	Pump Intake Depth (ft btoc)	Pump Intake Elevation (ft NGVD29)	Pump Intake Above Well Bottom (feet)	Water Level-07/22/2016 (ft btoc)	Water Column Above Intake (feet)
Dry Ash Stack	93-1	N36°23'10.14"	W87°39'52.95"	397.17	394.9	2.0	52.3 - 62.3	62.3	334.9	2.3	60	337.2	2.3	35.6	24.4
Gypsum Storage Area	93-2R	N36°22'58.67"	W87°39'42.29"	397.88	395.3	2.0	62.3 - 72.0	72.8	325.1	2.6	71	326.9	1.8	39.3	31.8
Gypsum Storage Area	93-3	N36°22'50.93"	W87°39'11.76"	397.50	395.2	2.0	45.0 - 55.0	55.1	342.4	2.3	53	344.5	2.1	30.0	23.0
Stilling Pond / Retention Pond	93-4	N36°23'32.36"	W87°39'36.63"	397.34	394.6	2.0	27.2 - 36.6	36.6	360.7	2.7	34	363.3	2.6	26.1	7.9
Background	CUF-201	N36°23'16.63"	W87°40'46.48"	400.41	396.7	4.0	17.6 - 27.7	28.1	372.3	3.7	26	374.4	2.1	12.4	13.6
Background	CUF-202	N36°23'12.67"	W87°40'34.02"	383.28	379.5	4.0	14.3 - 19.6	19.9	363.4	3.8	18	365.3	1.9	5.8	12.2
Background	CUF-204	N36°22'35.15"	W87°40'36.56"	439.66	435.9	4.0	38.2 - 48.4	48.8	390.8	3.8	47	392.7	1.8	31.0	16.1
Stilling Pond / Retention Pond	CUF-205	N36°23'45.42"	W87°39'38.18"	384.51	380.8	4.0	16.9 - 27.1	27.5	357.0	3.7	25	359.5	2.5	18.0	7.0
Stilling Pond / Retention Pond	CUF-206	N36°23'44.48"	W87°39'47.21"	398.67	394.9	4.0	82.7 - 92.9	93.6	305.1	3.8	92	306.7	1.6	33.4	58.6
Stilling Pond / Retention Pond	CUF-207	N36°23'40.91"	W87°39'53.24"	398.19	394.4	4.0	75.0 - 85.1	85.7	312.5	3.8	84	314.2	1.7	32.0	52.0
Stilling Pond / Retention Pond	CUF-208	N36°23'31.88"	W87°39'59.86"	398.38	394.6	4.0	47.9 - 58.0	58.6	339.8	3.8	57	341.4	1.6	36.1	20.9
Dry Ash Stack	CUF-209	N36°23'20.31"	W87°40'01.40"	398.23	394.5	4.0	53.1 - 63.3	63.8	334.4	3.7	62	336.2	1.8	35.2	26.9
Dry Ash Stack	CUF-210	N36°23'14.45"	W87°39'58.80"	398.20	394.5	4.0	63.5 - 68.5	69.0	329.2	3.7	67	331.2	2.0	26.9	40.1
Dry Ash Stack	CUF-211	N36°23'08.15"	W87°39'50.30"	398.76	395.0	4.0	57.7 - 67.9	68.6	330.2	3.8	67	331.8	1.6	37.4	29.6
Dry Ash Stack	CUF-212	N36°22'50.52"	W87°39'28.74"	398.71	395.0	4.0	62.6 - 72.8	73.2	325.5	3.7	71	327.7	2.2	40.3	30.7
Gypsum Storage Area	CUF-213	N36°22'50.17"	W87°39'06.70"	399.05	395.3	4.0	40.0 - 45.2	45.7	353.4	3.8	44	355.1	1.7	21.2	22.8

ft btoc - feet below top of casing

D M S - Degrees, Minutes, Seconds

ft NGVD29 - feet National Geodetic Vertical Datum 1929

ft ags - feet above ground surface

Well Wizard (R) Specification Sheet

Customer: Stantec — Rev Date: 7/15/16

Site/Location: Cumerland Fossil Planr, TN

Date: 7/15/2016

Salesperson: RPO/sds

NOTE: All dimensions from Top of Casing, unless specified.

Well ID No.	**CUF-201**	**CUF-202**	CUF-204 ~~**A1**~~	**CUF-205**	**CUF-206**	**CUF-207**
Well System Type	A	A	A	A	A	A
Casing Material & Schedule						
Well Diameter OD (Inches)	4	4	4	4	4	4
Well Depth	28.02	19.86	48.75	27.45	93.95	85.7
Static Water Level	12.86	5.93	29.65	18.55	33.73	31.93
Water Column Height	15.16	13.93	19.1	**8.9**	60.22	53.77
Screen Length						
Casing Length to Screen	17.52	14.66	38.25	16.95	83.45	75.2
Recovery Rate (gpm)						
Sample Collection Point	**26**	**18**	**47**	**25**	**92**	**84**
Cold Weather Protection	38458	38458	38458	38458	38458	38458
Cap Model	C46	C46	C46	C44	C46	C46
Elbow/Flex Flow Model	37740	37740	37740	37739	37740	37740
Cap Adapter Model						
Tubing Stick-up Above Cap (included in total tube length)	0	0	0	0	0	0
Bladder Pump Model	P1101M	P1101M	P1101M	P1150	P1101M	P1101M
Bladder Pump Inlet Screen	37789	37789	37789	37727	37789	37789
Pump Submergence	13.14	12.07	17.35	6.45	58.27	52.07
Bladder PumpTubing Model	PT5000	PT5000	PT5000	PT5200	PT5000	PT5000
Bladder Pump Tubing Length	22.5	14.5	43.5	23.5	88.5	80.5
System L - Pump Tubing Length						
System L - Submergence						
Drop Tube Kit						
Drop Tubing Model						
Drop Tubing Length						
Drop Tube Inlet Screen						
Drop Tube Weight Model						
Drop Tube Extra Weights						
Initial Purge Volume (ml) (pump & tubing)	609	533	808	130	1,236	1,160
Initial Purge Volume (ml) System L (pump & tubing)						

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APPROVAL:
Signature: ____________
Date: ____________

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6:15 PM

Well Wizard (R) Specification Sheet

Customer: Stantec — Rev Date: 7/15/16

Site/Location: Cumerland Fossil Planr, TN

Date: 7/15/2016

Salesperson: RPO/sds — NOTE: All dimensions from Top of Casing, unless specified.

Well ID No.	**CUF-208**	**CUF-209**	**CUF-210**	**CUF-211**	**CUF-212**	**CUF-213**
Well System Type	A	A	A	A	A	A
Casing Material & Schedule	________	________	________	________	________	________
Well Diameter OD (Inches)	4	4	4	4	4	4
Well Depth	58.55	63.8	68.96	68.53	73.2	45.63
Static Water Level	35.85	35.25	28.6	37.16	40.05	21.22
Water Column Height	22.7	28.55	40.36	31.37	33.15	24.41
Screen Length	________	________	________	________	________	________
Casing Length to Screen	48.05	53.3	63.76	58.03	62.7	40.43
Recovery Rate (gpm)	________	________	________	________	________	________
Sample Collection Point	**57**	**62**	**67**	**67**	**71**	**44**
Cold Weather Protection	38458	38458	38458	38458	38458	38458
Cap Model	C46	C46	C46	C46	C46	C46
Elbow/Flex Flow Model	37740	37740	37740	37740	37740	37740
Cap Adapter Model	________	________	________	________	________	________
Tubing Stick-up Above Cap (included in total tube length)	0	0	0	0	0	0
Bladder Pump Model	P1101M	P1101M	P1101M	P1101M	P1101M	P1101M
Bladder Pump Inlet Screen	37789	37789	37789	37789	37789	37789
Pump Submergence	21.15	26.75	38.4	29.84	30.95	22.78
Bladder PumpTubing Model	PT5000	PT5000	PT5000	PT5000	PT5000	PT5000
Bladder Pump Tubing Length	53.5	58.5	63.5	63.5	67.5	40.5
System L - Pump Tubing Length	________	________	________	________	________	________
System L - Submergence	________	________	________	________	________	________
Drop Tube Kit	________	________	________	________	________	________
Drop Tubing Model	________	________	________	________	________	________
Drop Tubing Length	________	________	________	________	________	________
Drop Tube Inlet Screen	________	________	________	________	________	________
Drop Tube Weight Model	________	________	________	________	________	________
Drop Tube Extra Weights	________	________	________	________	________	________
Initial Purge Volume (ml) (pump & tubing)	903	951	998	998	1,036	780
Initial Purge Volume (ml) System L (pump & tubing)	________	________	________	________	________	________

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APPROVAL:
Signature: ____________________
Date: ____________________

Printed 7/15/2016
6:15 PM

Well Wizard (R) Specification Sheet

Customer: Stantec — Rev Date: 7/15/16

Site/Location: Cumerland Fossil Planr, TN

Date: 7/15/2016

Salesperson: RPO/sds — NOTE: All dimensions from Top of Casing, unless specified.

Well ID No.	93-1	932R	93-3	93-4		
Well System Type	A	A	A	A		
Casing Material & Schedule						
Well Diameter OD (Inches)	2	2	2	2		
Well Depth	62.1	72.8	55.1	36.4		
Static Water Level	34.3	39.01	30.43	20.56		
Water Column Height	27.8	33.79	24.67	15.84		
Screen Length						
Casing Length to Screen	47.1	62.3	45.1	26.4		
Recovery Rate (gpm)						
Sample Collection Point	**60**	**71**	**53**	**34**		
Cold Weather Protection	38458	38458	38458	38458		
Cap Model	C26	C26	C26	C26		
Elbow/Flex Flow Model	37740	37740	37740	37740		
Cap Adapter Model						
Tubing Stick-up Above Cap (included in total tube length)	0	0	0	0		
Bladder Pump Model	P1101M	P1101M	P1101M	P1101M		
Bladder Pump Inlet Screen	37789	37789	37789	37789		
Pump Submergence	25.7	31.99	22.57	13.44		
Bladder PumpTubing Model	PT5000	PT5000	PT5000	PT5000		
Bladder Pump Tubing Length	56.5	67.5	49.5	30.5		
System L - Pump Tubing Length						
System L - Submergence						
Drop Tube Kit						
Drop Tubing Model						
Drop Tubing Length						
Drop Tube Inlet Screen						
Drop Tube Weight Model						
Drop Tube Extra Weights						
Initial Purge Volume (ml) (pump & tubing)	932	1,036	865	685		
Initial Purge Volume (ml) System L (pump & tubing)						

APPROVAL:
Signature: ____________
Date: ____________

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6:15 PM

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-8-16
Time: 10:54

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	90°F
Other Comments:	

Well Information	
Well Number:	CUF-201
Reference Point:	TOC
Screened Interval:	17.52 - 28.02
Static Water Level:	12.86
Total Depth of Well:	28.02
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete*
Well ID:	CUF-201
Static Water Level:	12.12 feet
Pump Inlet Depth:	26 feet
System Volume[3]:	609 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	15 PSI
Confirmed Flow Rate:	112 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK*

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	CUF-201
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	26.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments
Well depth: 28.02'
Water level (initial): 12.20'
(final): 12.43'
ID 97 13.0 Sec. refill
2.0 Sec. discharge
Turbidity @ 10:56 = 5.77 NTU
@ 11:01 = 1.62 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-8-16
Time: 11:07

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	@ 88°F
Other Comments:	

Well Information	
Well Number:	CUF-202
Reference Point:	TOC
Screened Interval:	14.66 - 19.86
Static Water Level:	5.93
Total Depth of Well:	19.86
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	
Complete / Incomplete*	
Well ID:	CUF-202
Static Water Level:	5.91 feet
Pump Inlet Depth:	18 feet
System Volume[3]:	533 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	7 PSI
Confirmed Flow Rate:	108 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	
OK / Not OK*	

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	CUF-202
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	18.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments
Well depth: 19.86'
Water level (initial): 5.93'
(final): 8.23'
ID 95 14.0 sec. refill
1.0 sec. discharge
Turbidity @ 11:09 = 14.2 NTU
@ 11:12 = 2.75 NTU
Note: Slight drawdown still.

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-8-16
Time: 11:22

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	90°F
Other Comments:	

Well Information	
Well Number:	CUF-204 (A1)
Reference Point:	TOC
Screened Interval:	38.25 - 48.75
Static Water Level:	29.65
Total Depth of Well:	48.75
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete*
Well ID:	CUF-204 (A1)
Static Water Level:	29.05 feet
Pump Inlet Depth:	47 feet
System Volume[3]:	808 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	25 PSI
Confirmed Flow Rate:	344 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK*

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	CUF-204
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	47.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments
Well depth: 48.73'
Water level (initial): 29.19'
(final): 29.53'
ID 101 11.0 sec refill
4.0 sec discharge
Turbidity @ 11:26 = 0.90 NTU
@ 11:29 = 0.64 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9/7/2016
Time: 15:39

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny, 87°F
Air Temp:	87°F
Other Comments:	

Well Information	
Well Number:	CUF-205
Reference Point:	TOC
Screened Interval:	16.95 - 27.45
Static Water Level:	18.55
Total Depth of Well:	27.45
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	
Complete / Incomplete*	Complete
Well ID:	CUF-205
Static Water Level:	18.20 feet
Pump Inlet Depth:	25 feet
System Volume[3]:	130 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	19 ~~110~~ PSI
Confirmed Flow Rate:	236 mL/min
> 100 mL/min?	Y / N* — Y
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK* — OK

Pump Information	
Pump/Equipment in Good Condition:	Y / N* — Y
Comments:	
Pump Serial Number:	061601
Well ID listed on pump box:	~~0~~ CUF-205
- Matches Well ID	Y / N* — Y
Discharge Tubing Diameter:	1/4 inches
Intake Depth Listed On Spec Sheet:	25.0 Feet
- SWL above intake depth?	Y / N* — Y
- Intake depth matches desired?	Y / N* — Y
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N* — Y
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N* — Y
Install pump in well[2]	OK / Not OK* — OK
Well cap fits properly:	OK / Not OK* — OK
All fittings on cap properly tightened:	OK / Not OK* — OK

Additional Comments
Well depth - 27.43'
Water level (initial) 18.27'
(final): 18.39'
ID 102 10.5 refill (sec)
4.5 discharge (sec)
Turbidity @ 15:41 = 0.78 NTU
@ 15:47 = 0.44 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

Turb. calib. checks. 20 NTU read @ 19.0NTU 800 NTU @ 806 NTU
(9-7-16) 100 NTU @ 99.6 NTU 10 NTU @ 10.6 NTU

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-7-16
Time: 16:14

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	88°F
Other Comments:	

Well Information	
Well Number:	CUF-206
Reference Point:	TOC
Screened Interval:	83.45 - 93.95
Static Water Level:	33.73
Total Depth of Well:	93.95
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete*
Well ID:	CUF-206
Static Water Level:	35.14 feet
Pump Inlet Depth:	92 feet
System Volume[3]:	1236 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	50 PSI
Confirmed Flow Rate:	360 ~~320~~ mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK*

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	D61602
Well ID listed on pump box:	CUF-206
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	92.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments

Well depth: 93.58'

Water Level (initial): 35.21'
(final): 35.26'

ID 1D3 10 sec refill
5 sec discharge

Turbidity @ 16:15 = 124 NTU
@ 16:20 = 15.9 NTU
@ 16:23 = 4.29 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-7-16
Time: 16:26

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	88°F
Other Comments:	

Well Information	
Well Number:	CUF-207
Reference Point:	TOC
Screened Interval:	75.2 - 85.7
Static Water Level:	31.93
Total Depth of Well:	85.7
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	
Complete / Incomplete*	
Well ID:	CUF-207
Static Water Level:	33.72 feet
Pump Inlet Depth:	84 feet
System Volume[3]:	1160 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	45 PSI
Confirmed Flow Rate:	400 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	
OK / Not OK*	

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	CUF-207
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	84.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments
Well depth: 85.12'
Water level (initial): 33.74'
(final): 33.86'
ID 103 10 sec. refill
5 sec. discharge
Turbidity @ 16:28 = 128 NTU
@ 16:32 = 18.8 NTU
@ 16:34 = 2.77 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-7-16
Time: 16:39

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	88°F
Other Comments:	

Well Information	
Well Number:	CUF-208
Reference Point:	TOC
Screened Interval:	48.05 - 58.55
Static Water Level:	35.85
Total Depth of Well:	58.55
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	
Complete / Incomplete*	
Well ID:	CUF-208
Static Water Level:	38.09 feet
Pump Inlet Depth:	57 feet
System Volume[3]:	903 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	27.5 PSI
Confirmed Flow Rate:	112 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	
OK / Not OK*	

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	CUF, 208
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	57.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments
Well depth: 57.07'
Water level (initial): 38.15'
(final): 38.42'
ID 103 10 sec. refill
5 sec. discharge
Turbidity @ 16:44 = 8.92 NTU
@ 16:49 = 5.35 NTU

Signature: [signature]

Notes:

*Stop work and contact PM

1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-8-16
Time: 08:37

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	88°F
Other Comments:	

Well Information	
Well Number:	CUF-209
Reference Point:	TOC
Screened Interval:	53.3 - 63.8
Static Water Level:	35.25
Total Depth of Well:	63.8
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	
Complete / Incomplete*	Complete
Well ID:	CUF-209
Static Water Level:	36.41 feet
Pump Inlet Depth:	62 feet
System Volume[3]:	951 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	34 PSI
Confirmed Flow Rate:	136 mL/min
> 100 mL/min?	Y / N* — Y
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	
OK / Not OK*	OK

Pump Information	
Pump/Equipment in Good Condition:	Y / N* — Y
Comments:	
Pump Serial Number:	061102
Well ID listed on pump box:	CUF-209
- Matches Well ID	Y / N* — Y
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	62.0 Feet
- SWL above intake depth?	Y / N* — Y
- Intake depth matches desired?	Y / N* — Y
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N* — Y
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N* — Y
Install pump in well[2]	OK / Not OK* — OK
Well cap fits properly:	OK / Not OK* — OK
All fittings on cap properly tightened:	OK / Not OK* — OK

Additional Comments
Well depth: 63.83'
Water level (initial): 36.45'
(final): 36.68'
10 98 12.5 sec. refill
2.5 sec. discharge
Turbidity @ 08:45 = 18.1 NTU
@ 08:48 = 16.7 NTU
@ 08:51 = 15.9 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

Turb. calib. checks: 20 NTU read @ ~~[illegible]~~ 21.0 NTU
(9-8-16) 100 NTU read @ 101 NTU
800 NTU read @ 807 NTU
10 NTU read @ 10.2 NTU

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-8-16
Time: 08:55

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	88°F
Other Comments:	

Well Information	
Well Number:	CUF-210
Reference Point:	TOC
Screened Interval:	63.76 - 68.96
Static Water Level:	28.6
Total Depth of Well:	68.96
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete*
Well ID:	CUF-210
Static Water Level:	27.66 feet
Pump Inlet Depth:	67 feet
System Volume[3]:	998 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	30 PSI
Confirmed Flow Rate:	100 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK*

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	CUF-210
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	67.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments

Well depth: 68.98'

Waterlevel (initial): 27.46'
(final): 28.07'

ID 101 11.0 sec. refill
4.0 sec. discharge

Turbidity @ 08:58 = 3.36 NTU
@ 09:07 = 2.22 NTU

Note: Still drawing down @ 100 mL/min

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-8-16
Time: 09:26

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	88°F
Other Comments:	

Well Information	
Well Number:	CUF-211
Reference Point:	TOC
Screened Interval:	58.03 - 68.53
Static Water Level:	37.16
Total Depth of Well:	68.53
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete* (Complete circled)
Well ID:	CUF-211
Static Water Level:	39.71 feet
Pump Inlet Depth:	67 feet
System Volume[3]:	998 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	32 PSI
Confirmed Flow Rate:	216 ~~216~~ mL/min
> 100 mL/min?	Y / N* (Y circled)
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK* (OK circled)

Pump Information	
Pump/Equipment in Good Condition:	Y / N* (Y circled)
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	CUF-211
- Matches Well ID	Y / N* (Y circled)
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	67.0 Feet
- SWL above intake depth?	Y / N* (Y circled)
- Intake depth matches desired?	Y / N* (Y circled)
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N* (Y circled)
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N* (Y circled)
Install pump in well[2]	OK / Not OK* (OK circled)
Well cap fits properly:	OK / Not OK* (OK circled)
All fittings on cap properly tightened:	OK / Not OK* (OK circled)

Additional Comments
Well depth: 68.55'
Water level (initial): 39.75'
(final): 39.80'
10 103 10.0 sec. refill
5.0 sec discharge
Turbidity @ 09:30 = 52.6 NTU
@ 09:34 = 17.6 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-8-16
Time: 10:04

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	90°F
Other Comments:	

Well Information	
Well Number:	CUF-212
Reference Point:	TOC
Screened Interval:	62.7 - 73.2
Static Water Level:	40.05
Total Depth of Well:	73.2
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete*
Well ID:	CUF-212
Static Water Level:	43.22 feet
Pump Inlet Depth:	71 feet
System Volume[3]:	1036 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	36 PSI
Confirmed Flow Rate:	304 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK*

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	CUF-212
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	71.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	4.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments
Well depth: 73.21'
Water level (initial): 42.92'
(final): 43.28'
ID 101 11.0 sec. refill
4.0 sec. discharge
Turbidity @ 10:07 = 12.5 NTU
@ 10:11 = 6.91 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 9-8-16
Time: 10:27

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	90°F
Other Comments:	

Well Information	
Well Number:	CUF-213
Reference Point:	TOC
Screened Interval:	40.43 - 45.63
Static Water Level:	21.22
Total Depth of Well:	45.63
Well Diameter:	4
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	
Complete / Incomplete*	Complete
Well ID:	CUF-213
Static Water Level:	20.94 feet
Pump Inlet Depth:	44 feet
System Volume[3]:	780 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	23 PSI
Confirmed Flow Rate:	108 mL/min
> 100 mL/min? Y / N*	Y
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag: OK / Not OK*	OK

Pump Information		
Pump/Equipment in Good Condition:	Y / N*	Y
Comments:		
Pump Serial Number:	061602	
Well ID listed on pump box:	CUF-213	
- Matches Well ID	Y / N*	Y
Discharge Tubing Diameter:	3/8 inches	
Intake Depth Listed On Spec Sheet:	44.0 Feet	
- SWL above intake depth?	Y / N*	Y
- Intake depth matches desired?	Y / N*	Y
Cap Diameter:	4.0 Inches	
- Equal to casing diameter?	Y / N*	Y
Difference from TOC to reference point[1]:	0 inches	
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*	Y
Install pump in well[2]	OK / Not OK*	OK
Well cap fits properly:	OK / Not OK*	OK
All fittings on cap properly tightened:	OK / Not OK*	OK

Additional Comments
Well depth: 45.67'
Water level (initial): 20.94'
(final): 21.30'
ID 98 12.5 sec. refill
2.5 sec. discharge.
Turbidity @ 10:30 = 3.68 NTU
@ 10: = 3.32 NTU
Note: Slight drawdown

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: ~~9-9~~ 9-8-16
Time: 09:12

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	88°F
Other Comments:	

Well Information	
Well Number:	93-1
Reference Point:	TOC
Screened Interval:	47.1 - 62.1
Static Water Level:	34.3
Total Depth of Well:	62.1
Well Diameter:	2
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete*
Well ID:	93-1
Static Water Level:	37.97 feet
Pump Inlet Depth:	60 feet
System Volume[3]:	932 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	32 PSI
Confirmed Flow Rate:	124 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK*

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	93-1
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	60.0 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	2.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments
Well depth: 62.06'
Water level (initial): 37.97'
(final): 38.48'
ID 98 12.5 sec. refill
2.5 sec. dis
Turbidity @ 09:17 = 22.2 NTU
09:21 = 21.9 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D.West/C.Ramser
Date: 09/08/2016
Time: 09:40

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	M. Sunny
Air Temp:	90°F
Other Comments:	

Well Information	
Well Number:	93-2R
Reference Point:	TOC
Screened Interval:	62.3 - 72.8
Static Water Level:	39.01
Total Depth of Well:	72.8
Well Diameter:	2
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete*
Well ID:	93-2R
Static Water Level:	42.29 feet
Pump Inlet Depth:	71 feet
System Volume[3]:	1036 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	37 PSI
Confirmed Flow Rate:	400 mL/min
> 100 mL/min?	Y / N*
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK*

Pump Information	
Pump/Equipment in Good Condition:	Y / N*
Comments:	
Pump Serial Number:	061602
Well ID listed on pump box:	93.2R
- Matches Well ID	Y / N*
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	72.8 Feet
- SWL above intake depth?	Y / N*
- Intake depth matches desired?	Y / N*
Cap Diameter:	2.0 Inches
- Equal to casing diameter?	Y / N*
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N*
Install pump in well[2]	OK / Not OK*
Well cap fits properly:	OK / Not OK*
All fittings on cap properly tightened:	OK / Not OK*

Additional Comments
Well depth: 72.81
Water level (initial): 42.02'
(final) 42.07'
ID 103 10.0 sec. refill
5.0 sec. discharge
Turbidity @ 09:45 = 18.2 NTU
@ 09:48 = 103 NTU
@ 09:53 = 262 NTU
@ 09:57 = 269 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D. West/C.Ramser
Date: 9-8-16
Time: 10:17

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	90°F
Other Comments:	

Well Information	
Well Number:	93-3
Reference Point:	TOC
Screened Interval:	45.1 - 55.1
Static Water Level:	30.43
Total Depth of Well:	55.1
Well Diameter:	2
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete* (Complete circled)
Well ID:	93-3
Static Water Level:	30.07 feet
Pump Inlet Depth:	53 feet
System Volume[3]:	865 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	25 PSI
Confirmed Flow Rate:	228 mL/min
> 100 mL/min?	Y / N* (Y circled)
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK* (OK circled)

Pump Information	
Pump/Equipment in Good Condition:	Y / N* (Y circled)
Comments:	
Pump Serial Number:	061102
Well ID listed on pump box:	93-3
- Matches Well ID	Y / N* (Y circled)
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	53.0 Feet
- SWL above intake depth?	Y / N* (Y circled)
- Intake depth matches desired?	Y / N* (Y circled)
Cap Diameter:	2.0 Inches
- Equal to casing diameter?	Y / N* (Y circled)
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N* (Y circled)
Install pump in well[2]	OK / Not OK* (OK circled)
Well cap fits properly:	OK / Not OK* (OK circled)
All fittings on cap properly tightened:	OK / Not OK* (OK circled)

Additional Comments
Well depth: 55.12'
Water level (initial): ~~29.39'~~ 30.11'
(final): 30.54'
ID 103 10.0 sec. refill
5.0 sec. discharge
Turbidity @ 10:19 = 35.1 NTU
@ 10:23 = 12.2 NTU

Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

QED Well Wizard Dedicated Sampling Pump Installation Checklist

Stantec

Name: D. West/C.Ramser
Date: 9-7-16
Time: 15:58

Important: Staff must read and be familiar with QED's Installation procedure (attached) prior to installing pump

Site Information	
Project Number:	175565299
Facility Name:	TVA-CUF
Weather:	Sunny
Air Temp:	88°F
Other Comments:	

Well Information	
Well Number:	93-4
Reference Point:	TOC
Screened Interval:	26.4 - 36.4
Static Water Level:	20.56
Total Depth of Well:	36.4
Well Diameter:	2
Casing Material:	PVC
Condition of Well:	New
Other Comments:	

Initial Testing	
Complete "Initial Pump Flow Test Procedures" from QED Sampling System Installation Checklist	Complete / Incomplete* (Complete circled)
Well ID:	93-4
Static Water Level:	26.42 feet
Pump Inlet Depth:	34 feet
System Volume[3]:	685 mL
MP50 Controller ID #:	1723
Throttle Pressure Setting:	16 PSI
Confirmed Flow Rate:	120 mL/min
> 100 mL/min?	Y / N* (Y circled)
Controller Cycle Frequency	4 CPM[4]
Complete MicroPurge Dust Cover Info Tag:	OK / Not OK* (OK circled)

Pump Information	
Pump/Equipment in Good Condition:	Y / N* (Y circled)
Comments:	
Pump Serial Number:	060602
Well ID listed on pump box:	93-4
- Matches Well ID	Y / N* (Y circled)
Discharge Tubing Diameter:	3/8 inches
Intake Depth Listed On Spec Sheet:	34.0 Feet
- SWL above intake depth?	Y / N* (Y circled)
- Intake depth matches desired?	Y / N* (Y circled)
Cap Diameter:	2.0 Inches
- Equal to casing diameter?	Y / N* (Y circled)
Difference from TOC to reference point[1]:	0 inches
Clearance between top of well cap and bottom of vault cover > 2"?	Y / N* (Y circled)
Install pump in well[2]	OK / Not OK* (OK circled)
Well cap fits properly:	OK / Not OK* (OK circled)
All fittings on cap properly tightened:	OK / Not OK* (OK circled)

Additional Comments
Well depth: 36.40'
Water level (initial): 26.50'
(final): 27.60'
99
ID ~~103~~ 12.0sec. refill
3.0sec. discharge
Turbidity @ 16:02 = 1.29 NTU
@ 16:08 = 7.0 NTU

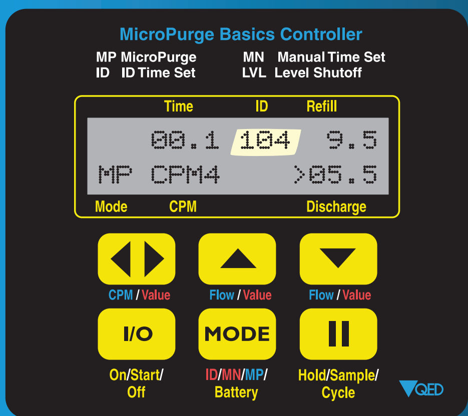
Signature: [signature]

Notes:
*Stop work and contact PM
1) See Section 6 of the provided Installation Checklist
2) See Section 8 of the provided Installation Checklist
3) See QED supplied Well Data Specification Sheet for instructions on how to calculate this
4) See Section 4 of Initial Pump Flow Test Procedure. Maximum CPM must comply with these instructions

MICRO PURGE® basics QED

MP50 CONTROLLER/12 VDC COMPRESSOR

PATENT PENDING



NEW!

Expert flow and drawdown control for low-volume purging, and air compressor - all in one!

QED has combined its rugged and reliable fan-cooled 12 VDC air compressor with the time-proven QED MicroPurge Basics controller to provide an “all-in-one” package.

The MP50 also offers an easy way to prevent excessive monitoring well drawdown during purging, by linking to the optional MP30 Drawdown/Water Level Meter.

MicroPurge® basics™ MP50 Controller/Compressor Advantages

- Built-in rugged, durable fan-cooled 12 VDC air compressor, with the option to use an external air source, if desired.
- Exclusive MicroPurge control mode uses simple arrow keys to adjust low-flow rates easily and repeatably, using a microprocessor to re-create the flow adjustment strategies used by experienced samplers.
- Connection port allows linking to optional MP30 Drawdown/Water Level Meter, which signals MP50 Controller to enter standby mode if drawdown limit is exceeded.
- Multi-mode digital control includes MicroPurge Mode, ID Mode for repeat events, and manual control.
- Weatherproof controls are housed in a rugged, compact (16" x 13" x 6.5") case.
- Full digital display of all setting and status information

QED *First in Control & Power for Low-Flow Sampling*

P.O. Box 3726 Ann Arbor, MI 48106-3726 USA FAX 734-995-1170 1-800-624-2026

e-mail info@qedenv.com www.micropurge.com

Simple, stable, repeatable flow rate setting

The MP50 puts you in control of the most advanced low-flow sampling system ever made. You will purge and sample quickly and easily, with precise, steady low-flow pumping rates from one sampling event to the next. QED's new basics equipment is also designed to take advantage of the opportunities for downsized equipment, which is lighter and more portable, reduces equipment cost and increases sampling crew productivity. Simplified, sealed electronics are put together in a design that delivers famous QED durability and value.

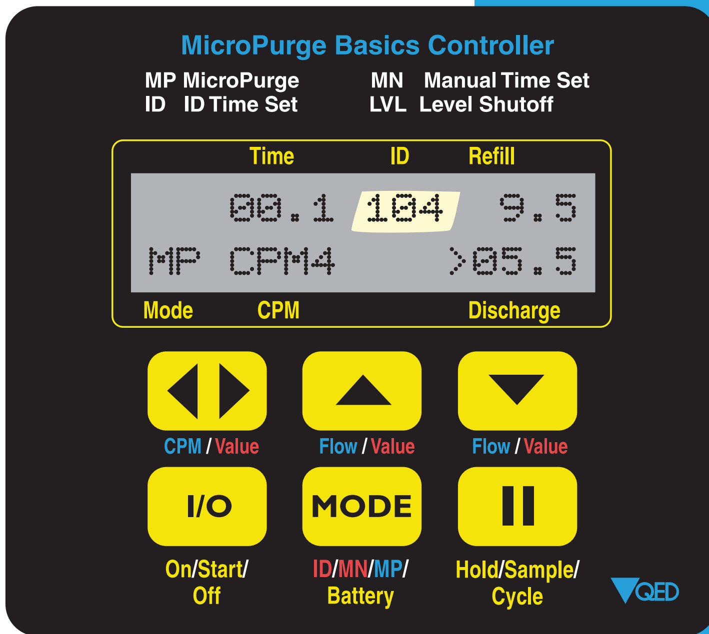
MicroPurge basics controllers can be connected to the MP30 Drawdown Meter for optional Automatic Drawdown Control, an industry first.

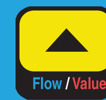
Multi-mode digital control

The MP50 gives you three easy-to-use operating modes, to cover every sampling protocol and situation.

- **MicroPurge (MP) Mode** quickly optimizes control settings to reach the desired pump flow rate. You don't have to worry about calculating pump cycles or refill and discharge times.
- **ID Mode** instantly recalls optimized settings previously established for each well, providing precise, consistent performance from event to event.
- **User Set (MN) Mode** provides manual control of pump operation for extreme depths and other special cases.

HOW IT WORKS





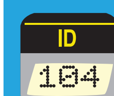
Pressing the **UP** Arrow increases the pump flow in controlled steps.

The **DOWN** Arrow Key decreases the flow rate in controlled steps.

MicroPurge Mode Quick Guide

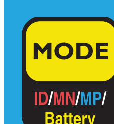
1. Press I/O key to turn power ON.
2. Select desired Cycles Per Minute (CPM) with the ◀▶ key (default value is 4 CPM).
3. Turn throttle to set depth on gauge to 10 - 20 feet deeper than the pump location in the well.
4. Press I/O again to START pumping.
5. When water discharge begins, adjust throttle until a slow, steady flowstream is achieved.
6. Press ▲▼ keys to set the desired purge flow rate.
7. To collect samples, continue purge flow, or use II key to directly controls ample flow and pause.

The **LEFT/ RIGHT** Arrow Key adjusts the Cycles PerMinute (CPM) of your pump.

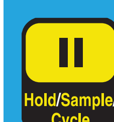


The **ID** Number changes when an **UP** or **DOWN** Arrow is pressed. This number can be used in **ID Mode** to recall the setting for the next sampling round.

The **I/O** Key steps through the sequence of **On-Start-Off**.



The **MODE** Key changes modes from default **MP** (MicroPurge) to **ID Mode** to **MN** (User Set) Mode. This key also allows battery check.



Pressing the **PAUSE** Key puts the controller in **HOLD** Mode, stopping flow. A second press delivers push button controlled vial filling. A third press returns the system to normal cycling.

Can be used with any bladder pump system, with the use of simple adapters

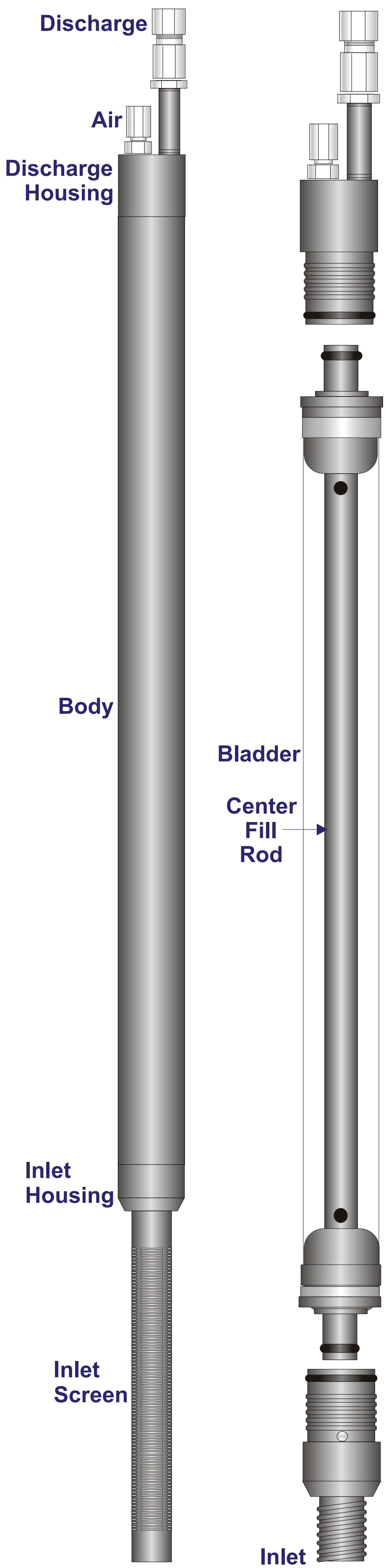
SPECIFICATIONS

Model No.:	MP50
Dimensions:	16" x 13" x 6.5" (40.6 x 33 x 16.5 cm)
Weight:	21 lbs (9.52 kg)
Case Material:	Structural Resin
Keypad:	6 keys
Display:	2 line, 16 character / LCD Display
Controller Power:	3 "AA" Batteries
Controller Battery Life:	50,000 Cycles @ 70° F (21° C)
Compressor Power:	12 VDC (Battery Cable)
*Max. Lift:	200 Feet (60 m)
Output:	0.21 SCFM@ 100 psi (0.357 m 3/h@ 6.89 kPa)
Max. Pressure:	105 psi (7.24 kPa)
Operating Temperature:	-20° - 120° F (-29° - 49° C)
Connection to MP30 Drawdown Meter:	Heavy-Duty Cable (Supplied with MP30)

*Pump flow rates in deeper wells (>100 feet) may be low, especially where pumps have limited liquid submergence.

WELL WIZARD® P1101(M) Bladder Pump

Technical Data/ Specifications



PUMP TYPE:
Positive Air Displacement

DIMENSIONS:

Pump O.D.:	1.66" (42 mm)
Length:	42.25" (107.3 cm)
Length w/Screen:	48.25" (122.5 cm)
Screen Slot Size:	.010
Weight:	4.05 lbs. (1.8 kg)

MATERIALS:
PVC, Teflon® Polypropylene and Viton

FITTINGS:
Polypropylene Compression

Discharge Size:	1/2" O.D., 3/8" I.D. (12.7 mm / 9.5 mm)
Air Supply Size:	1/4" O.D., 3/16" I.D. (6.3 mm / 4.7 mm)
(M) Discharge Size:	3/8" O.D., 1/4" I.D. (9.5 mm / 6.3 mm)

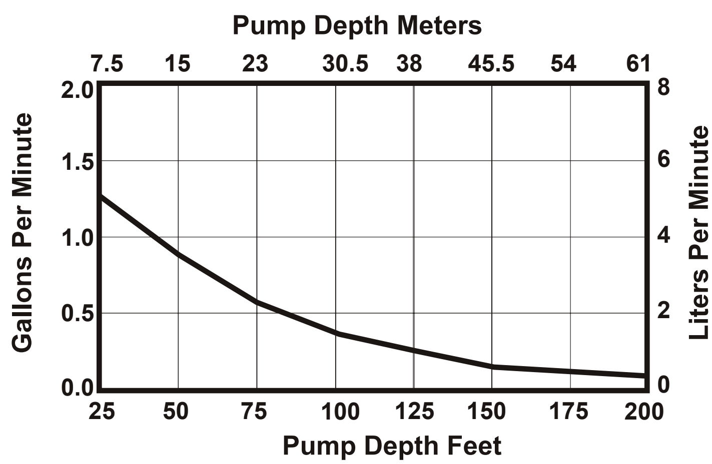
PUMP PERFORMANCE:

MAXIMUM LIFT: 300 Feet (90 m)

PUMP STROKE VOLUME:

Liters	Milliliters	Gallons	Ounces
.395	395	.10	12.8

PUMP FLOW RATES:

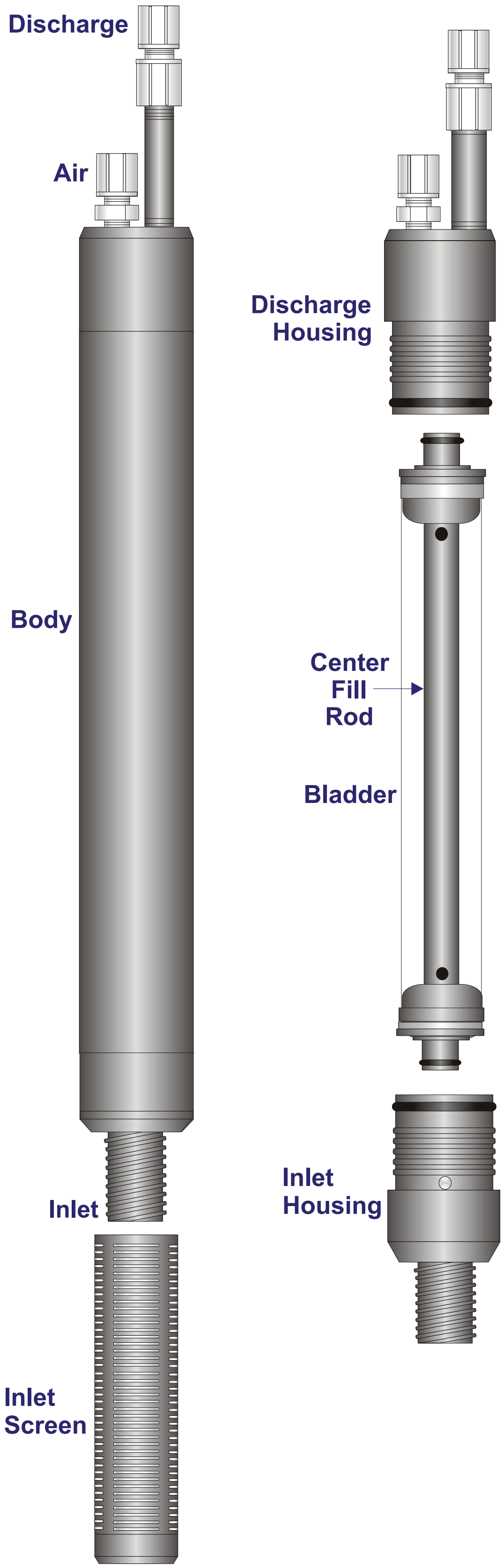


NOTE: Flow rates are based on a pump submergence of 25' (7.5 m), 1/2" (12.7 mm) discharge tubing and an operating gas pressure of 100 P.S.I. (7 bar) from an 3111HR air source/controller.

ACCESSORIES:

P/N	37789	Inlet Screen 6" (15.2 cm) PVC
P/N	38035	Bladder Kit
P/N	14002	Bladder Cartridge
P/N	35052	Clamp Hand Tool

WELL WIZARD® P1150 Bladder Pump — Technical Data/ Specifications



PUMP TYPE: Positive Air Displacement

DIMENSIONS:

Pump O.D.:	1.66" (42 mm)
Length:	19.5" (49.5 cm)
Length w/Screen:	22.75" (57.8 cm)
Screen Slot Size:	.010
Weight:	1.6 lbs. (.7 kg)

MATERIALS: PVC, Teflon® Polypropylene and Viton

FITTINGS: Polypropylene Compression

Discharge Size:	1/4" O.D., 3/16" I.D. (6.3 mm / 4.7 mm)
Air Supply Size:	1/4" O.D., 3/16" I.D. (6.3 mm / 4.7 mm)

PUMP PERFORMANCE:

MAXIMUM LIFT: 300 Feet (90 m)

PUMP STROKE VOLUME:

Liters	Milliliters	Gallons	Ounces
.130	130	.03	4.3

ACCESSORIES:

P/N	**37727**	Inlet Screen 4.5" (11.4 cm) PVC
P/N	**37763**	Bladder Kit
P/N	**37764**	Bladder Cartridge
P/N	**35052**	Clamp Hand Tool

APPENDIX J
WELL CLOSURE DOCUMENTATION

CLOSED WELL LOCATIONS

WELL ID	NORTHING (FEET)	EASTING (FEET)	LATITUDE (D-M-S)	LONGITUDE (D-M-S)
10-1	733964.17	1510857.48	N36°23'49.08"	W87°39'43.16"
10-2	733314.35	1511682.69	N36°23'42.80"	W87°39'32.94"
93-2	728878.79	1510835.68	N36°22'58.80"	W87°39'42.37"
96-6	728384.44	1516057.34	N36°22'54.79"	W87°38'38.42"
96-7	731602.79	1512058.75	N36°23'25.94"	W87°39'27.98"
96-8	732119.74	1516057.34	N36°23'31.72"	W87°38'39.19"
A-2	728746.39	1510853.35	N36°22'57.49"	W87°39'42.13"
A-3	728764.24	1510884.74	N36°22'57.68"	W87°39'41.75"
A-3 (OFFSET)	728610.11	1510905.65	N36°22'56.16"	W87°39'41.46"
B-106	729832.70	1510221.34	N36°23'08.13"	W87°39'50.08"
B-112	730213.25	1512266.88	N36°23'12.24"	W87°39'25.15"
B-113	730401.21	1511902.35	N36°23'14.03"	W87°39'29.65"
B-114	729321.95	1510823.51	N36°23'03.18"	W87°39'42.61"
B-115	730406.31	1511811.58	N36°23'14.07"	W87°39'30.76"
UNKNOWN #1	728466.06	1510999.53	N36°22'54.75"	W87°39'40.28"
UNKNOWN #2	728433.46	1510977.12	N36°22'54.42"	W87°39'40.55"

NOTES:

1. THE AERIAL MAPPING PROVIDED BY USDA NAIP IS BASED ON HORIZONTAL DATUM NAD27 USING STATE PLANE TENNESSEE COORDINATE SYSTEM AND VERTICAL DATUM NGVD29. THE ORTHO-PHOTOGRAPHY WAS PERFORMED IN 2014. GEODETIC COORDINATES SHOWN ARE NAD83.
2. ALL BOUNDARY LINES ARE APPROXIMATE WORKING BOUNDARIES, TO BE CONFIRMED BY TVA.
3. WELLS CLOSED BY STANTEC JUNE 1-16, 2016. WELLS 96-7, B-106, B-112 THROUGH B-115 PREVIOUSLY CLOSED BY OTHERS.

LEGEND

TVA BOUNDARY LINE

CLOSED WELL LOCATION

RECORD DRAWING

R 0 02/06/17 DRP MSJ JGB BLB SEB MST JCK 609389
ISSUED AS-BUILT AS PER PROJECT ID 609389

SCALE: 1"=400' EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

MONITORING WELL NETWORK AND OBSERVATION WELLS CLOSED WELL PLAN

DESIGNED BY: D.R. PLEIMAN | DRAWN BY: M.S. JENNINGS | CHECKED BY: J.G. BANTON | SUPERVISED BY: B.L. BRYANT | REVIEWED BY: S.E. BENNET | APPROVED BY: M.S. TURNBOW | ISSUED BY: J.C. KAMMEYER

Stantec
3052 Beaumont Centre Circle
Lexington, Kentucky 40513
www.stantec.com

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2013 | DATE 02/10/17 | 46 | C | 10W858-06 | R 0

STANTEC 0
TASK COMPLETED BY: REV NO.

PLOT FACTOR:400
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

46 C 10W858-06

Groundwater Monitoring Well Abandonment Checklist

Plant: ~~SHF~~ TVA Cumberland

Date: 6/9/16

Page 1 of 1

Project Number: 609397

Well No. 10-1

No.	Description	Yes	No	N/A	Comments / Notes
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -				
	Latitude: N36° 23' 45"				
	Longitude: W 87° 39' 51"				
3	Correct well ID and location verified by the following people (min. of two signatures required):				10-1
	Stantec Rep. Signature - Bill Rosen Bill Rosen				
	P&CC Engineering Rep. Signature - Jeff Gray J Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				47' feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				18.0 feet
7	Approximate well casing stickup above ground =				32 inches
8	Construction debris\materials removed from well abandonment site?				34" PVC Below pad
	Concrete pad and bollards removed by - Cascade				5'x5'x4" PAD 4 4" Ø Bollards
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By:				Bill Rosen
12	Miscellaneous				Well Casing Broke off to deep to retrieve
a.					
b.					4 - 50" Bags Bentonite
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: ~~SHF~~ TVA Cumberland

Date: 6/9/16

Page 1 **of** 1

Project Number: 609397

Well No. 10-2

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -	X			
	Latitude: N 36° 23' 45"				
	Longitude: W 87 39 28"				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				10-2
	Stantec Rep. Signature -				Bill Rosen Bill Rosen
	P&CC Engineering Rep. Signature - Jeff Gray Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				~~3~~4' feet
5	Well depth in general agreement with existing well construction details?				??
6	Water Depth (feet below top of casing)				18.3 feet
7	Approximate well casing stickup above ground =				32' ~~43~~ inches
8	Construction debris\materials removed from well abandonment site?				39" of Stickup - Remainder Grouted
	Concrete pad and bollards removed by - Cascade				5'x5' x 3 1/2" PAD, 4 - 4"ø Bollards
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?		X		
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By:				Bill Rosen
12	Miscellaneous				Well Casing broke off to deep to retrieve
a.					
b.					
c.					4 - 50# Bags Bentonite

Groundwater Monitoring Well Abandonment Checklist

Plant: SHF | **Date:** 05/31/2016
Project Number: 609397 | **Page** 1 **of** 1
Well No. 93-2

#	Description	Yes	No	N/A	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (min. of two signatures required):				
	Stantec Rep. Signature - James Andrew [signature]				
	P&CC Engineering Rep. Signature - Jeff Leary [signature]				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				45.25 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				11.4 feet
7	Approximate well casing stickup above ground =				24 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature: [signature]				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?		✓		
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	✓			
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.					
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: ~~[illegible]~~ CUF

Date: 6-16-16

Project Number: ~~[illegible]~~ 60 93 89

Page 1 of 1

Well No. 98-6

	Description	Yes	No	NA	Comments
		✓			
1	Existing groundwater monitoring well to be closed.				
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude: 36.389N ~~[illegible]~~				
	Longitude: 87.6494 W				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - [signature]				
	P&CC Engineering Rep. Signature -				
	Generation Construction Rep. Signature - [signature]				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				20.65 feet
5	Well depth in general agreement with existing well construction details?	✓			
6	Water Depth (feet below top of casing)				3.1 feet
7	Approximate well casing stickup above ground =				-2 ~~0.5~~ inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by - STANTEC				
9	Well Closure Documented By: STANTEC				
	Print Name: Briggs Evans				
	Signature: [signature]				
	Company: STANTEC				
10	All areas impacted by construction activities graded, re-seeded and straw added?	✓			
	Performed By: STANTEC				
	Verified & Approved By: [signature] (JVD)				
11	Picture taken at well site?	✓			
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: Briggs Evans - STANTEC				
12	Miscellaneous				
a.					
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: TVA Cumberland

Date: 6/10/16

TVA Project Number:

Page 1 of 1

Well No. 96-8

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -	X			
	Latitude: N 36° 23' 42"				
	Longitude: W 87° 48' 22"				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature -	Bill Rosen			Bill Rosen
	P&CC Engineering Rep. Signature - Jeff Gray	Jeff Gray			
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				36.9 feet TOP OF 2" PVC
5	Well depth in general agreement with existing well construction details?				??
6	Water Depth (feet below top of casing)				8.3 feet Top of 2" PVC
7	Approximate well casing stickup above ground =				0.0" inches
8	Construction debris\materials removed from well abandonment site?				31'6" 2" PVC RISER 15'.11" 4" PVC RISER
	Concrete pad and bollards removed by -	Metal surface cover & Concrete, 3-2"ø Bollards			
9.	Well Closure Documented By:				
	Print Name:	Bill Rosen			
	Signature:	Bill Rosen			
	Company:	Stantec			
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By:				Bill Rosen
12	Miscellaneous				No well screen recovered
a.					
b.					6-50# Bags Bentonite
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: ~~SHE~~ TVA Cumberland

Date: 6/9/16

Page 1 of 1

Project Number: 609397

Well No. A-2

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -	X			
	Latitude: N 36° 23' 39"				
	Longitude: W 87° 39' 20"				
3	Correct well ID and location verified by the following people (min. of two signatures required):				
	Stantec Rep. Signature - Bill Rosen				Bill Rosen
	P&CC Engineering Rep. Signature - Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				57.0' feet
5	Well depth in general agreement with existing well construction details?				??
6	Water Depth (feet below top of casing)				28.1 feet
7	Approximate well casing stickup above ground =				40" inches
8	Construction debris\materials removed from well abandonment site?				Cutoff 39" of stickup Remainder left in well
	Concrete pad and bollards removed by -				N/A
9	Well Closure Documented By:				
	Print Name:				Bill Rosen
	Signature:				Bill Rosen
	Company:				Stantec
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By:				Bill Rosen
12	Miscellaneous				3-50# Bags Bentonite
a.					
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: SHF TVA Cumberland

Date: 6/8/16

Project Number: 609397

Page 1 of 1

Well No. A-3

	Description	Yes	No	N/A	Comments
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -	X			
	Latitude: N36° 23' 4"				
	Longitude: W 87° 39' 53"				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				A3
	Stantec Rep. Signature - Bill Rosen	Bill Rosen			
	P&CC Engineering Rep. Signature - Jeff Gray	Jeff Gray			
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				43.2 feet
5	Well depth in general agreement with existing well construction details?				??
6	Water Depth (feet below top of casing)				9.0 feet
7	Approximate well casing stickup above ground =				42 inches
8	Construction debris\materials removed from well abandonment site?				7.5' PVC RISER; 1.5' Screen; 5 10' Screens; 4" Ø
	Concrete pad and bollards removed by -				No PAD No Bollards
9	Well Closure Documented By:				
	Print Name:	BILL ROSEN			
	Signature:	Bill Rosen			
	Company:	Stantec			
10	All areas impacted by construction activities graded, re-seeded and straw added?	~~X~~	X		Spoils - shoveled around hole closure.
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By:				Bill Rosen
12	Miscellaneous				9 - 50# Bags Bentonite
a.					
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: SHF TVA Cumberland

Date: 6/8/16

Project Number: 609397

Page 1 **of** 1

Well No. A-3 off set

	Description	Yes	No	N.A.	Comments
1	Existing groundwater monitoring well to be closed.	X			2" ϕ
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -	X			
	Latitude: N 36° 23' 58"				
	Longitude: W 87° 39' 42"				
3	Correct well ID and location verified by the following people (min. of two signatures required):				A3 offset
	Stantec Rep. Signature - Bill Rosen	Bill Rosen			
	P&CC Engineering Rep. Signature - Jeff Gray	JK Gray			
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				28.2 feet
5	Well depth in general agreement with existing well construction details?				??
6	Water Depth (feet below top of casing)				9.4 feet
7	Approximate well casing stickup above ground =				48 inches
8	Construction debris\materials removed from well abandonment site?				2-10' PVC RISER Approx. 8' well screen } 2" ϕ
	Concrete pad and bollards removed by -				NO PAD NO BOLLARDS
9	Well Closure Documented By:				
	Print Name:	Bill Rosen			
	Signature:	Bill Rosen			
	Company:	Stantec			
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By:				Bill Rosen
12	Miscellaneous				
a.					5 bag-50# Bentonite
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: ~~SEP~~ TVA Cumberland

Date: 6/9/14

Page 1 of 1

Project Number: 609397

Well No. UK #1

	Description	Yes	No	N/A	Comments
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -	x			
	Latitude: N 36° 22' 50"				
	Longitude: W 87° 39' 36"				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature -	Bill Rosen			Bill Rosen
	P&CC Engineering Rep. Signature - Jeff Gray	J Gray			
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				40.9 feet
5	Well depth in general agreement with existing well construction details?				??
6	Water Depth (feet below top of casing)				16.4 feet
7	Approximate well casing stickup above ground =				52" inches
8	Construction debris/materials removed from well abandonment site?				9'-10' Riser removed. Remainder grouted
	Concrete pad and bollards removed by -			N/A	
9	Well Closure Documented By:				
	Print Name:	Bill Rosen			
	Signature:	Bill Rosen			
	Company:	Stantec			
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By:				Bill Rosen
12	Miscellaneous				3 - 50# Bags Bentonite
a.					
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: ~~SHF~~ TVA Cumberland

Date: 6/9/16

Page 1 of 1

Project Number: 609397

Well No. Unknown #2

	Description	Yes	No	N/A	Comments
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-held GPS readings -	X			
	Latitude: N 34° 23' 10"				
	Longitude: W 87° 39' 48"				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):	X			
	Stantec Rep. Signature -	Bill Rosen Bill Rosen			
	P&CC Engineering Rep. Signature -				
	Generation Construction Rep. Signature -	Dale Bishop TVA 6/9/16			
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
					53.2 feet
4	Well Depth (feet below top of casing)				
5	Well depth in general agreement with existing well construction details?				??
					26.4 feet
6	Water Depth (feet below top of casing)				
					53" inches
7	Approximate well casing stickup above ground =				
					9' Riser. Approx 20' Screen Remainder grouted in well
8	Construction debris\materials removed from well abandonment site?				
	Concrete pad and bollards removed by -	NA			
9	Well Closure Documented By:				
	Print Name:	Bill Rosen			
	Signature:	Bill Rosen			
	Company:	Stantec			
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By:				Bill Rosen
12	Miscellaneous				11 - 50# Bags Bentonite
a.					
b.					
c.					

Groundwater Monitoring Well Checklist

Plant: TVA Cumberland Date: 6-9-16

Project Number: 609389 Page: 1 of 1

Well No. 10-1

	Description	**Yes**	**No**	**N/A**	**Comment**
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -				
	Latitude: N 36° 23’ 45”				
	Longitude: W 87° 39’ 51”				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				10-1
	Stantec Rep. Signature - /s/ Bill Rosen				
	P&CC Engineering Rep. Signature - /s/ Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				47.0 feet
5	Well Depth in general agreement with existing well construction details				
6	Water Depth (feet below top of casing)				18.0 feet
7	Approximate well casing stickup above ground =				32 inches
8	Construction debris/materials removed from well abandonment site				
	Concrete pad and bollards removed by - Cascade				5’ x 5’ x 4” pad, 4 - 4” bollards
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: /s/ Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Bill Rosen				
12	Miscellaneous				4 – 50 lb. bags Bentonite Clay
a.	Well casing broke off – too deep to retrieve				
b.					
c.					

Groundwater Monitoring Well Checklist

Plant: TVA Cumberland | Date: 6-9-16

Project Number: 609389 | Page: 1 of 1

Well No. 10-2

	Description	**Yes**	**No**	**N/A**	**Comment**
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -	X			
	Latitude: N 36° 23' 45"				
	Longitude: W 87° 39' 28"				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				10-2
	Stantec Rep. Signature - /s/ Bill Rosen				
	P&CC Engineering Rep. Signature - /s/ Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				34.0 feet
5	Well Depth in general agreement with existing well construction details				??
6	Water Depth (feet below top of casing)				18.3 feet
7	Approximate well casing stickup above ground =				32 inches
8	Construction debris/materials removed from well abandonment site				
	Concrete pad and bollards removed by - Cascade				5' x 5' pad, 4 - 4" bollards
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: /s/ Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?		X		
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Bill Rosen				
12	Miscellaneous				4 – 50 lb. bags Bentonite Clay
a.	Well casing broke off – too deep to retrieve				
b.					
c.					

Groundwater Monitoring Well Checklist

Plant: SHF Date: 5-31-16

Project Number: 609389 Page: 1 of 1

Well No. 93-2

	Description	**Yes**	**No**	**N/A**	**Comment**
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				
	Stantec Rep. Signature - /s/ Jim Andrew				
	P&CC Engineering Rep. Signature - /s/ Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				45.25 feet
5	Well Depth in general agreement with existing well construction details				
6	Water Depth (feet below top of casing)				11.4 feet
7	Approximate well casing stickup above ground =				21.5 inches
8	Construction debris/materials removed from well abandonment site	X			
	Concrete pad and bollards removed by - Stantec				
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature: /s/ James Andrew				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?		X		
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.					
b.					
c.					
d.					
e.					

Groundwater Monitoring Well Checklist

Plant: TVA Cumberland   Date: 6-16-16

Project Number: 609389   Page: 1 of 1

Well No. 96-6

	Description	Yes	No	N/A	Comment
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -	X			
	Latitude: N 36° 23' 2.04"				
	Longitude: W 87° 38' 57.84"				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				
	Stantec Rep. Signature - /s/ Briggs Evans				
	P&CC Engineering Rep. Signature -				
	Generation Construction Rep. Signature - /s/ D.J. McJunkin				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				25.65 feet
5	Well Depth in general agreement with existing well construction details	X			
6	Water Depth (feet below top of casing)				3.1 feet
7	Approximate well casing stickup above ground =				2 inches
8	Construction debris/materials removed from well abandonment site	X			
	Concrete pad and bollards removed by - Stantec				
9	Well Closure Documented By:				
	Print Name: Briggs Evans				
	Signature: /s/ Briggs Evans				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?	X			
	Performed By: Stantec				
	Verified & Approved By: /s/ D.J. McJunkin				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Briggs Evans				
12	Miscellaneous				
a.					
b.					
c.					

Groundwater Monitoring Well Checklist

Plant: CUF Date: 6-10-16

Project Number: Page: 1 of 1

Well No. 96-8

	Description	Yes	No	N/A	Comment
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -	X			
	Latitude: N 36° 23’ 42”				
	Longitude: W 87° 48’ 22”				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				
	Stantec Rep. Signature - /s/ Bill Rosen				
	P&CC Engineering Rep. Signature - /s/ Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				36.9 feet
5	Well Depth in general agreement with existing well construction details				
6	Water Depth (feet below top of casing)				8.3 feet
7	Approximate well casing stickup above ground =				0.0 inches
8	Construction debris/materials removed from well abandonment site	X			
	Concrete pad and bollards removed by - Stantec				
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: /s/ Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Bill Rosen				
12	Miscellaneous				No well screen recovered
a.					Sealed with 6-50 lb bags of
b.					bentonite
c.					

Groundwater Monitoring Well Checklist

Plant: TVA Cumberland | Date: 6-9-16

Project Number: 609389 | Page: 1 of 1

Well No. A-2

	Description	Yes	No	N/A	Comment
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -	X			
	Latitude: N 36° 23’ 59”				
	Longitude: W 87° 39’ 20”				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				
	Stantec Rep. Signature - /s/ Bill Rosen				
	P&CC Engineering Rep. Signature - /s/ Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				54.0 feet
5	Well Depth in general agreement with existing well construction details				??
6	Water Depth (feet below top of casing)				28.1 feet
7	Approximate well casing stickup above ground =				40 inches
8	Construction debris/materials removed from well abandonment site				
	Concrete pad and bollards removed by -			X	
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: /s/ Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Bill Rosen				
12	Miscellaneous				3 – 50 lb. bags Bentonite Clay
a.					
b.					
c.					

Groundwater Monitoring Well Checklist

Plant: TVA Cumberland | Date: 6-8-16

Project Number: 609389 | Page: 1 of 1

Well No. A-3

	Description	**Yes**	**No**	**N/A**	**Comment**
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -	X			
	Latitude: N 36° 23' 04"				
	Longitude: W 87° 39' 53"				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				A3
	Stantec Rep. Signature - /s/ Bill Rosen				
	P&CC Engineering Rep. Signature - /s/ Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				43.2 feet
5	Well Depth in general agreement with existing well construction details			X	
6	Water Depth (feet below top of casing)				9.0 feet
7	Approximate well casing stickup above ground =				42 inches
8	Construction debris/materials removed from well abandonment site				
	Concrete pad and bollards removed by -				No pad, no bollards
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: /s/ Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?		X		
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Bill Rosen				
12	Miscellaneous				9 – 50 lb. Bags Bentonite Clay
a.					
b.					
c.					

Groundwater Monitoring Well Checklist

Plant: TVA Cumberland Date: 6-8-16

Project Number: 609389 Page: 1 of 1

Well No. A-3 offset

	Description	**Yes**	**No**	**N/A**	**Comment**
1	Existing groundwater monitoring well to be closed.	X			2”
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -	X			
	Latitude: N 36° 23’ 58”				
	Longitude: W 87° 39’ 42”				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				A3 offset
	Stantec Rep. Signature - /s/ Bill Rosen				
	P&CC Engineering Rep. Signature - /s/ Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				28.2 feet
5	Well Depth in general agreement with existing well construction details				??
6	Water Depth (feet below top of casing)				9.4 feet
7	Approximate well casing stickup above ground =				48 inches
8	Construction debris/materials removed from well abandonment site				
	Concrete pad and bollards removed by -				No pad, no bollards
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: /s/ Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Bill Rosen				
12	Miscellaneous				5 – 50 lb. bags Bentonite Clay
a.					
b.					
c.					

Groundwater Monitoring Well Checklist

Plant: TVA Cumberland　　Date: 6-9-16

Project Number: 609389　　Page: 1 of 1

Well No. Unknown #1

	Description	Yes	No	N/A	Comment
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -	X			
	Latitude: N 36° 22' 50"				
	Longitude: W 87° 39' 36"				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				
	Stantec Rep. Signature - /s/ Bill Rosen				
	P&CC Engineering Rep. Signature - /s/ Jeff Gray				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				40.9 feet
5	Well Depth in general agreement with existing well construction details				??
6	Water Depth (feet below top of casing)				16.4 feet
7	Approximate well casing stickup above ground =				52 inches
8	Construction debris/materials removed from well abandonment site				
	Concrete pad and bollards removed by -			X	
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: /s/ Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Bill Rosen				
12	Miscellaneous				3 – 50 lb. bags Bentonite Clay
a.					
b.					
c.					

Groundwater Monitoring Well Checklist

Plant: TVA Cumberland　　Date: 6-9-16

Project Number: 609389　　Page: 1 of 1

Well No. Unknown #2

	Description	**Yes**	**No**	**N/A**	**Comment**
1	Existing groundwater monitoring well to be closed.	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -	X			
	Latitude: N 36° 23’ 10”				
	Longitude: W 87° 39’ 48”				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				
	Stantec Rep. Signature - /s/ Bill Rosen				
	P&CC Engineering Rep. Signature -				
	Generation Construction Rep. Signature - /s/ Dale Bishop - TVA				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				53.2 feet
5	Well Depth in general agreement with existing well construction details				??
6	Water Depth (feet below top of casing)				26.4 feet
7	Approximate well casing stickup above ground =				53 inches
8	Construction debris/materials removed from well abandonment site				
	Concrete pad and bollards removed by -			X	
9	Well Closure Documented By:				
	Print Name: Bill Rosen				
	Signature: /s/ Bill Rosen				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			X	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?	X			
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Bill Rosen				
12	Miscellaneous				11 – 50 lb. bags Bentonite Clay
a.					
b.					
c.					

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: 10-1

Date: 6-9-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: B. Rosen _ Abandoned By: Cascade

Well Details (Check one per section):

Casing Diameter

x 2"
4"
6"
Other/NA

Well Type

x Permanent
Temporary
Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

x PVC
Steel
Other/NA

Pre-Abandonment Measurements:

Well Depth: 47 feet Below Top of Casing (BTOC)
Depth to Water: 18 feet Below Top of Casing (BTOC)
Stickup = 32"

Abandonment Details (Check one per section):

Overdrilled with sonic casing full depth; removed most of well casing (broke-off too deep for retrieval); tremmie-backfilled w/ 30% solids bentonite grout.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

x Overdrill and Grout
Well Extraction
Grout in Place
Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
Bentonite Sealing- Pellets Only (low-risk GSP only)
Probe Hole Grouting (higher risk GSP only)
Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

Type I Portland Cement mixed with 3-5% bentonite
Bentonite Pellets
Neat Cement
68 gallons Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
x Disposed of at TVA on-site disposal area

Reviewed By: [signature] 6/10/16
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: 10-2

Date: 6-9-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: B. Rosen _ Abandoned By: Cascade

Well Details (Check one per section):

Casing Diameter

X 2"
___ 4"
___ 6"
___ Other/NA

Well Type

X Permanent
___ Temporary
___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

X PVC
___ Steel
___ Other/NA

Pre-Abandonment Measurements:

Well Depth: 34 feet Below Top of Casing (BTOC)
Depth to Water: 18.3 feet Below Top of Casing (BTOC)
Stickup = 32"

Abandonment Details (Check one per section):

Overdrilled with sonic casing full depth; removed most of well casing (casing broke-off too deep for retrieval); tremmie-backfilled with 30% solids bentonite grout.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

X Overdrill and Grout
X Well Extraction
___ Grout in Place
___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
___ Bentonite Sealing- Pellets Only (low-risk GSP only)
___ Probe Hole Grouting (higher risk GSP only)
___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

___ Type I Portland Cement mixed with 3-5% bentonite
___ Bentonite Pellets
___ Neat Cement
68 gallons Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

___ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
X Disposed of at TVA on-site disposal area

Reviewed By: [signature] 6/10/16
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: 93-2

Date: 6-1-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: J. Andrew Abandoned By: D. Jessie

Well Details (Check one per section):

Casing Diameter

X 2”
4”
6”
Other/NA

Well Type

X Permanent
Temporary
Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

X PVC
Steel
Other/NA

Pre-Abandonment Measurements:

Well Depth: 45.25 feet Below Top of Casing (BTOC)
Depth to Water: 11.4 feet Below Top of Casing (BTOC)
Stickup = 2.75’

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

X Overdrill and Grout
X Well Extraction
Grout in Place
Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
Bentonite Sealing- Pellets Only (low-risk GSP only)
Probe Hole Grouting (higher risk GSP only)
Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug using drill rods and tremmie-backfilled with 30% bentonite grout; overdrill with HSAs to 45’ bgs; extracted 12.4’ of PVC well casing; tremmie-backfilled borehole w/ 30% bentonite grout and retrieved HSAs.

Materials and Quantity Used

Type I Portland Cement mixed with 3-5% bentonite
Bentonite Pellets
Neat Cement
84 gallons Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
X Disposed of at TVA on-site disposal area

Reviewed By: [signature] 6/7/16
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: 96-6

Date: 6-16-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: B. Evans _ Abandoned By: G. Thompson

Well Details (Check one per section):

Casing Diameter

X 2"
___ 4"
___ 6"
___ Other/NA

Well Type

X Permanent
___ Temporary
___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

X PVC
___ Steel
___ Other/NA

Pre-Abandonment Measurements:

Well Depth: 25.65 feet Below Top of Casing (BTOC)
Depth to Water: 3.1 feet Below Top of Casing (BTOC)
Stickup = -2" (Flushmount)

Abandonment Details (Check one per section):

Well located off TVA property and inaccessible w/ drill rig. Closed well by tremmie-backfilling well casing w/ bentonite pellets and removing the surface pad. Casing removed ~3' bgs.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

___ Overdrill and Grout
___ Well Extraction
___ Grout in Place
___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
X Bentonite Sealing- Pellets Only (low-risk GSP only)
___ Probe Hole Grouting (higher risk GSP only)
___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

___ Type I Portland Cement mixed with 3-5% bentonite
40 lbs Bentonite Pellets
___ Neat Cement
___ Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

___ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
X Disposed of at TVA on-site disposal area

Reviewed By: [signature] 6/17/16

Signature Date/Time

Barry Bryant TN Driller #949

Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: 96-8

Date: 6-10-16
Project Name: TVA-CUF-GWMW Closures
Oversight By: B. Rosen _
Abandoned By: Cascade

Well Details (Check one per section):

Casing Diameter
- x 2”
- ___ 4”
- ___ 6”
- ___ Other/NA

Well Type
- x Permanent
- ___ Temporary
- ___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material
- x PVC
- ___ Steel
- ___ Other/NA

Pre-Abandonment Measurements:

Well Depth: 36.9 feet Below Top of Casing (BTOC)
Depth to Water: 8.3 feet Below Top of Casing (BTOC)
Stickup = 0” (Flushmount)

Abandonment Details (Check one per section):

Over-drilled full well depth using sonic casing; retrieved 31.5’ of 2” PVC riser and 15.9’ of 4” PVC overburden casing; screen irretrievable. Tremmie backfilled resulting borehole with 30% bentonite grout.

Abandonment Method (as detailed in TVA-KIF-SOP-46)
- x Overdrill and Grout
- x Well Extraction
- ___ Grout in Place
- ___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ___ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ___ Probe Hole Grouting (higher risk GSP only)
- ___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used
- ___ Type I Portland Cement mixed with 3-5% bentonite
- ___ Bentonite Pellets
- ___ Neat Cement
- 102 gal Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris
- ___ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- x Disposed of at TVA on-site disposal area

Reviewed By: [signature] 6/11/16
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: A-2

Date: 6-9-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: B. Rosen _ Abandoned By: Cascade

Well Details (Check one per section):

Casing Diameter

- ____ 2"
- X 4"
- ____ 6"
- ____ Other/NA

Well Type

- X Permanent
- ____ Temporary
- ____ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

- X PVC
- ____ Steel
- ____ Other/NA

Pre-Abandonment Measurements:

Well Depth: 54.0 feet Below Top of Casing (BTOC)
Depth to Water: 28.1 feet Below Top of Casing (BTOC)
Stickup = 40"

Abandonment Details (Check one per section):

Well location inaccessible with rig. Tremmie backfilled well casing from bottom up and removed well casing 39 inches below ground.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- ____ Overdrill and Grout
- ____ Well Extraction
- X Grout in Place
- ____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ____ Probe Hole Grouting (higher risk GSP only)
- ____ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

- ____ Type I Portland Cement mixed with 3-5% bentonite
- ____ Bentonite Pellets
- ____ Neat Cement
- 51 gal Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

- ____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- X Disposed of at TVA on-site disposal area

Reviewed By: [signature] 6/10/16
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: A-3

Date: 6-9-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: B. Rosen _ Abandoned By: Cascade

Well Details (Check one per section):

Casing Diameter

____ 2”
X 4”
____ 6”
____ Other/NA

Well Type

X Permanent
____ Temporary
____ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

X PVC
____ Steel
____ Other/NA

Pre-Abandonment Measurements:

Well Depth: 43.2 feet Below Top of Casing (BTOC)
Depth to Water: 9.0 feet Below Top of Casing (BTOC)
Stickup = 42”

Abandonment Details (Check one per section):

Over-drilled full depth of well using sonic casing; removed all well casing and screen; tremmie-backfilled borehole with 30% bentonite grout. No concrete pad or bollards.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

X Overdrill and Grout
X Well Extraction
____ Grout in Place
____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
____ Bentonite Sealing- Pellets Only (low-risk GSP only)
____ Probe Hole Grouting (higher risk GSP only)
____ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

____ Type I Portland Cement mixed with 3-5% bentonite
____ Bentonite Pellets
____ Neat Cement
153 gal Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
X Disposed of at TVA on-site disposal area

Reviewed By: ____________________ 6/10/16
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: A-3 Offset

Date: 6-8-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: B. Rosen _ Abandoned By: Cascade

Well Details (Check one per section):

Casing Diameter

x 2”
___ 4”
___ 6”
___ Other/NA

Well Type

x Permanent
___ Temporary
___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

x PVC
___ Steel
___ Other/NA

Pre-Abandonment Measurements:

Well Depth: 28.2 feet Below Top of Casing (BTOC)
Depth to Water: 9.4 feet Below Top of Casing (BTOC)
Stickup = 48”

Abandonment Details (Check one per section):

Over-drilled full depth of well using sonic casing; removed 2” PVC riser and portion of screen; tremmie-backfilled borehole with 30% bentonite grout. No concrete pad or bollards.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

x Overdrill and Grout
x Well Extraction
___ Grout in Place
___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
___ Bentonite Sealing- Pellets Only (low-risk GSP only)
___ Probe Hole Grouting (higher risk GSP only)
___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

___ Type I Portland Cement mixed with 3-5% bentonite
___ Bentonite Pellets
___ Neat Cement
85 gal Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

___ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
x Disposed of at TVA on-site disposal area

Reviewed By: [signature] 6/10/16
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: Unknown #1

Date: 6-9-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: B. Rosen _ Abandoned By: Cascade

Well Details (Check one per section):

Casing Diameter

X 2”
___ 4”
___ 6”
___ Other/NA

Well Type

X Permanent
___ Temporary
___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

X PVC
___ Steel
___ Other/NA

Pre-Abandonment Measurements:

Well Depth: 40.9 feet Below Top of Casing (BTOC)
Depth to Water: 16.4 feet Below Top of Casing (BTOC)
Stickup = 52”

Abandonment Details (Check one per section):

Well location inaccessible to over-drill. Removed 10 feet of 2” PVC riser and tremmie-backfilled with 30% bentonite grout. No pad or bollards.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

___ Overdrill and Grout
X Well Extraction
X Grout in Place
___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
___ Bentonite Sealing- Pellets Only (low-risk GSP only)
___ Probe Hole Grouting (higher risk GSP only)
___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

___ Type I Portland Cement mixed with 3-5% bentonite
___ Bentonite Pellets
___ Neat Cement
51 gal Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

___ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
X Disposed of at TVA on-site disposal area

Reviewed By: ______________________ 6/10/16
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: Unknown #2

Date: 6-9-16 Project Name: TVA-CUF-GWMW Closures

Oversight By: B. Rosen _ Abandoned By: Cascade

Well Details (Check one per section):

Casing Diameter

	2”
X	4”
	6”
	Other/NA

Well Type

X	Permanent
	Temporary
	Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

X	PVC
	Steel
	Other/NA

Pre-Abandonment Measurements:

Well Depth: 40.9 feet Below Top of Casing (BTOC)
Depth to Water: 16.4 feet Below Top of Casing (BTOC)
Stickup = 52”

Abandonment Details (Check one per section):

Over-drilled full depth of well and retrieved all 4” PVC riser and 20’ of PVC screen. Tremmie-backfilled borehole with 30% bentonite grout. No pad or bollards.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

X	Overdrill and Grout
X	Well Extraction
	Grout in Place
	Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
	Bentonite Sealing- Pellets Only (low-risk GSP only)
	Probe Hole Grouting (higher risk GSP only)
	Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

	Type I Portland Cement mixed with 3-5% bentonite
	Bentonite Pellets
	Neat Cement
187 gal	Other - High Solids Bentonite grout (30%)

Overdrilled Well Cuttings and Debris

	Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
X	Disposed of at TVA on-site disposal area

Reviewed By: [signature] 6/10/16

Signature Date/Time

Barry Bryant TN Driller #949

Print Name

APPENDIX K
PHOTOGRAPHS OF WELL CLOSURES

Photo 1. Well 10-1: Pre-Closure

Photo 2. Well 10-1: Post-Closure

Photo 3. Well 10-2: Pre-Closure

Photo 4. Well 10-2: Post-Closure

Photo 5. Well 93-2: Pre-Closure

Photo 6. Well 93-2: Post-Closure

Photo 7. Well 96-6: Pre-Closure (Located off TVA Property)

Photo 8. Well 96-6: Post-Closure

Photo 9. Well 96-8: Pre-Closure

Photo 10. Well 96-8: Post-Closure

Photo 11. Well A-2: Pre-Closure (Closed In-Place; Inaccessible with Rig)

Photo 12. Well A-2: Post-Closure

Photo 13. Well A-3: Pre-Closure

Photo 14. Well A-3: Post-Closure

Photo 15. Well A-3 Offset: Pre-Closure

Photo 16. Well A-3 Offset: Post-Closure

Photo 17. Well Unknown #1: Pre-Closure

Photo 18 Well Unknown #1: Post-Closure

Photo 19. Well Unknown #2: Pre-Closure

Photo 20. Well Unknown #2: Post-Closure

APPENDIX L
REQUESTS FOR INFORMATION

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-001	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/11/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Adjustment of screen interval for Well CUF-201 based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 11, 2016 (11:16 am) Jim Andrew (Stantec) called Meghan Seremet (AECOM) to discuss the subsurface conditions and proposed screen placement at CUF-201. The proposed screen interval was 4 to14 feet below the ground surface. Jim noted the following subsurface profile during drilling:

- 0-15' -Fine grained alluvium
- 15-17.5' –Silty SAND
- 17.5-20' – Stiff GRAVEL
- 20-23.5' – Silty SAND
- Groundwater was at 15'

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After reviewing the geology with Jim, Meghan decided a screen interval of about 14-24' bgs was appropriate for this location.

Signature:	**Date:** 5/11/2016

Other Comments:
None

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	**RFI No:**
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-002	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/11/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Adjustment of screen interval for Well CUF-205 based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 11, 2016 (10:36 am) Jim Andrew (Stantec) called Meghan Seremet (AECOM) to discuss the subsurface conditions and proposed screen placement at CUF-205. The proposed screen interval was 26 to 36 feet below the ground surface. Jim noted the following subsurface profile during drilling:

15-25.2' – Brown GRAVEL
Refusal at 25.2' (assumed bedrock)
Groundwater at 14 ft below ground surface (bgs)

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After reviewing the geology with Jim, Meghan decided a screen interval of about 14-24' bgs was appropriate for this location.

Signature: Meghan Seremet	**Date:** 5/11/2016

Other Comments:
None

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	**RFI No:**
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-003	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/12/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Relocation of Well CUF-202 based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 12, 2016 (about 10:30 am) Jim Andrew (Stantec) called Meghan Seremet (AECOM) to discuss the subsurface conditions for CUF-202. The proposed screen interval was to be 25 to 35 feet below the ground surface. Jim noted the following subsurface profile during drilling:

0 to 9' – highly weathered to moderately weathered shale with rapidly increasing N-values.
No groundwater encountered, shale was relatively dry.
Expected soil not encountered.

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After reviewing the geology with Jim, Meghan decided to offset the well approximately 450 to 650 feet down the hill toward the northwest. This will likely require and update to the CEC and a new excavation permit with utility locate.

Signature:	**Date:** 5/12/2016

Other Comments:
Stantec elected to move on to another well location at the stacks until the new location has been staked and cleared.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s): RFI No:
Project:
Area/Task:
Date:
Scope/MOA: (yes/no description):
Q.C. Requirements:
Safety: (yes/no description): No
Schedule: (yes/no description): No
Cost: (yes/no description):

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-004	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/12/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Extension of Well CUF-207 based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 12, 2016 (about 4:30 pm) Briggs Evans (Stantec) called Meghan Seremet (AECOM) to discuss the subsurface conditions for CUF-207. The proposed screen interval was to be 44 to 54 feet below the ground surface. Briggs noted the following subsurface profile during drilling:

the expected coarser grained soils were not encountered until about 72 feet below the ground surface.
groundwater was encountered at about 26.7 feet.
top of rock was at about 82 fett and auger refusal was at about 84.3 feet bgs

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After reviewing the geology with Briggs, Meghan decided to extend the well screen to approximately 73 to 83 feet below the ground surface to be in the wet coarser grained soils.

Signature:	**Date:** 5/12/2016

Other Comments:

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-005	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/17/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Extension of Well CUF-210 and change in screen length based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 17, 2016 (about 5:25 pm) Jim Andrew (Stantec) called Meghan Seremet (AECOM) to discuss the subsurface conditions for CUF-210. The proposed screen interval was to be 50 to 60 feet below the ground surface. Jim noted the following subsurface profile during drilling:

Moist clayey fill and overburden soils to about 60'
Sand unit at 60-65' bgs.
Clay below sand at 65-70.5' bgs
Weathered Shale at 70.5'-72'
groundwater was encountered at about 30 feet.

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After reviewing the geology with Jim, Meghan decided to extend the well screen to approximately 60 to 65 feet below the ground surface to be in the wet coarser grained soils. A 5 foot screen was used in lieu of a 10 foot screen.

Signature: Meghan Seremet	**Date:** 5/17/2016

Other Comments:

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-006	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/17/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Extension of Well CUF-204 based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 17, 2016 (about 5:30 pm) Briggs Evans (Stantec) called Meghan Seremet (AECOM) to discuss the subsurface conditions for CUF-204. The proposed screen interval was to be 5 to 15 feet below the ground surface. Briggs noted the following subsurface profile during drilling:

- Bedrock encountered at ~15' bgs
- Fracture zone ~24-27' bgs, but not water-bearing (maybe clay-filled)
- Preliminary well depth at 33' bgs (2' of cuttings from 33-35').
- Apparent groundwater at about 33' bgs

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After reviewing the geology with Briggs, Meghan decided to extend the well to approximately 33 feet below the ground surface. After an hour of waiting, the groundwater did not rise. It was agreed to drill deeper to around 45' bgs and let sit overnight.

Signature: Meghan Seremet	**Date:** 5/17/2016

Other Comments:
5/18/2016 - Follow up: The water level in the borehole did not change overnight. The water in the borehole is likely from the drilling process. It was decided that the well would be abandoned and relocated to the north and east within the CEC permit area. A revised excavation permit will likely be required. Stantec has staked a new well location which will be cleared for utilities on Thursday (5/19/2016) along with the revised locations for CUF-202.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-007	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/18/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Extension of Well CUF-203 based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 18, 2016 (about 5:00 pm) Briggs Evans (Stantec) called Meghan Seremet (AECOM) to discuss the subsurface conditions for CUF-203. The proposed screen interval was to be 15 to 25 feet below the ground surface. Briggs noted the following subsurface profile during drilling:

Bedrock encountered at ~10' bgs
Borehole was extended to 40 feet with no apparent water bearing fractures

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After reviewing the geology with Briggs, Meghan decided to extend the well to approximately 60 feet below the ground surface to see if a water bearing zone could be located. It was decided that if the borehole was dry it would be abandoned and relocated to the west within the CEC permit area.

Signature: Meghan Seremet	**Date:** 5/18/2016

Other Comments:
Borehole was extended to 50 feet on 5/18/2016. It will be extended an additional 10 feet on 5/19/2016. If found to be dry, a revised excavation permit will likely be required. Stantec has staked a new well location which will be cleared for utilities on Thursday (5/19/2016) along with the revised locations for CUF-202, and 204.

This RFI does not represent approval of scope, fee, or schedule change. .

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

TVA

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-008	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/19/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Extension of Well CUF-213 based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 19, 2016 (about 5:30 pm) Jim Andrew (Stantec) called Meghan Seremet (AECOM) to discuss the subsurface conditions for CUF-213. The proposed screen interval was to be 55 to 65 feet below the ground surface. Jim noted the following subsurface profile uring drilling:

Bedrock encountered at ~45.6' bgs
Silty gravel layer from about 36.5-40' bgs

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After discussing CUF-213 with Jim, Meghan also called Elizabeth Perry to discuss the situation. It was decided that two wells would be preferred here (one bedrock and one overburden). We would like to set the overburden well at the current CUF-213 location with a screen interval at 36.5-41.5' bgs. This is the silty gravel layer. We informed Shannon (TVA) about a second well in bedrock, but she is out until Monday. Stantec will wait until we hear back from TVA before installing this second well.

Signature: Meghan Seremet	**Date:** 5/19/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-009	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/25/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Extension of Well CUF-204A1 based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 25, 2016 (about 4:30 pm) Briggs Evans (Stantec) contacted Meghan Seremet (AECOM) to discuss the subsurface conditions for CUF-204A1 (offset location for CUF-204). The proposed screen interval was to be 5 to 15 feet below the ground surface. Briggs noted the following subsurface profile uring drilling:

Bedrock encountered at ~30.5' bgs
Two fracture zones from about 34 to 35' and 36 to 38.5'
Approximately 2300 ml/min of groundwater inflow was measured.
Borehole advanced to 46' to allow for screen to be set.

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After discussing CUF-204A1 with Briggs, Meghan decided that the groundwater inflow was sufficient and recommended that the well screen be set at about 35-45' bgs.

Signature: Meghan Seremet	**Date:** 5/27/2016

Other Comments:
Stantec set the well screen at about 35-45' bgs on 5/26/2016. This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	**RFI No:**
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-010	**Submitted By:** Darren Pleiman - Stantec	**Date:** 5/31/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Possible relocation or shortening of Well CUF-202A based on observed site conditions.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
On May 31, 2016 (about 4:40 pm) Jim Andrew (Stantec) contacted Meghan Seremet (AECOM) to discuss the subsurface conditions for CUF-202A (offset location for original CUF-202). The proposed screen interval was to be 25 to 35 feet below the ground surface. Jim noted the following subsurface profile during drilling:

Bedrock encountered at ~31' bgs
Water bearing granular layer encountered from about 28.5' to 31'
Casing was left in the hole until a final descision is made.

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
After discussing CUF-202A with Jim, Meghan decided that the groundwater inflow was marginal and that the second offset location (CUF-202B, closer to the creek) should be drilled first to see if better conditions could be found. Stantec will move their ATV rig to the second offset location and drill down to the proposed depth. Based on a comparison of the subsurface conditions at both locations, AECOM will decide which borehole will receive a well and what length of screen will be used. The remaining borehole will then be grouted.

Signature: Meghan Seremet	**Date:** 5/31/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-011	**Submitted By:** Darren Pleiman - Stantec	**Date:** 6/1/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Installation of CUF-214.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF and AECOM's email from Meghan Seremet dated 5/26/2016 (2:29 pm).

Issues/Concerns:
On May 26, 2016 (about 2:49 pm) Meghan Seremet (AECOM) issued an email regarding the installation of CUF-214. Proposed Well CUF-214 was not part of the original scope of services. Based on the subsurface conditions encountered at CUF-213 an additional well was planned to be installed in proximity to CUF-213 with a bearing elevation up to 30-ft into competent bedrock, but not greater than 80-ft below the ground surface and with sufficient groundwater inflow. A 4-in diameter by 10-ft long screen was to be set at an anticipated depth of about 50 to 60-ft below the ground surface. Stantec's representative (Briggs Evans) noted the following subsurface profile during drilling:

Bedrock encountered at ~45' bgs
Borehole was extended about 32' into bedrock.
No water bearing fractures were encountered during drilling.

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
The boring was performed on June 1, 2016. After discussing CUF-214 with Briggs, Meghan decided to backfill the borehole due to the lack of groundwater inflow. CUF-214 was backfilled with high solids bentonite grout to the ground surface.

Signature: Meghan Seremet	**Date:** 6/1/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-012	**Submitted By:** Darren Pleiman - Stantec	**Date:** 6/6/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Well Development: Adjusting target turbidity value (NTU) for observation wells.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF and Stantec's email from Barry Bryant dated 6/6/2016 (2:15 pm).

Issues/Concerns:
On June 6, 2016 (about 2:15 pm) Barry Bryant (Stantec) issued an email regarding well development for observation wells at the Cumberland Fossil Plant. Based on well development records over the past few weeks, development has been very slow for existing wells due to the high fines (clay and silt) content in the screened interval. To date only 6 of the 24 wells have been completed for development.

Sender's Recommendation(s):
Stantec recommends that the target turbidity for development be 50 NTUs for observation wells. Wells where dedicated pumps and sampling will be performed will remain at the previous target of 5 NTUs.

Reply:

Signature: Meghan Seremet **Date:** 6/6/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s): **RFI No:**

Project:

Area/Task:

Date:

Scope/MOA: (yes/no description):

Q.C. Requirements:

Safety: (yes/no description):
No

Schedule: (yes/no description):
The recommended change has the potential to shorten the well installation/development schedule and provide for a quicker return-to-service date.

Cost: (yes/no description):

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-013	**Submitted By:** Darren Pleiman - Stantec	**Date:** 6/8/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Well Closure: Well A-2

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF.

Issues/Concerns:
On or about June 8, 2016 Jim Andrew (Stantec) contacted Jeff Gray (TVA) regarding the closure of Well A-2. Based on the observed site conditions, Well A-2 is located on a rip rap slope that is very difficult to access even with an ATV drill rig. See attached photo.

Sender's Recommendation(s):
Jim discussed the access issues with Jeff Gray and it was decided to abandon the well in place and cut the stickup flush with the ground surface. Well back fill would consits of high solids bentonite.

Reply:

Signature: Meghan Seremet	**Date:** 6/8/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	**RFI No:**
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): Yes, the rip rap slope around the well poses a footing hazard for both machine and people.	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Photo 1. Well A-2 – To be closed – Existing Conditions

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-014	**Submitted By:** Darren Pleiman - Stantec	**Date:** 6/16/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Well Development: Adjusting target turbidity value (NTU) for new and existing CCR compliance wells.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF.

Issues/Concerns:
The current turbidity target level for well development is 5 NTUs. The subsurface conditions at the installed well screen depths across the site typically consist of silty sands and sands with appreciable amounts of fines (i.e., clay and silt). Additionally, the granular layers where screens are set tend to be relatively thin (less than the proposed screen length), which forces a portion of the screen to be set in a fine grained cohesive soil. Due to the subsurface conditions at the existing and newly installed wells across the site, well development over the past few weeks has been very slow.

Wells, CUF-210 and 93-4, new and existing compliance wells, have been very difficult to develop. At these two well locations, the NTU levels fluctuate between 20 and 30. They are also slow to recharge, with a rate typically less than 100 ml/min.

Sender's Recommendation(s):
Stantec recommends that the target turbidity for development be 20 NTUs for new and existing CCR compliance wells. This should cover all of the wells except CUF-210 and 93-4. For wells CUF-210 and 93-4, the turbitity threshold will likely be a little higher due to the subsurface conditions.

Reply:

Signature:	**Date:** 6/16/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description):	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-015	**Submitted By:** Darren Pleiman - Stantec	**Date:** 6/8/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Installation of CUF-120.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF and AECOM's email from Meghan Seremet dated 6/8/2016 (12:47 pm).

Issues/Concerns:
On June 8, 2016 (AM) Jim Andrew contacted Meghan Seremet (AECOM) regarding the installation of CUF-120. On June 6 a boring was extended to a depth of about 29 ft below the ground surface with bedrock encountered at about 12 ft and no groundwater encountered during drilling. The drilling casing was left in the hole overnight for the groundwater level to develop. Groundwater eventually rose to about 8 ft below the ground surface. In order to verify the water bearing strata, an additional boring was performed approximately 9 ft from the original location within the overburden soils. Bedrock was encountered at about 14 ft and the groundwater rose to a depth of about 8.5 ft below the ground surface.

Sender's Recommendation(s):
As previously agreed (TVA, Stantec, and AECOM), Stantec's field supervisor, after calling Stantec's project manager, called AECOM's site project manager to discuss the issue. Unless otherwise noted, Stantec concurs with AECOM's direction.

Reply:
Meghan Seremet decided to set a 5-ft screen from about 6 to 11 ft below the ground surface, within the overburden. The original location will be grouted with high solids bentonite grout.

Signature: Meghan Seremet	**Date:** 6/8/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-016	**Submitted By:** Darren Pleiman - Stantec	**Date:** 6/9/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Well Closure: Well Unknown #1

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF.

Issues/Concerns:
On June 9, 2016, Jim Andrew (Stantec) observed rig access conditions regarding the closure of Well Unknown #1. Based on the observed site conditions, Well Unknown #1 is located at the edge of a steep slope that puts the drill crew in a very difficult and potentially risky situation on the hillside. See attached photos.

Sender's Recommendation(s):
Because of the access issues we recommend the well be abandoned in place and cut the stickup flush with the ground surface. Well back fill would consits of high solids bentonite.

Reply:

Signature: Meghan Seremet	**Date:** 6/9/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): Yes, steep slope around the well poses a footing and tool handling hazard for the drill crew.	
Schedule: (yes/no description): No	
Cost: (yes/no description):	

Photo 1. Well Unknown#1 – To be closed – At top of slope

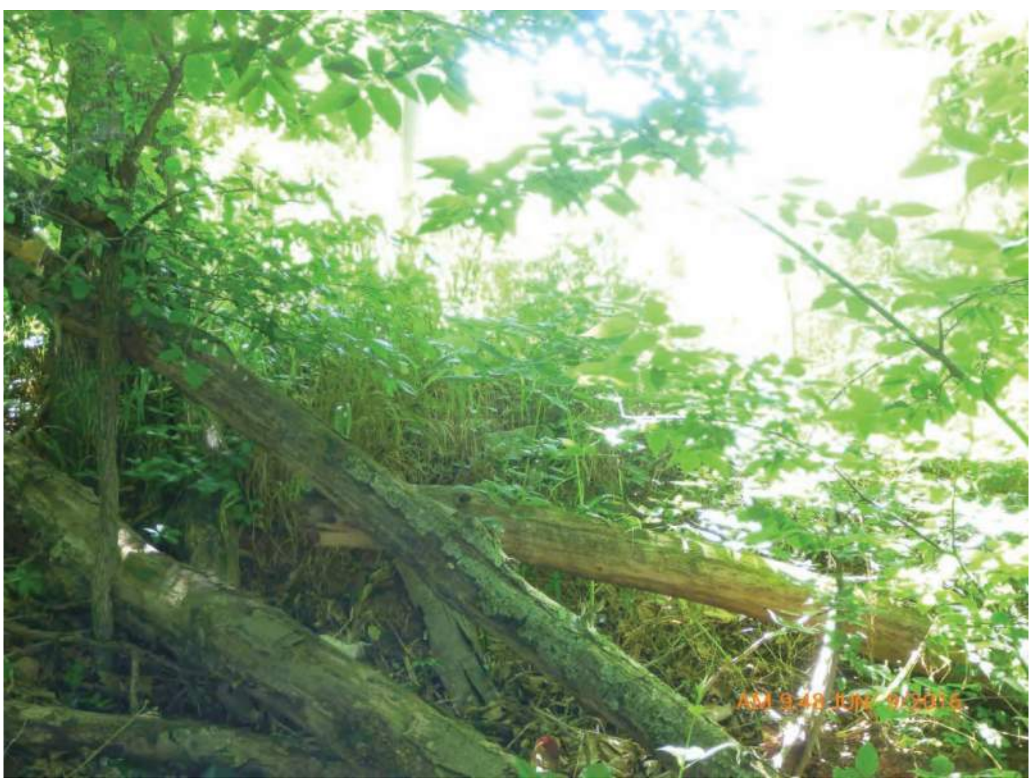


Photo 2. Well Unknown#1 – To be closed – Looking up slope

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-017	**Submitted By:** Darren Pleiman - Stantec	**Date:** 6/9/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Well Closure: Well 96-6 - Offsite on Georgia Pacific property.

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF.

Issues/Concerns:
On June 9, 2016, Jim Andrew (Stantec) observed that Well 96-6 was located off TVA property on Georgia Pacific property. Jim discussed the location and access with Dale Bishop (TVA) and they met with Georgia Pacific's site manager Kevin Lucas (Reliability Leader) regarding the closure of the well. Mr. Lucas indicated that he would have to refer the matter to his environmental division and get back with TVA.

Sender's Recommendation(s):
Recommend removing this well from the list as it is no longer on TVA property. The 2-in. diameter by ~26-ft deep well was installed about 20 years ago. Suggest reviewing legal ramification of leaving this well open on property not owned by TVA. Follow up at a later date.

Reply:

Signature:	**Date:** 6/9/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:

For Construction Purposes Only - Impact(s):	RFI No:
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description):	
Cost: (yes/no description):	

Request For Information (RFI)

Tennessee Valley Authority **Location** Cumberland Fossil Plant **Project** Groundwater Monitoring Well (Phase 3)

RFI No: 609389-018	**Submitted By:** Barry Bryant - Stantec	**Date:** 7/15/2016
Project: 609389	**Area/Task:** Groundwater Monitoring Well Installation	

Subject:
Well screen installation depths differing from optimization plan

References (drawings/spec's/conditions/assumptions):
Stantec's Work Plan for CUF

Issues/Concerns:
Depth intervals for installed screens of some new wells at CUF differ from the proposed well screen intervals shown in the referenced work plan based on actual subsurface stratigraphy encountered. The actual screen intervals were installed following instructions by AECOM personnel. Planned and actual screen intervals are tablulated below:

Well ID	Proposed Screen Interval (ft bgs)	Actual Screen Interval (ft bgs)
CUF-202	25-35	11.0 - 16.2
CUF-206	67-77	79.0 - 89.5
CUF-209	43-53	49.4 - 59.9
CUF-212	63-73	59.1 - 69.5
CUF-213	55-65	36.3 - 41.5

Sender's Recommendation(s):
The wells were installed and completed based on encountered subsurface stratigraphy and instuctions provided by AECOM during the course of the field work.

Reply:

Signature:	**Date:** 7/15/2016

Other Comments:
This RFI does not represent approval of scope, fee, or schedule change.

Document Control Received Date/Initial:	
For Construction Purposes Only - Impact(s):	**RFI No:** 608390-018
Project:	
Area/Task:	
Date:	
Scope/MOA: (yes/no description):	
Q.C. Requirements:	
Safety: (yes/no description): No	
Schedule: (yes/no description):	
Cost: (yes/no description):	

APPENDIX O
WATER USE SURVEY SAP

Water Use Survey
Sampling and Analysis Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

WATER USE SURVEY
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Water Use Survey
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ______________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

______________________ 6/25/18
TVA Investigation Project Manager — Date

______________________ 6/25/18
TVA Investigation Field Lead — Date

______________________ 6/25/18
Health, Safety, and Environmental (HSE) Manager — Date

______________________ 06/25/18
Investigation Consultant Project Manager — Date

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.06.21 15:57:51 -04'00'
QA Oversight Manager — Date

______________________ 6/22/18
Laboratory Project Manager — Date

____
Charles L. Head
TDEC Senior Advisor — Date

____
Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, TVA has developed this Water Use Survey Sampling and Analysis Plan (SAP) to conduct a water use survey and sampling of groundwater and surface water supplies within ½ mile of the boundary of the CUF Plant (Plant). This plan includes a schedule and procedures for identifying the locations and owner of each water source, soliciting permission to collect groundwater or surface water samples, and reviewing and reporting the gathered information.

2.0 OBJECTIVES

The objectives of this Water Use Survey SAP are to establish procedures for identifying and sampling usable water supply wells and surface water sources being used for domestic purposes located within the Survey Area (defined in Section 4.0). Sampling will assist in the evaluation of constituents that may be related to coal ash in water supply wells or surface water supplies within the survey area. TVA defines a usable water well to be one that will house a pump (even if a pump is not currently present), and does not contain an obstruction or defective construction that would prevent the insertion or operation of a pump.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLE LOCATIONS

Domestic water wells identified within a ½ mile radius of the Plant will be surveyed and sampled if access is granted. A map showing properties within ½ mile of the Plant is provided in Attachment A. A final map displaying all surveyed and sampled wells will be provided in the EAR.

Based on a request by TDEC, existing reports with information regarding water well and surface water supply locations, including the 1992 Law Engineer Hydrogeology Report and 1990 TVA CUF Drastic Application Report, will be utilized to determine sampling locations.

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, identify locations of domestic water supply and collect water samples, and assist in providing scientifically defensible results.

Sample collection will adhere to applicable United States Environmental Protection Agency (EPA) and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer
- Complete required health and safety paperwork and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator to ensure that sample bottles and preservatives are ordered, coolers and analyte-free deionized water are obtained, and sampling and sample arrival dates are communicated to the laboratories
- Obtain required functional and calibrated field instruments, including health and safety equipment
- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TI ENV-TI-05.80.03, *Field Record Keeping* and TVA TI ENV-TI-05.80.02, *Sample Labeling and Custody*
- Obtain ice daily prior to beginning work for sample preservation

5.2 PROPERTY AND OWNER IDENTIFICATION

Sources of information on the potential presence of private water supplies in the survey area include:

- Water supply well locations within the local quadrangle(s) provided by TVA
- Public utilities water service maps
- County water well inventory records on file with TDEC
- Existing reports with information regarding water well and surface water supply locations. TVA will compile information from county tax maps on properties and cross-reference sources of information to create a map of potential water supplies within the survey boundary. This map will be used to guide door-to-door surveys that seek to confirm ownership and locations of groundwater supply wells or surface water sources, identify previously unknown water sources, and evaluate whether the water source is now or in the future could be used as a source of water supply.

A template for the properties identified through this data comparison process is provided as Table 1 in Attachment B. This master table will list potential properties identified via this survey where a private water supply is present and whether the supply is located within the survey area. Each property will be assigned an identification number to preserve the owner's privacy. The identification numbers will begin with "Plant specific three letter acronym-PV-00#" (or similar designation) and will be assigned sequentially as the property appears on the list, beginning with "-001". Key data relating to each property identification number (i.e. property owner, resident name and address) will be stored and managed on a secure server.

5.3 DOOR-TO-DOOR SURVEY

This section provides a generic access agreement letter (Attachment C), example survey form (Attachment D), and procedure to be used by TVA to conduct the survey.

5.3.1 Survey Description

This survey will allow TVA to identify persons either currently using groundwater or surface water as a drinking water source or if persons have usable water wells. The updated list of survey properties will be visited by TVA personnel or their contractors to gather information using the same or similar questions to those in the example survey form (Attachment D) The door-to-door survey will be conducted between the hours of 8 am and 8 pm (to be staggered to cover a general 8-hour work day each day) to increase the likelihood that someone will be present.

Locations where contact is not made will be revisited as needed, including weekend contact attempts if necessary.

TVA or their contractors will discuss the access agreement letter with each property owner to determine if access will be granted to allow sampling of their well or water supply source at a later date. In the event that access is not initially granted, TDEC will be contacted to assist in gaining access. Two copies of the access agreement letter (example in Attachment C) will be left with the property owner, one for the owner's records, and one to be signed and returned to TVA if an immediate signature is not obtained during the initial visit. If the occupant is not the property owner, then TVA will work with the occupant to contact the property owner for access.

Contact information for appropriate TVA personnel will be provided in the access agreement letter.

The survey team will consist of at least two people. To the extent possible, at least one member will be a TVA employee.

5.3.2 Well-Owner Questionnaire

The personnel conducting the door-to-door survey will complete a Water Supply Well Survey Form (Attachment D) for each property owner. If necessary, the information will be supplemented with the following information if it is known by the owner:

- Well construction information, including construction material and date drilled
- Septic system type and location (if present) relative to well location
- Which taps receive treated vs untreated water
- Typical use of water (irrigation, residential water source, etc.)
- Determine if the well or source has ever gone dry or if water supply is a concern
- Water quality concerns or complaints, if any
- Number of occupants living at the location

5.3.3 Survey Information Management

Information forms will be compiled in an electronic format, such as Microsoft Excel and key data relating to each property (i.e. property owner, resident name, and address) will be stored and managed on a secure server. The information will be used to finalize a map showing homes and businesses within the survey area that TVA contacted, wells within the survey area, and locations of water sources that are used as a drinking water source or have usable water wells. The final map will indicate one of the following for each property:

- Water supply well or surface water source used as primary drinking water source
- Water supply well present and usable, is not used as primary drinking water source, but is used for other activities (e.g., irrigation)
- Water supply well present and usable, but is not currently being used
- Water supply well present but not in a usable condition (i.e., no pump is present and the field team is unable to sample the well with field pumps)
- No water supply well or surface water supply present
- Information not available

This map will be provided to TDEC and will be used to prepare for a water supply sampling event.

5.4 SAMPLE LOCATIONS

TVA will collect samples from locations identified during the door-to-door survey that are using groundwater or surface water as a drinking water source or have useable wells and where permission has been obtained from the owner/operator.

If sampling reveals CCR constituents present above maximum contaminant levels (MCLs) within the initial survey boundary, TVA will promptly report the information to TDEC. In the event of an emergency related to elevated CCR constituents in groundwater associated with Plant operations, TVA will work with TDEC to implement a contingency plan. As part of the contingency plan, TVA will work with TDEC to notify appropriate parties, implement necessary safety measures, and provide an alternative source of potable water.

5.5 SAMPLING METHODS AND PROTOCOL

Water supply sample collection will adhere to applicable EPA (EPA 2001) and TVA TI documents. The related TVA TIs follow:

- ENV-GAF-PW.01 *Potable Water Sampling*
- ENV-TI-05.80.01 *Planning Sample Events*
- ENV-TI-05.80.02 *Sample Labeling and Custody*
- ENV-TI-05.80.03 *Field Record Keeping*
- ENV-TI-05.80.04 *Field Sampling Quality Control*
- ENV-TI-05.80.05 *Field Sampling Equipment Cleaning and Decontamination*
- ENV-TI-05.80.06 *Handling and Shipping of Samples*
- ENV-TI-05.80.46 *Field Measurement Using a Multi-Parameter Sonde*

5.5.1 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment E. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.5.2 Field Documentation

Field documentation will be maintained in accordance with TVA TI *ENV-05.80.03, Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/global positioning system (GPS) documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.5.2.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.5.2.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.5.2.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Consultant will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.5.2.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.5.3 Collection of Samples

5.5.3.1 GENERAL SAMPLING PROCEDURES

Prior to sampling, a multi-parameter meter will be used to record conventional water parameters at the tap. Water quality measurement instrumentation will be calibrated and used in accordance with the QAPP. Conventional field parameters to be measured include:

- Dissolved Oxygen
- Oxidation Reduction Potential
- pH
- Specific Conductance
- Temperature
- Turbidity

The sampling point will be selected from within the system as close to the well as possible but prior to the addition of water softeners, filters, and treatment systems when possible. If a sample cannot be collected prior to a water treatment device, then the type of treatment device will be documented in the field logbook. Aerators and screens/fixtures attached to the faucet will be removed prior to sampling. The system will be purged by allowing cold water to run for at least 15 minutes. If there is an inline tank prior to the sampling tap, enough water will be purged to complete a full exchange of water in the tank after the 15-minute purge has been completed. During purging, field parameters will be measured every 3-5 minutes to assess stability. If water quality parameters have not stabilized after purging, then TVA will note that they have not stabilized, record the final field parameter values, and collect a sample.

5.5.3.2 WATER SUPPLY SAMPLING FROM A TAP

TVA and its contractors will collect samples in accordance with the procedures provided in the QAPP. Water samples will be collected directly from a faucet or pipe valve with any screens/fixtures removed directly into laboratory-supplied bottleware or will be collected from the screenless/fixtureless faucet into laboratory-supplied bottleware utilizing new, clean sample tubing connected to the tap/faucet. The tubing will be connected to the tap/faucet via a properly decontaminated adapter with a ribbed nipple that will be screwed on the faucet outlet. The tubing will be flush for at least three minutes prior to sampling. The sample will be collected at the indoor or outdoor tap closest to the wellhead, prior to any water treatment devices. If a sample cannot be collected prior to a water treatment device, then the type of treatment device will be documented in the field logbook.

5.5.3.3 WATER SUPPLY WELL SAMPLING WHERE THERE IS NO TAP

Water supply wells that do not have a tap will be sampled in a manner that allows collection of samples that will be representative of ambient groundwater quality. This typically requires that the well is purged to remove stagnant water prior to sample collection. For wells that have existing pumps, purging will be conducted in a manner to minimize disturbance of water in the well bore by pumping at low rates. If wells without functioning pumps installed are identified during the initial sampling event, then a second visit to the property may be required for sample collection. Available information regarding the condition of the well and the equipment needed to collect a sample will be will be recorded in the field logbook during the initial visit to the property.

The methods to be used for sample collection are provided in the TIs and ENV-GAF-PW.01, *Potable Water Sampling* which describes use of bailers, peristaltic, or submersible pumps for sample collection at wells where there is no tap or existing pump. Water samples will be collected directly from a pump discharge point directly into laboratory-supplied bottleware or will be collected from the pump into laboratory-supplied bottleware utilizing new, clean sample tubing which has been connected to the pump and flushed for three minutes.

5.5.4 Preservation and Handling

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody*. Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Gel ice or loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form.

If multiple coolers are required to ship samples contained on a single COC form the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Consultant Project Manager.

5.5.5 Sample Analyses

Samples will be submitted to the TVA-approved laboratory for analysis. Samples will be analyzed for the CCR related constituents listed in Title 40 of the Code of Federal Regulations Part 257 (40 CFR 257), Appendices III and IV. In addition, five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the 40 CFR 257 Appendices III and IV, will be analyzed to maintain continuity with TDEC environmental programs. The additional constituents listed in TDEC Appendix 1 include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as "CCR Parameters."

For geochemical evaluation, major cations/anions not included in the CCR Parameters are included in the analyses for this SAP. The additional geochemical parameters include magnesium, potassium, sodium, carbonate and bicarbonate.

Tables 1 through 4 summarize the constituents requiring analysis. Analytical methods, preservation requirements, container size, and holding times for each chemical analysis are presented in Table 5. Additional sampling and laboratory specific information is covered in more detail in the QAPP.

Table 1. 40 CFR Part 257, Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids

Table 2. 40 CFR Part 257, Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium

Appendix IV Constituents
Thallium
Radium 226 and 228 Combined

Table 3. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents*

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 4. Additional Geochemical Parameters

Major Cations/Anions
Bicarbonate
Carbonate
Magnesium
Potassium
Sodium

* Constituents not included in the CCR Parameters

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Radium 226	SW-846 903.0	HNO3 to pH < 2 Cool to <6°C	1 L glass or Plastic	180 days
Radium 228	SW-846 904.0	HNO3 to pH < 2 Cool to <6°C	2 L glass or plastic	180 days
Chloride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Fluoride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Sulfate	SW-846 9056A	Cool to <6°C	125-mL HDPE	28 days
pH	SW-846 9040C (field measurement)	NA	NA	15 minutes
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	Cool to <6°C	250-mL HDPE	14 days

The pH of groundwater samples will be measured in the field.

5.5.6 Equipment Decontamination Procedures

Documented decontamination will be performed for non-dedicated sampling equipment and instruments that in contact with groundwater or surface water in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination.

Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets. Following decontamination, fluids will be disposal in accordance with Section 5.5.7

Decontamination of sampling equipment and instruments (i.e., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.5.7 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to the Water Use Survey SAP.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One field duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. MS/MSD samples will be collected filling bottles alternately by thirds in accordance with ENV-TI-05.80.04, *Field Sampling Quality Control* into three sets of identical, laboratory-prepared sample bottles. Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels.

The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD. For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of blank per lot.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals, (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to ensure the label is not removed. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 6. Preliminary Schedule for Water Use Survey Activities

Project Schedule		
Task	**Duration**	**Notes**
Water Use Survey SAP Submittal		Completed
Field Activities Preparation	30 Days	Following EIP Approval
Field Activities Implementation	65 Days	Following Field Preparation
Lab Analysis	30 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Private water sources will only be sampled and measured when access is granted. The Investigation Consultant will record the address and information provided by the owner when access is not granted.
- This scope of work does not include the repair of wells or pumps. Wells or pumps in a condition that will not allow sampling will be noted in the field logbook.

9.0 REFERENCES

Environmental Protection Agency (EPA) Region 4. 2001. "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual." November.

Foust, D.D., and Beard, L., 1990. "Cumberland Fossil Plant Drastic Application, Tennessee Valley Authority Engineering Laboratory WR28-1-46-104."

Law Engineering. 1992. "Report of Hydrogeologic Evaluation – Proposed Dry Fly Ash and Gypsum Disposal Facility TVA Cumberland Fossil Plant Cumberland City, Tennessee."

Tennessee Valley Authority (TVA). 2016. "Potable Water Sampling." Technical Instruction ENV-GAF-PW.01, Revision 0. August 29.

Tennessee Valley Authority (TVA). 2017a. "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017b. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017f. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017g. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

ATTACHMENT A
½ MILE RADIUS MAP

Figure No.
1

Title

Facility 1/2 Mile Buffer

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

Stewart County, Tennessee

175566329
Prepared by TR on 2017-10-17
Technical Review by EM on 2017-10-17

0 600 1,200 1,800 2,400 3,000 Feet

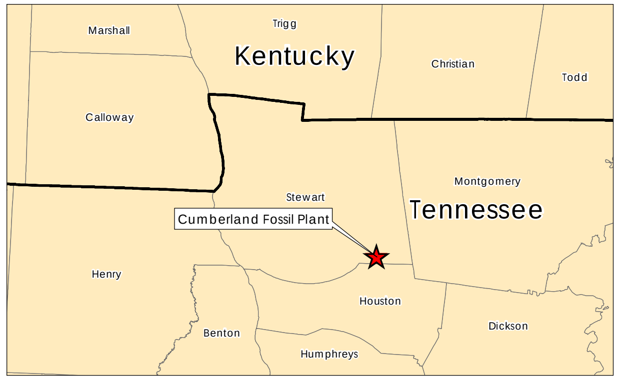
1:12,000 (At original document size of 22x34)

Legend

- CCR Unit Area (Approximate)
- CUF Parcel Boundary
- CUF Parcel 1/2 Mile Buffer

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017) and ESRI Basemaps (NAIP c. 2016)



Stantec

TVA

U:\TVA-EP\175566329\gis\mxds\REV2\CUF_Half_Mile_Buffer.mxd Revised: 2017-10-17 By: mbough

ATTACHMENT B
PRIVATE WATER WELL LIST TEMPLATE

Stantec

Table 1
Water Supply Survey List
Template

KIF ID No.	KIFPV-001	KIFPV-002	KIFPV-003
Owners Name			
Property Address			
Alt. Property Address			
Mailng Address			
Stewart County Tax Assessor's Map No.			
Dwelling/Building Present? Y/N			
Data Source			
Municiple Water at This Location? Y/N			
Door-to- Door Survey? Y/N			
Comments			

ATTACHMENT C
GENERIC ACCESS AGREEMENT LETTER

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

Date: ____________________

Address:

____
____
____

SUBJECT: Access for Water Supply Survey

Dear Well Owner,

The Tennessee Valley Authority (TVA) is working with the Tennessee Department of Environment and Conservation (TDEC) to evaluate environmental conditions in and around the Kingston Fossil Plant. One of these activities is to conduct sampling of private well water. TVA would like to sample your well, and to do so, we need your written permission.

The purpose of this letter is to ask your permission, as the property owner, to allow TVA, its contractor, and their respective subcontractors and agents to conduct a water supply survey at your property located at [insert address]. A signed access agreement will allow TVA and its contractor to survey your well. An access agreement is provided at the end of this letter. If you are renting or leasing the property and/or are not the legal property owner, please let TVA know and we will work to contact the owner for this permission.

TVA would coordinate the timing of this work with you to minimize any inconvenience. The work would be conducted on weekdays, during normal business hours, and you would need to be present. However, we will work with you to schedule the work for a day when you are available. We hope to complete this work during June or July 2017 or as soon as we can schedule it with you; additional sampling may be requested for later dates, and this access agreement is also meant to cover future sampling.

The field staff will ask you about the location of the water supply entering your home and if your home has a water treatment system. Should water sampling be necessary they will try to collect a sample between the water well and the water treatment system, if you have one. Otherwise they will try to sample closest to the water entry point. In many cases, this will be a tap on the exterior of your home. The sampling activity involves filling sample bottles with tap water and will take approximately 30 minutes.

All TVA and contractor field staff would be identifiable by bright yellow safety vests and/or identification badges. No work would be performed at your property without your permission. Our field staff may need to go into your home, and they will be instructed to provide you with an

ID and a phone number should you wish to confirm with TVA that they are authorized personnel. The field staff would be available to answer any questions you may have during the well sampling.

You can also contact the following person if you have any questions:

If you agree to allow TVA, its contractor, and their respective subcontractors and agents access to your property to survey and/or sample your well water as described above, we ask that you sign this letter where indicated below and return it to TVA. So that you may also keep a copy for your records, we have provided a duplicate of this letter.

Thank you for considering participation in this well sampling program. Yours

sincerely,

CC:

As the owner(s) of the property located at, ________________ I/we hereby agree to allow TVA its contractor, and their subcontractors and agents the access described above.

Owner(s) Signature: ____

Owner(s) Printed Name: ____

Date(s) Signed by Owner(s): _______________________________________

Contact Phone Number: ____
(To be used only to coordinate sampling activities)

Contact email: ____

ATTACHMENT D
EXAMPLE DOOR-TO-DOOR SURVEY

Survey Team No.	Property Identification No.
	KIF-SW-

GPS Coordinates: ____________________

Date: ___________________

Name:	
Property Address:	
Mailing Address:	
E-mail Address:	
Telephone Number:	
1	Is there a well or surface water supply on the property?
2	If any, how many wells or surface water supplies are on the property?
3	Is this a drinking water or irrigation water supply (circle one)?
4	When was the last time water from the water supply was used?
5	Does the water supply on the property have a pump and is it operational?
6	How deep is the well or wells?
7	Do you have a septic system on the property?
8	Do you have municipal water and/or sewer? (circle all that apply)
9	Have any odors from the water been detected?
10	Has any discoloration in the water or staining in the sinks, tubs, ect. been observed?
11	Where on the property is the water supply located?
12	Can we walk over and see the well or surface water supply?
13	Can we return and take a sample of your water supply?
14	Do you treat your well or surface water supply water? Do you use a treatment system such as reverse osmosis system, filtration, or water softening unit?
15	Was Access Agreement provided to the water supply owner?
16	Was Access Agreement signed by water supply owner and provided to survey team?

Key Observations for Surveyor to Note: -Mark the well(s)/surface water supply and/or septic system location on the property map, or draw a diagram of these locations relative to the dwelling and other buildings.
-Describe the location(s) where the water supply can be accessed for sampling. Make sure you note if there is a sampling location located up flow of (before) any water treatment unit (if present).
-Is there a spigot at the wellhead that can be used for sampling?
-Provide a business card with TVA contact information for follow-up questions from the property owner.

Survey Complete (Circle One) Y N

General Notes or Drawing:

ATTACHMENT E
FIELD EQUIPMENT LIST

Field Equipment List
Water Use Survey

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Flow measurement supplies (for example: graduated cylinder and stop watch)
Multiparameter Sonde with flow-through cell
Turbidity meter
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for other drilling-specific field equipment

APPENDIX P
GROUNDWATER INVESTIGATION SAP

Groundwater Investigation Sampling and Analysis Plan Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

GROUNDWATER INVESTIGATION
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Groundwater Investigation
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ____________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

Signature / Role	Date
TVA Investigation Project Manager	6/25/18
TVA Investigation Field Lead	6/25/18
Health, Safety, and Environmental (HSE) Manager	6/25/18
Investigation Consultant Project Manager	06/25/18
Rock J. Vitale (Digitally signed by Rock J. Vitale) QA Oversight Manager	
Laboratory Project Manager	6/22/18
Charles L. Head, TDEC Senior Advisor	
Robert Wilkinson, TDEC CCR Technical Manager	

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, TVA has developed this Groundwater Investigation Sampling and Analysis Plan (SAP) to investigate groundwater conditions at the CUF Plant (Plant). The Groundwater Investigation SAP provides the procedures necessary to conduct investigation activities associated with the sampling and analysis of groundwater.

2.0 OBJECTIVES

The objective of the Groundwater Investigation SAP is to provide the procedures necessary to characterize existing groundwater quality and evaluate groundwater flow conditions on the Plant, in response to the TDEC Commissioner's Multi Site Order. The approach in characterizing the groundwater conditions is to collect groundwater samples for chemical analyses and measure groundwater and surface water elevations to evaluate the potential presence of CCR related constituents in groundwater and direction of groundwater flow to respond to TDEC's request.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

TVA is currently sampling groundwater at the Plant for TDEC Solid Waste Management permit requirements and the United States Environmental Protection Agency (EPA) CCR rule. Monitoring wells that are being sampled as part of other programs will not be sampled as part of this SAP. However, groundwater levels will be measured in certain wells that are not sampled as part of this SAP to provide information to prepare groundwater contour maps for the Plant.

TVA has other activities underway at the Plant for the CCR Rule, TDEC permitting requirements and capital projects that may include the installation of monitoring or observation wells. If monitoring or observation wells are installed as part of those activities, then TVA may sample groundwater or measure groundwater levels in them as part of this SAP.

Piezometers with vibrating wire transducers will be installed within the Dry Ash Stack and Gypsum Storage Area for other ongoing TVA projects. These vibrating wire piezometers are shown on the Proposed Borings figure in the EIP. The water level measurements collected from these piezometers will be used to characterize the groundwater flow beneath the units. No additional wells are proposed to be installed within the units. TVA's understanding is that the compliance boundary per TDEC solid waste regulations is defined as the perimeter of the CCR complex and does not include the areas within the units.

Sampling Scope

TVA will measure groundwater level elevations at the following monitoring and observation well locations across the Plant:

- Existing monitoring wells 93-1, 93-2R, 93-3, 93-4, B110, CUF-201, CUF-202 and CUF-205 through CUF-213.
- Existing observation wells 96-9, B103, CUF-101, CUF-102 and CUF-120.
- Three proposed background monitoring wells (CUF-1000, CUF-1001 and CUF-1004) to be installed as part of the environmental investigation.
- Three proposed monitoring wells installed as part of the environmental investigation and located between the CCR units and the main plant (CUF-1002 and CUF-1003) and east of the Gypsum Storage Area (CUF-1005).
- Piezometers installed in the CCR units as part of other activities.

Piezometers and observation wells will only be gauged to collect groundwater elevations because they were not designed to collect representative groundwater analytical samples. Groundwater flow direction and rate will be calculated for each sampling event.

The Hydrogeological Investigation SAP provides the rationale, locations, contingencies, and installation methods for proposed new monitoring wells.

Proposed background well locations CUF-1000 and CUF-1001 were discussed and selected during the onsite CUF meeting with TDEC prior to the EIP Rev 1 submittal. During the meeting, the locations of proposed background wells CUF-1000 and CUF-1001 were identified by TDEC. In addition, hydrogeological investigation activities are in progress to characterize the hydrogeology at CUF. After investigation activities have been completed, the results will be evaluated to select appropriate background monitoring well locations. The selected background well locations will be provided to TDEC for review and comment before finalizing these locations.

Surface water elevations will be measured at the one gauging station in the Cumberland River and one proposed gauging station in Wells Creek. The new location in Wells Creek will be installed as part of other activities and is not part of the environmental investigation. Figure 1 (Attachment A) shows the proposed location of the Wells Creek monitoring point.

Groundwater samples will be collected from the six new monitoring well locations and submitted for laboratory analysis of CCR Parameters as defined in Section 5.2.7 and major cations/anions (magnesium, potassium, sodium, carbonate and bicarbonate) (see Section 5.2.7 for the parameter list).

The results of groundwater samples collected from monitoring wells from other programs will be used as applicable to the TDEC Order. However, monitoring wells that are part of other programs will not be sampled as part of the environmental investigation. The data utilized from other programs will be provided in the Environmental Assessment Report (EAR).

Figure 1 shows the monitoring and observation well locations that will be sampled or from which groundwater elevation measurements will be collected as part of this SAP. This figure will be updated to show the actual locations for wells after execution of the Hydrogeological Investigation SAP.

Sampling Frequency

TVA plans to conduct six sampling events at a frequency of one event every two months for one year as part of the environmental investigation to characterize seasonal groundwater flow direction, rates, and quality. According to United States Environmental Protection Agency (U.S. EPA) Project Summary document "Sampling Frequency for Ground-Water Quality Monitoring" dated September 1989, quarterly and bimonthly groundwater sampling frequencies are appropriate for major, non-reactive chemical constituents. However, more frequent sampling intervals are not recommended due to potential statistical autocorrelation issues.

Data from these six sampling events will be provided in the EAR.

TVA will continue to collect groundwater samples from the existing monitoring wells and review the analytical results as part of other activities that are being conducted concurrently with this investigation.

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, collect groundwater samples, take groundwater and surface water elevation measurements, and assist in providing scientifically defensible results.

Groundwater sampling will adhere to applicable EPA and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will conduct the following:

- Designate a Safety Officer
- Complete required health and safety documentation and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator, including ordering sample bottles and preservatives, obtaining coolers and distilled water, if needed, and notifying the laboratory of sampling dates
- Obtain required calibrated field instruments, including health and safety equipment, water level meters, and equipment needed for measuring parameters that define stability during well purging
- Discuss project objectives and potential hazards with project personnel
- Obtain a control box for dedicated pumps
- Complete sample paperwork to the extent possible, prior to deploying into the field, including chain-of-custody forms and sample labels

Obtain ice prior to sample collection for sample preservation.

5.2 SAMPLING METHODS AND PROTOCOL

5.2.1 Groundwater and Surface Water Level Measurements

Prior to sampling, each monitoring well and staff gauge will be inspected for damage or indications that the well integrity has been compromised. If field observations indicate the need for well or staff gauge maintenance or repairs, the Field Team Leader will notify TVA.

After the monitoring well and staff gauge integrity inspection is completed, the water level in each well and at each staff gauge will be measured in relation to a surveyed reference point (e.g., top of well casing) using an electronic water level indicator. Groundwater elevation data will be measured and recorded in accordance with TVA TI ENV-TI-05.80.44, *Groundwater Level and Well Depth Measurement*. The elevation will be recorded to the nearest 0.01 foot. To the extent possible, the field team will minimize the length of time between collection of the first and last water level measurement for the monitoring well network and staff gauges. At a minimum, measurements will be made within the same day. In addition, barometric pressure readings will be recorded daily. TVA plans to use a multi-parameter sensor equipped with a National Institute of Science & Technology (NIST) certified temperature sensor.

The water level indicator will be decontaminated between each well by following the decontamination procedures provided below in Section 5.2.8.

5.2.2 Well Purging

Following the measurement of groundwater levels, monitoring wells will be purged using pumps dedicated to each well. Purging will continue until field measurements of water quality parameters stabilize during three consecutive readings at 3 to 5 minute intervals per the criteria listed in TVA TI ENV-TI-05.80.42, *Groundwater Sampling*. The stabilization criteria follow:

- pH - ±0.1
- Specific conductivity - ±5% µS/cm
- Dissolved oxygen (DO) - ±10% for > 0.5 mg/L or <0.5 mg/L
- Turbidity - below 10 NTUs or ±10% for values above 10 NTUs

Field measurements, including pH, specific conductivity, turbidity, oxidation/reduction potential, and temperature, will be collected during purging using a flow-through cell. Once the field parameters have stabilized, samples will be collected. For low yield wells, field parameters will be measured at the time of sample collection in an open sample container using a multi-parameter probe. A final turbidity measurement will be made after each sample is collected.

If after two hours of purging field parameters have not stabilized, then groundwater samples will be collected and the efforts to stabilize parameters will be recorded in the field log book and field data sheet. A final turbidity measurement will be made after each sample is collected.

Purging beginning and end times, pumping rates, water quality parameter readings, and groundwater levels will be recorded throughout the purging operation on field sampling forms. The total volume purged at each well may vary based on recharge rates and stabilization of water quality parameters.

Low-flow purging techniques will be used to collect a representative sample from the water bearing unit unless the wells do not yield sufficient water. If the well has been sampled historically using low-flow sampling methods, then the well will be purged at the rate known to induce minimal drawdown. If pump settings are unknown, purging will begin at a minimum pumping rate of 0.1 liter per minute (L/min) and will be slowly increased to a setting that induces little or no drawdown, if possible. Pumping rates will not exceed 0.5 L/min. If drawdown exceeds 0.3 feet, but reaches stability, purging of the well will continue and the current flow rate, drawdown, and time will be recorded on the field data sheet by the sampler.

Low yield wells will be purged until standing water is removed. Groundwater samples will be collected with a low-flow pump, as soon as water levels return to 80% within the well bore to obtain the necessary sample volume, but no later than 24 hours after the well purge.

5.2.3 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the Quality Assurance Project Plan (QAPP).

5.2.4 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/global positioning system (GPS) documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.4.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.4.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. TVA groundwater sampling forms will be used to document groundwater level measurements, stabilization parameters and field observations at each monitoring well location.

5.2.4.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Consultant will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.4.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.5 Collection of Samples

5.2.5.1 Groundwater Sampling

A final reading of water quality parameters will be conducted and documented on field sampling forms at the time of sample collection, but these measurements will not be from the sample itself. Unfiltered groundwater samples will be collected in appropriate, laboratory provided, pre-preserved sample containers. Samples will be collected directly from the pump discharge line.

The sampler will wear clean latex (or equivalent) gloves when handling sample containers and will not touch the interior of containers or container caps. New gloves will be used when handling each sample. When filling sample bottles, care will be taken to minimize sample aeration (i.e., water will be directed down the inner walls of the sample bottle) and avoid overfilling and diluting preservatives. Each sample bottle will be capped before filling the next bottle.

It will be necessary to collect filtered (dissolved) inorganic constituent samples, in addition to unfiltered (total) inorganic constituent samples, if the final turbidity value prior to sampling exceeds 10 NTUs. Dissolved sample collection will be accomplished in accordance with TVA TI ENV-TI-05.80.42.

Issues that could affect the quality of samples will be recorded on the field data sheet or in the log book along with the action(s) taken to resolve the issue. These could include observations such as clogged sampling tubes, highly turbid samples or defective materials or equipment.

5.2.6 Preservation and Handling

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody*. Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-TI-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Consultant Project Manager.

5.2.7 Sample Analyses

Groundwater samples will be submitted to the TVA-approved laboratory for analysis. Samples will be analyzed for the CCR related constituents listed in Title 40 of the Code of Federal Regulations Part 257 (40 CFR 257), Appendices III and IV. In addition, five inorganic constituents listed in Appendix I of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the 40 CFR 257 Appendices III and IV, will be analyzed to maintain continuity with TDEC environmental programs. The additional constituents listed in TDEC Appendix 1 include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix I inorganic constituents, will hereafter be referred to collectively as "CCR Parameters."

For geochemical evaluation, major cations/anions not included in the CCR Parameters are included in the analyses for this SAP. The additional geochemical parameters include bicarbonate, carbonate, magnesium, potassium and sodium.

Tables 1 through 4 summarize the constituents requiring analysis. Analytical methods, preservation requirements, container size, and holding times for each chemical analysis are presented in Table 5. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 1. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids

Table 2. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 3. TN Rule 0400-11-01-.04, Appendix I Inorganic Constituents

TDEC Appendix I Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 4. Additional Geochemical Parameters

Major Cations/Anions
Bicarbonate
Carbonate
Magnesium
Potassium
Sodium

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Radium 226	SW-846 903.0	HNO_3 to pH < 2 Cool to <6°C	1 L glass or Plastic	180 days
Radium 228	SW-846 904.0	HNO_3 to pH < 2 Cool to <6°C	2 L glass or plastic	180 days
Chloride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Fluoride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Sulfate	SW-846 9056A	C	125-mL HDPE	28 days
pH	SW-846 9040C (field measurement)	NA	NA	15 minutes
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	Cool to <6°C	250-mL HDPE	14 days

The pH of groundwater samples will be measured in the field.

5.2.8 Equipment Decontamination Procedures

Documented decontamination will be performed for non-dedicated groundwater sampling equipment in contact with groundwater or surface water in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Pumps are dedicated to each well and do not need to be decontaminated.

Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox ® or other appropriate non-phosphatic detergent in 5-gallon buckets. Following decontamination, fluids will be disposal in accordance with Section 5.2.9.

Decontamination of sampling equipment and instruments (i.e., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.9 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Purge water
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to groundwater sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below.

Field Duplicate Samples – One duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with the exception of parameters that are not amenable to MS/MSD.

For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a groundwater sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment (e.g., a decontaminated water level meter), then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the monitoring well location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of one blank per lot.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a groundwater sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, Sample Labeling and Custody and ENV-TI-05.80.03, Field Record Keeping. Each sample container will have a sample label affixed and secured with clear package tape as necessary to ensure the label is not removed. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP

Table 6. Preliminary Schedule for Groundwater Investigation SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Groundwater Investigation SAP Submittal		Completed
Prepare for Field Activities for the first bi-monthly sampling event	10 Days	Following Completion of Monitoring Well Development
Conduct Field Activities	5 Days	Following Field Preparation
Laboratory Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

Note: Monitoring well installation and development schedules are provided in the Hydrogeological Investigation SAP.

Six bimonthly groundwater sampling events for one year are proposed for this environmental investigation. The first bimonthly sampling event will occur 10 days after completion of development of the proposed background monitoring wells. The next five sampling events will occur on a bimonthly basis according to the schedule above.

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Access to well locations will be provided prior to the field preparation start date for each round of sampling.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017a. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017f. "Groundwater Sampling." Technical Instruction ENV-TI-05.80.42, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017g. "Groundwater Level and Well Depth Measurement." Technical Instruction ENV-TI-05.80.44, Revision 0000. March 31

Tennessee Valley Authority (TVA). 2017h. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

United States Environmental Protection Agency (US EPA). 1989. Sampling Frequency for Ground-Water Quality Monitoring Project Summary Document, September.

ATTACHMENT A
FIGURE

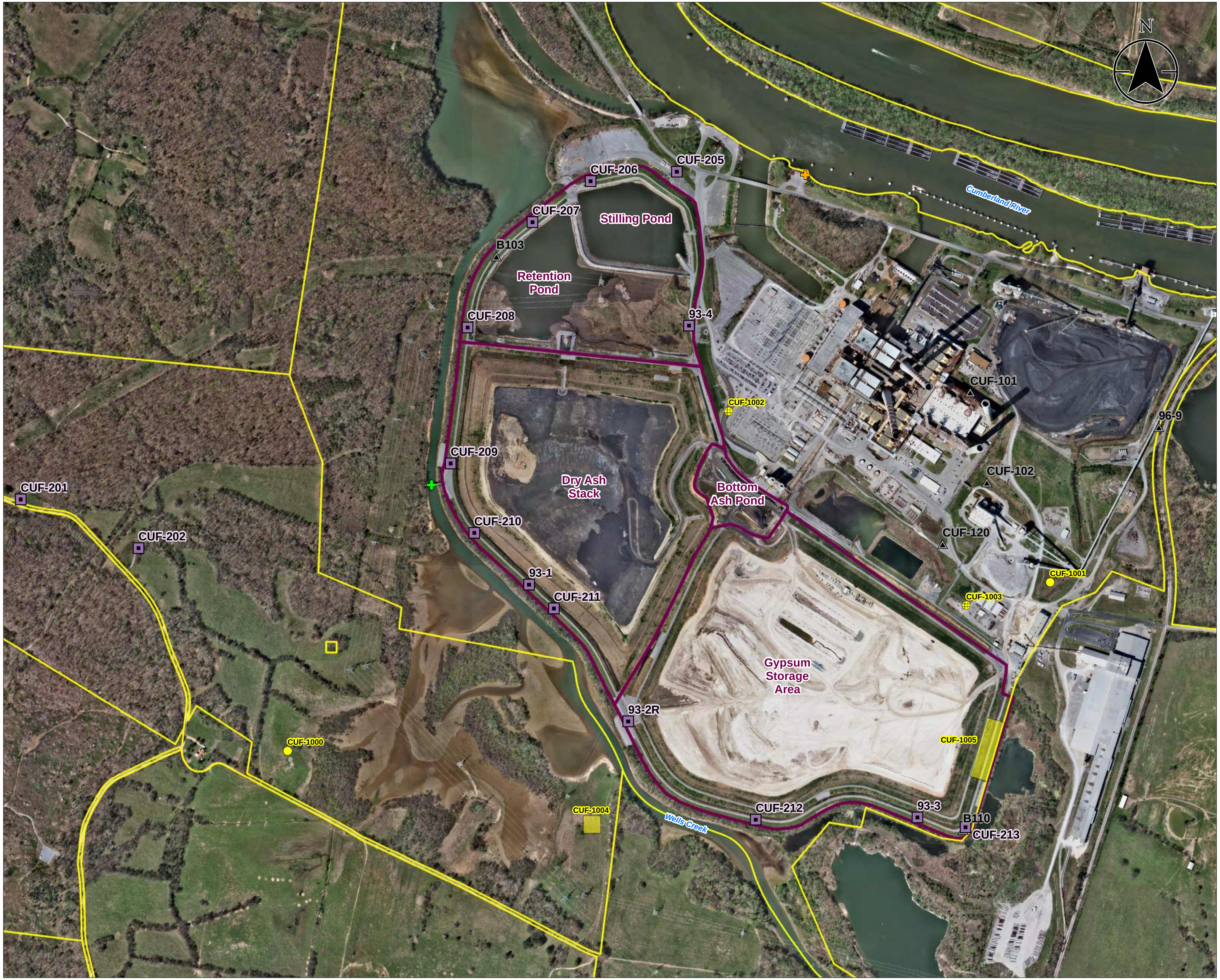


Figure No.
1

Title
Groundwater Sampling Locations

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

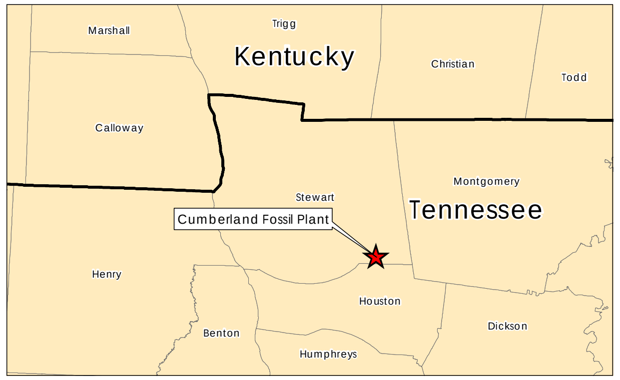
175566329
Prepared by MW on 2018-01-23
Technical Review by JG on 2018-01-23

0 400 800 1,200 1,600 Feet
1:4,800 (At original document size of 22x34)

Legend

- Existing Observation Well
- Existing Groundwater Monitoring Well
- Proposed Monitoring Well
- Proposed Background Monitoring Well
- Proposed Wells Creek Gage
- River Gage
- Proposed Well Area
- TVA Property Boundary
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Groundwater Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Flow measurement supplies (e.g. graduated cylinder, stop watch)
Water level indicator meter
Oil/water interface meter
Photoionization detector (PID)
Sample filtration device and filters
Dedicated well sampling pumps, fittings, and tubing
Stainless steel clamps
Pump controller and power supply
Air compressor, air line heads, and end fittings
Generator (if needed)
Multi-parameter Sonde with flow-through cell
Multi-parameter sensor equipped with a National Institute of Science & Technology (NIST) certified temperature sensor
Turbidity meter
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX Q
GROUNDWATER QUALITY ASSESSMENT PLAN (DECEMBER 11, 2017)

Tennessee Valley Authority, 1101 Market Street, BR4A, Chattanooga, Tennessee 37402

December 12, 2017

Mr. Alan Spear, P.G.
Division of Solid Waste Management
Nashville Environmental Assistance Center
Tennessee Department of Environment
and Conservation (TDEC)
711 R. S. Gass Boulevard
Nashville, Tennessee 37243

Dear Mr. Spear:

TENNESSEE VALLEY AUTHORITY (TVA) – CUMBERLAND FOSSIL PLANT (CUF) – DRY FLY ASH AND GYPSUM DISPOSAL AREAS (IDL 81-0086) – GROUNDWATER QUALITY ASSESSMENT PLAN

Enclosed is the Groundwater Quality Assessment Plan for the Gypsum Disposal Area per the Solid Waste Disposal Act, TCA 68-211-101 et. seq. and applicable regulations. As requested in the Environmental Investigation Plan (EIP) correspondence from TDEC, dated January 13, 2017, and a subsequent revision request, this plan addresses relevant comments and concerns in that letter. This plan is being submitted under separate cover from the EIP.

If you have questions, please contact Taylor Korth at (423) 751-3162, or by email at tkorth@tva.gov.

Sincerely,

Shawn Rudder
Senior Manager
Waste Permits, Compliance, and Monitoring

Enclosure
cc (Enclosure):

Mr. Robert Burnette, P.E.
Tennessee Department of Environment
and Conservation
1301 Riverfront Parkway, Suite 206
Chattanooga, Tennessee 37402

Mr. James Clark
Tennessee Department of Environment
and Conservation
1421 Hampshire Pike
Columbia, Tennessee 38401

Tennessee Valley Authority
Cumberland Fossil Plant
Dry Fly Ash and Gypsum Disposal Areas
(IDL 81-102-0086)

GROUNDWATER QUALITY ASSESSMENT PLAN

Prepared by

Taylor Korth, PE

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December 11, 2017

DOCUMENT CERTIFICATION

I certify under penalty of law that this document was prepared by me or under my supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. The information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

Maggie Gilliland, PG

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REVISION LOG

Revision Number	Effective Date	Affected Page Numbers	Description of Revision
0001	12/11/2017	All	Minor revisions per TDEC correspondence

ACRONYMS AND ABBREVIATIONS

CCR	Coal Combustion Residuals
COC	Chain of Custody
CUF	Cumberland Fossil
EAR	Environmental Assessment Report
EIP	Environmental Investigation Plan
FGD	Flue Gas Desulfurization
GFAA	Graphic Furnace Atomic Adsorption
GWPS	Groundwater Protection Standard
ICPMS	Inductively-coupled Plasma Mass Spectroscopy
MCL	Maximum Contaminant Limit
MSL	Mean Sea Level
SWM	Division of Solid Waste Management
TDEC	Tennessee Department of Environment and Conservation
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
UPL	Upper Prediction Limit
EPA	U. S. Environmental Protection Agency

1 INTRODUCTION

1.1 Purpose and Scope

The Dry Fly Ash and Gypsum Disposal Areas (IDL 81-102-0086) located at Tennessee Valley Authority's Cumberland Fossil Plant (CUF) was placed in *Groundwater Assessment Monitoring – Phase 3* pursuant to the February 23, 2009 letter from Tennessee Department of Environment and Conservation (TDEC) to Tennessee Valley Authority (TVA). This action resulted from a confirmed maximum contaminant level (MCL) exceedance for selenium in the July 16, 2008 sample from facility compliance well 93-2. Subsequent quarterly groundwater assessment monitoring performed since April 2009 has indicated additional groundwater protection standard (GWPS) exceedances for arsenic and selenium and alternate GWPS exceedances for vanadium. A Groundwater Quality Assessment Plan was initially submitted to TDEC on December 12, 2011. Though TDEC has not formally responded to the initial Plan, TVA offers this document to replace the initial submittal.

In accordance with Rule 0400-11-01-.04(7)(a)6(iv), TDEC's request in their January 13, 2017 CUF EIP letter and subsequent request for revision dated August 25, 2017, the TVA has prepared the following *Groundwater Quality Assessment Plan* to further investigate groundwater impacts related to coal combustion residuals (CCR) in the vicinity of the Dry Fly Ash and Gypsum Disposal Areas. The plan describes proposed activities necessary to:

- Determine whether CCR constituents from CUF have impacted groundwater.
- Quantify the rate of CCR constituent migration in groundwater.
- Delineate the horizontal and vertical extent of groundwater affected by CCR constituents using existing and new monitoring wells, and determine the concentration of CCR constituents in the groundwater.
- Establish whether sampling or analytical error might account for past constituent concentration exceedances of GWPSs.
- Identify domestic and commercial water use within a one mile radius from the center of the facility, and notify water users potentially affected by groundwater impacts from the CUF plant site.
- Sample private wells within one mile of the center of the landfill for Solid Waste Processing and Disposal Regulations (SWPDR) Appendix I parameters and for CCR Rule Appendix III and Appendix IV parameters with approval from property owners.
- Conduct on-going quarterly sampling and analysis of groundwater at the disposal facility, as directed by TDEC.

The plan includes a brief description of hydrogeological conditions at the CUF plant site as it relates to potential migration of constituents from the CCR disposal areas. A brief summary of historical groundwater monitoring data associated with the CCR disposal areas is presented to provide the necessary background for discussing proposed groundwater quality investigations. The TVA Technical Instruction, ENV-TI-05.80.42, Groundwater Sampling, will be followed in performing monitoring activities connected with this *Groundwater Quality Assessment Plan*, and is included in Appendix A for reference. The Technical Instruction provides field sampling protocols, quality control procedures, field parameter analysis requirements and methods, sample custody and other recordkeeping requirements. Per TDEC solid waste regulations, on-site filtration is not performed for TN landfills and is exempt from the portion of the procedure regarding field filtration.

1.2 Location and Background

The Cumberland Fossil Plant is located on the south bank of the Cumberland River (Lake Barkley) at approximate river mile 103 in Stewart County, Tennessee (Figure 1). The site is approximately three miles north of Erin, Tennessee, and 10 miles southwest of Clarksville, Tennessee. The plant operates two, 1,300-megawatt units that together burn approximately 5.6 million tons of coal per year and produces approximately 1.2 million tons of CCR per year. This annually generates approximately 328,000 tons of fly ash, most of which has been deposited in the Dry Fly Ash Disposal Area since 1996 or sold as a beneficial use product. Both generating units were equipped with flue gas desulfurization (FGD) systems in October 1996 to reduce SO2 emissions from the flue gas. The FGD system produces approximately 817,000 tons per year of byproduct containing predominantly calcium sulfate (gypsum).

Until May 2009 gypsum was sluiced from the filter plant to the settling pond and stacking area. In May 2009 gypsum was 100% dewatered at the gypsum dewatering system (operated by Synthetic Materials (Synmat)) and fine rejects (fines) from their process was rerouted to the bottom ash pond via the gypsum primary dipping ditch where the fines solids settled out. The fines are then excavated, allowed to dry, and then placed on the Gypsum Disposal Area. As a result of diverting the routine sluicing operations from the top of the stack, infiltration of transport water into the gypsum byproduct was eliminated. In the spring of 2013, new lined gypsum slurry settling channels and a gypsum dewatering pad went into operation on the northwest side of the Gypsum Disposal Area. The channels included a flexible membrane liner to minimize infiltration of water into the stack. The channels are intermittently operated when there is an interruption at the Synmat dewatering facility. TVA sells approximately 75 percent of the CCR produced at CUF annually (662,000 tons of gypsum and 221,000 tons of fly ash) for beneficial reuse as raw manufacturing material. Laboratory reports indicating the chemical characteristics of the gypsum and dry fly ash byproducts produced by the plant are presented in Appendix B.

1.3 Hydrogeological Conditions

The Cumberland Fossil Plant site lies within the Wells Creek Basin formed by a meteor impact which occurred several hundred million years ago. The meteor impact had a profound effect on the structure of bedrock underlying the site and produced a series of concentric, ring-like horst and graben structures with several faults radiating outward from the center of the impact area. Because of the shattered condition of the bedrock beneath the impact area, the circular impact zone eroded faster and deeper than the surrounding region forming Wells Creek Basin.

The CCR disposal area (which includes both the dry fly ash and gypsum disposal areas) is situated in the former floodplains of Wells Creek and the Cumberland River. The southern portion of the Dry Fly Ash Disposal Area is occupying an area that was formerly the main channel and floodplain of Wells Creek. Soil dikes were constructed around low-lying areas adjacent to Wells Creek to isolate the CCR disposal area from the 100-year flood elevation (approximate elevation 380 feet above mean sea level (amsl)). The dikes were subsequently raised to 395 feet amsl and then to 404 feet amsl.

Floodplain alluvium beneath the CCR disposal area is generally found below about elevation 360 feet amsl. Shallow alluvial deposits typically consist of clays and silts grading downward to coarser sands and gravels. The alluvium averages less than 25 feet in thickness beneath the ash disposal areas, but may be as great as 45 feet thick in the abandoned channel of Wells Creek. Alluvium is underlain at some locations by a layer of residual soils primarily consisting of clay and silt.

Ordovician age carbonate rocks of the Knox Group, Stones River Group, and Hermitage-Fernvale formations comprise bedrock beneath most of the CCR disposal area. An exception is the northwest corner of the Dry Fly Ash Disposal Area where younger Silurian-Mississippian age rocks are present. The limestones and dolomites which predominantly underlie the site are generally interbedded with clay, shale, and siltstone between soluble limestone strata that tend to limit fracture enlargement in the more soluble carbonate units.

The first occurrence of groundwater beneath the CCR disposal area is generally within the alluvium or residuum. In the main plant area where bedrock is relatively shallow, the first occurrence of groundwater is typically in upper bedrock or basal residuum. Historical monitoring indicates that groundwater levels across most of the site are influenced by water levels in the Cumberland River and Wells Creek. Local groundwater recharge at the CUF plant site occurs by infiltration of precipitation and by lateral flow from the north-south trending ridge, bounding the eastern side of the plant site (Figure 1). Essentially shallow groundwater originating as infiltration over the plant site is expected to ultimately discharge into the

Cumberland River and Wells Creek, as indicated by the July 10, 2017 groundwater potentiometric map shown on Figure 2.

Two production wells operated by SynMat were located on adjoining property bordering the southeastern side of the CUF plant site (Figure 1) and did not appear to be receptors of significant amounts of shallow groundwater from the CUF site. SynMat reported to TVA that these wells were closed in 2000.

Both of the Synmat production wells were completed in limestone of the Stones River Group at depths of approximately 300 feet. Although actual pump rates from these wells is unknown, SynMat reportedly anticipated intermittently pumping up to 300 gpm to supply wash water for gypsum processing (TVA, 1998). Separate pumping tests of the production wells conducted in May 1998 produced little discernable drawdown in CUF wells monitored during the test. Based on pumping test results and the absence of any evidence of drawdown in CUF monitoring wells after the SynMat wells went into operation, the contribution of shallow groundwater from the CUF site to the production wells is expected to be negligibly small.

CUF is hydrologically bounded by the Cumberland River to the north, by Wells Creek to the south and west, and by a north-south trending ridge on the east side. As previously noted, shallow groundwater movement inferred from the potentiometric surface is toward Wells Creek and the Cumberland River which represent the ultimate receptors of groundwater originating at the plant (Figure 2). The ridge on the eastern side of the site exceeds elevation 600 feet in some areas and represents a local groundwater divide. The presence of Rye Spring (and other springs) emanating from the western slope of the ridge is an indication that shallow groundwater movement is westward from the ridge towards CUF. The presence of the natural hydrologic boundaries surrounding the plant indicate that potential infiltration from beneath the dry fly ash and gypsum stacks would flow toward Wells Creek and the Cumberland River without crossing private property.

The operational changes made in May 2009 for gypsum handling have reduced the potential for CCR constituents in gypsum and the underlying previous ash pond to migrate to groundwater.

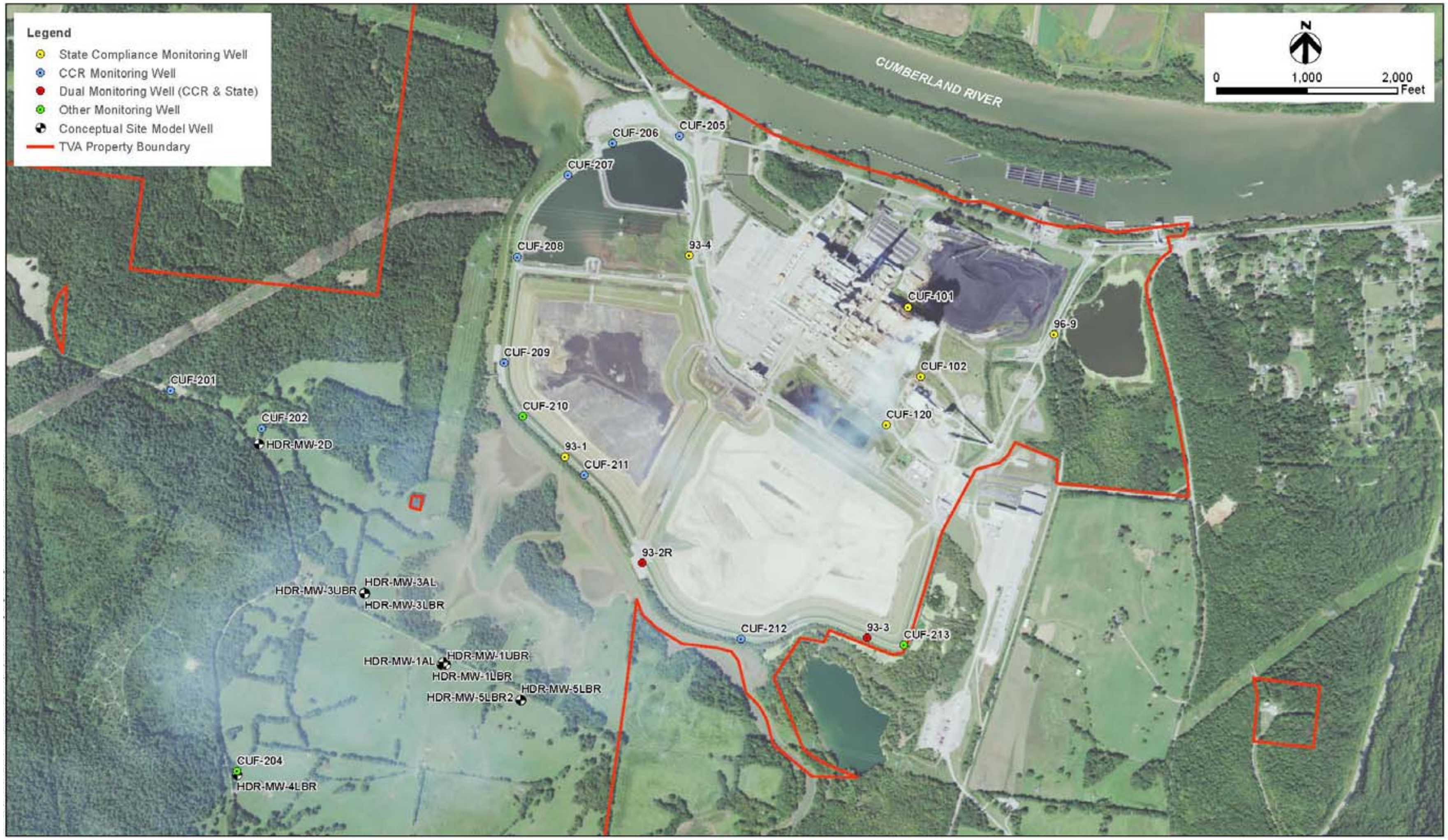

FIGURE 1. Site Location Map

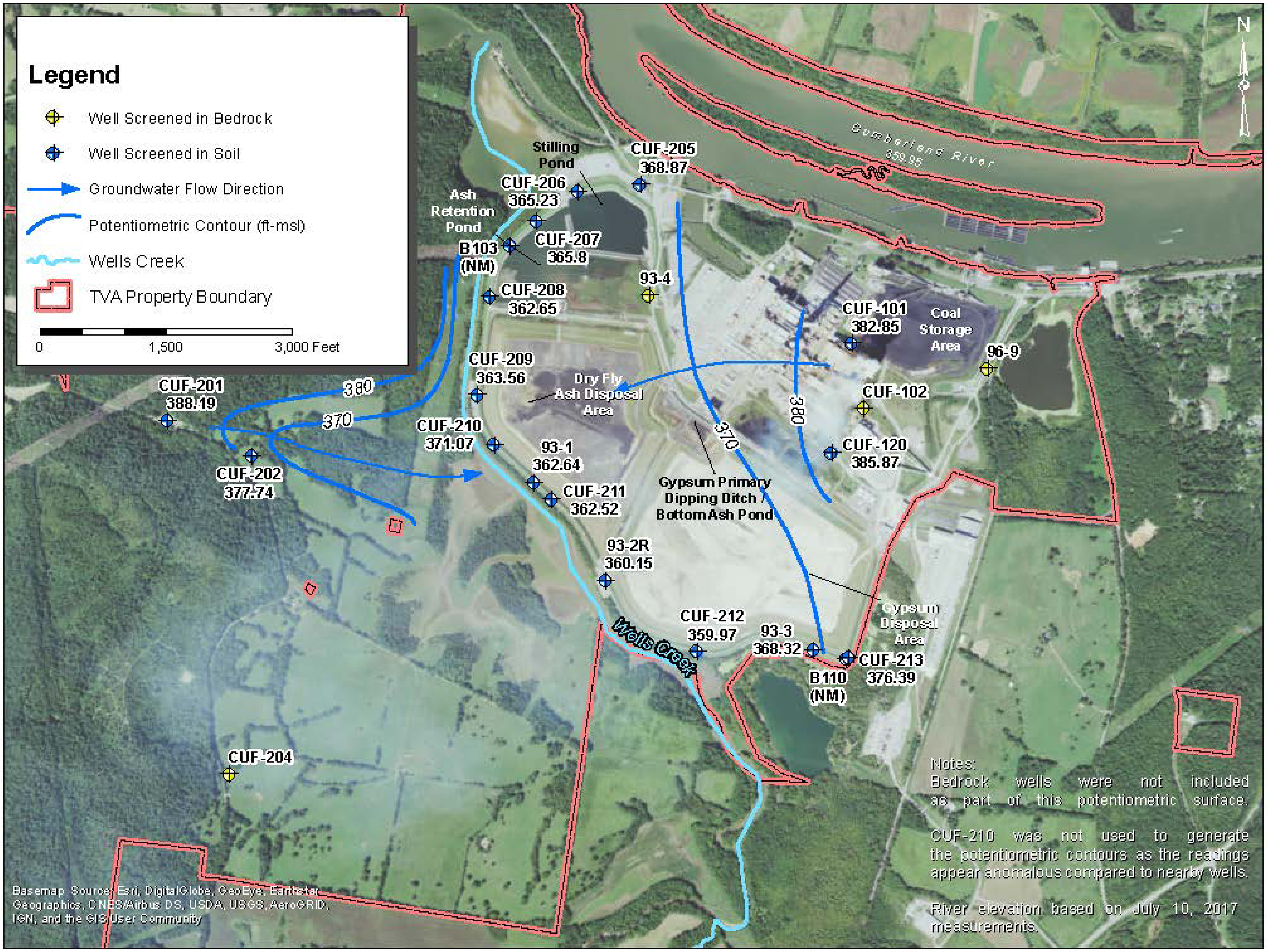

FIGURE 2. Groundwater Potentiometric Surface (7/10/2017)

As a result of diverting the routine sluicing operations from the top of the stack, infiltration of transport water into the gypsum byproduct was eliminated thereby reducing the phreatic surface within the gypsum stack and its perimeter dikes. After a period of attenuation, groundwater quality improved and is expected to continue improving with the use of the lined channel sluicing operation. Once a new landfill has been sited and permitted, the closure of this disposal area is expected to have a positive impact on the groundwater in the vicinity.

1.4 Current Monitoring System

The current groundwater monitoring system associated with the CCR disposal area consists of three downgradient wells (CUF-93-1, CUF-93-2R, CUF-93-3), an upgradient bedrock well (CUF-93-4), and one background sampling station at Wells Creek (CUF-WCUP). The sixth location, Rye Spring, was historically monitored but has been removed from the system due to the fact that the property owner rescinded access in 2016. TDEC has offered assistance in gaining access to continue sampling this location. If approval is granted by the property owner, sampling will resume. Note that well CUF-93-2R was installed in September 2005 as a replacement for CUF-93-2 which was partially screened in coal ash. TDEC approval to close well CUF-93-2 was granted in a letter dated April 7, 2011 and closure was completed in June 2016. General information regarding the design and construction of the monitoring wells is summarized in Table 1. Well construction diagrams and boring logs are included in Appendix C. With TDEC approval, TVA plans to close any other wells determined to be screened in coal ash. Additional wells to be installed are depicted on Figure 1.

TABLE 1. Monitoring Well/Station Installation Information

Location ID	Top of Casing Elevation (feet)	Well Depth Below Top of Casing (feet)	Screen Length (feet)	Casing / Screen Diameter (inches)	Formation	Year Installed	Position
CUF-93-1	397.17	62.30	10	2	Alluvium	1993	downgradient
CUF-93-2R	397.88	72.8	9.7	2	Alluvium	2005	downgradient
CUF-93-3	397.50	55.10	10	2	Alluvium	1993	downgradient
CUF-93-4	397.34	36.6	9.4	2	Hermitage Limestone	1993	upgradient
CUF-WCUP	387.40*	NA	NA	NA	NA	NA	upgradient
CUF-RS	NA	NA	NA	NA	NA	NA	upgradient

NA - Not Applicable
* - Water surface elevation

2 HISTORICAL GROUNDWATER QUALITY

2.1 Detection Monitoring Period

Groundwater detection monitoring was conducted semi-annually at compliance monitoring wells and background monitoring stations surrounding the CCR disposal areas between April 1995 and January 2009. Samples were analyzed for the 17 inorganic constituents listed in Appendix I of Rule 0400-11-01. Detection monitoring data for the Appendix I inorganics for the period of record are summarized in time-series graphs provided in Appendix D. Few MCL or statistical upper prediction limit (UPL) exceedances were observed during the detection monitoring period. Detections were primarily associated with compliance well 93-2, which was partially screened in ash. Beginning in 2006 and 2007, increasing concentration trends were observed for arsenic, cadmium, chromium, cobalt, fluoride, nickel, selenium and zinc.

The facility was placed in *Groundwater Assessment Monitoring – Phase 3* on February 23, 2009, following the July 16, 2008 sampling event which indicated concentrations of selenium exceeding the GWPS (CUF-93-2). Other Appendix I constituents were below applicable GWPS and no statistical exceedances were observed for the July 2008 samples. The exceedance at well CUF-93-2 was confirmed by resampling on September 18, 2008. Because well CUF-93-2 was partially screened in ash, TDEC approved its closure, which occurred in June 2016.

2.2 Assessment Monitoring Period

The initial groundwater assessment monitoring event was conducted on April 13-14, 2009. In accordance with Rule 0400-11-01-.04, groundwater samples were analyzed for Appendix II constituents and fluoride. Laboratory results did not indicate detections of the Appendix II organics nor additional inorganics in any sample. Detected parameters from the April 2009 sampling event were from the Appendix I inorganic constituent list.

The April 2009 groundwater assessment monitoring data for well 93-2 exhibited a GWPS exceedance for selenium (120 ug/L) and a UPL exceedance for vanadium (26 ug/L). Exceedances of GWPS were not observed in the remaining compliance monitoring wells. The July 2009 groundwater assessment monitoring data indicated GWPS exceedances for arsenic in wells 93-1 (14 ug/L), 93-2 (22 ug/L), and 93-2R (22.5 ug/L), a selenium exceedance in 93-2 (150 ug/L) and a vanadium exceedance in 93-3 (13 ug/L). Exceedances of GWPS were not observed in the remaining compliance monitoring wells.

Suspected analytical bias associated with the selenium analysis by ICPMS (EPA 6020) lead to subsequent reanalysis of the April 2009 samples by GFAA (EPA 270.2). The GFAA results indicated selenium concentrations of 6 ug/L for both duplicate samples from well 93-2.

Selenium concentrations measured by GFAA were below the selenium GWPS of 50 ug/L and well below the original ICPMS estimates of 120 ug/L. Chloride present in water from well 93-2 was determined to interfere with selenium analyses by the ICPMS method at the lab. Subsequent selenium analyses of CUF water samples have been performed by GFAA until April 2014, except for one occasion in July 2009 when the GFAA instrument was unavailable. Current analyses for selenium is performed in compliance with ICPMS (EPA 6020).

Arsenic GWPS exceedances were detected beginning in 2009 based on updated EPA MCLs decreasing from 50 ug/L to 10 ug/L.

Due to the fact that vanadium has no MCL, an alternate GWPS consisting of the EPA interim secondary MCL for vanadium (5 ug/L) was adopted in April 2009 for compliance data evaluation at the suggestion of TDEC (05/05/2009 email communication from A.D. Spear). At that time the upper prediction limit (UPL) was calculated based on background concentrations from Wells Creek and Rye Spring. The UPL of 12 ug/L was determined to be the GWPS. In July 2011, TVA adopted EPA Region 9's Regional Screening Levels (RSL) as alternate GWPS for vanadium and other constituents without MCLs, as allowed under Section IV(1)(d)(iii) of *TDEC Ground Water Monitoring Guidance for Solid Waste Landfill Units Policy.* The current vanadium RSL is 86 ug/L which, if applied to previous vanadium data recorded during the assessment monitoring period, would have resulted in no alternate GWPS exceedances. TVA no longer uses this basis for comparing groundwater monitoring results for constituents without MCLs.

Table 2 summarizes GWPS exceedances during the groundwater assessment monitoring period. Arsenic, selenium, and vanadium have been the most prevalent compounds observed in compliance well samples during the period, with arsenic being the most prevalent, accounting for 20 GWPS exceptions. The highest arsenic exceedance observed was 22.5 ug/L. Assessment monitoring data for the Appendix I inorganics are summarized in time-series graphs provided in Appendix D.

Historically, vanadium detections in groundwater samples have been sporadic (see vanadium time-series graph presented in Appendix D), suggesting the possibility of sampling or analytical error. Vanadium exceptions reported during the assessment monitoring period were limited to one exception at well 93-2 and three at 93-3. However, as noted above, none of these exceedances would have occurred if data were compared to the current vanadium RSL of 86 ug/L.

TABLE 2. Summary of GWPS Exceptions during Assessment Monitoring Period

Sampling Date	CUF-93-1	CUF-93-2	CUF-93-2R	CUF-93-3	CUF-93-4	CUF-WCUP	CUF-RS	CUF-201	CUF-202
January 2009	Arsenic (13 ug/L);	Selenium (70 ug/L)	--	--	--	--	--		
March 2009 (resample)	Arsenic (15 ug/L)	--	--	--	--	--	--		
April 2009	--	Selenium (120 ug/L)	--	--	--	--	--		
July 2009	Arsenic (14 ug/L)	Arsenic (22 ug/L); Selenium (150 ug/L)	Arsenic (22.5 ug/L)	Vanadium (13 ug/L)	--	--	--		
October 2009	--	Arsenic (14 ug/L); Selenium (91 ug/L)	Arsenic (11 ug/L)	--	--	--	--		
January 2010	--	Arsenic (14.5 ug/L)	Arsenic (12 ug/L)	Vanadium (15 ug/L)	--	--	--		
April 2010	--	--	--	--	--	--	--		
July 2010	--	--	--	--	--	--	--		
October 2010	--	Arsenic (17 ug/L); Selenium (64 ug/L)	Arsenic (14 ug/L)	--	--	--	Lead (17 ug/L)		
January 2011	--	--	--	--	--	--	--		
April 2011	--	Arsenic (12 ug/L); Vanadium (18 ug/L)	Arsenic (11.8 ug/L)	Vanadium (20 ug/L)	--	--	--		
July 2011	--	N/A	--	--	--	--	--		
October 2011	Arsenic (13 ug/L)	N/A	--	--	--	--	--		

TABLE 2. Summary of GWPS Exceptions during Assessment Monitoring Period (cont.)

Sampling Date	**CUF-93-1**	**CUF-93-2**	**CUF-93-2R**	**CUF-93-3**	**CUF-93-4**	**CUF-WCUP**	**CUF-RS**	**CUF-201**	**CUF-202**
January 2012	--		--	--	--	--	--		
April 2012	--		--	--	--	--	--		
July 2012	--		--	--	--	--	--		
October 2012	Arsenic (11 ug/L)		--	--	--	--	--		
January 2013	--		--	--	--	--	--		
April 2013	--		Arsenic (11 ug/L)	--	--	--	--		
July 2013 - July 2016	**No exceedances for 13 consecutive sampling events.**								
October 2016	Arsenic (13.6 ug/L)		--	--	--	--		--	--
January 2017	Arsenic (12 ug/L)		--	--	--	--		--	--
April 2017	Arsenic (14.3 ug/L)		--	--	--	--		--	--
July 2017	Arsenic (12 ug/L)		--	--	--	--		--	--

- Arsenic Groundwater Protection Standard (GWPS) – 10 micrograms per liter (ug/L)
- Lead GWPS – 15 ug/L
- Selenium GWPS – 50 ug/L
- Vanadium GWPS – UPL of 12 ug/L through November 2011 then changed to the EPA RSL.
- Sampling of CUF-93-2 ended in April 2011 per correspondence from TDEC approving closure of that well.
- Sampling at Rye Spring (CUF-RS) ended prior to the July 2016 sampling event due to the property owner rescinding access to the property.
- CUF-201 and CUF-202 were installed in May and June 2016, respectively.
- Light grey shading indicates the sampling location was either not yet installed or no longer available

3 PROPOSED GROUNDWATER QUALITY ASSESSMENT ACTIONS

3.1 Installation of Additional Monitoring Wells

Existing locations CUF-201 and CUF-202 have been added in an effort to determine if they are suitable background wells. Piezometers CUF-101 and CUF-120 have been added to aid in the development of groundwater potentiometric surfaces.

A hydrogeological characterization of the CUF site is currently being conducted as part of the TDEC Commissioner's Order No. OGC15-0177 (Order) and requested Environmental Investigation Plan (EIP). The characterization includes an assessment of the groundwater monitoring program and hydrogeology of the site and CCR units. Upon completion of the hydrogeological characterization, groundwater monitoring plans will be developed which will include additional background and downgradient monitoring wells, if applicable; therefore, additional monitoring wells are not proposed in this plan. Determination of appropriate background well locations is of particular interest and will require coordination with TDEC. The results of the Environmental Investigation and applicable ongoing investigations will be compiled into an Environmental Assessment Report (EAR) for the Order, which will include the submittal of the hydrogeological characterization of CUF.

3.2 Additional Monitoring Parameters

In compliance with the minor modification dated November 2016, during the January 2017 sampling event and going forward, the Appendix III and IV constituents from the 40 CFR Part 257 Federal Coal Combustion Residuals regulations have been analyzed. Specifically the addition of boron, calcium, chloride, sulfate and Total Dissolved Solids (TDS) from Appendix III of the CCR detection monitoring parameters list, and lithium, molybdenum, and radium 226/228, from Appendix IV of the CCR assessment monitoring parameters list.

3.3 Estimation of Rate and Extent of CCR Leachate Migration

The CUF site is hydrologically bounded by the Cumberland River to the north, by Wells Creek to the south and west, and by north-south trending ridge to the east of the site. The inferred direction of shallow groundwater movement beneath the site is toward Wells Creek and the Cumberland River based on the potentiometric surface shown on Figure 2. The ridge line, creek, and river represent hydrologic divides beyond which shallow groundwater would not be expected to migrate. Under these conditions, potential CCR constituents entering groundwater from beneath the gypsum and bottom ash stacks would be expected to flow toward the Cumberland River or Wells Creek without traversing private property.

A hydrogeological characterization of the CUF site is currently being conducted as part of the TDEC requested EIP. The hydrogeological characterization will include evaluations of the groundwater flow system, vertical gradients, and the potential for transport of CCR constituents. The hydrogeological characterization will be included in the EAR. Based on the scope and results of the hydrogeological characterization, additional evaluation may be necessary.

3.4 Identification of Local Water Users

As part of the EIP, an off-site water use survey will be performed and will include identification of groundwater and surface water supplies. This will include water supply wells used for drinking water, and other uses, within a one-mile radius of the center of the facility (Figure 1). The final survey report will include a map showing verified groundwater and surface water sources used as water supplies and will be included in the EAR.

3.5 Notification of Land Owners

As part of the EIP, if water supply sources are located within the survey area, then the property owners will be notified and permission will be obtained to field verify the water source location.

4 MONITORING ACTIVITIES

4.1 Overview

Throughout the period of the review and implementation of the *Groundwater Quality Assessment Plan*, TVA will conduct quarterly monitoring of the monitoring well network, unless otherwise directed by TDEC. As discussed in Section 2.2, water samples will continue to be analyzed for the 17 inorganic constituents of Rule 0400-11-01-.04, Appendix I. In addition, the Appendix III and IV constituents from the 40 CFR Part 257 Federal Coal Combustion Residuals regulations will be analyzed. Specifically the addition of boron, calcium, chloride, Sulfate and Total Dissolved Solids (TDS) from Appendix III of the CCR detection monitoring parasmeters list, and lithium, molybdenum, and Radium 226/228, from Appendix IV of the CCR assessment monitoring parameters list. Analysis of required constituents will be performed in accordance with USEPA SW-846 methods. Groundwater concentrations for existing monitoring wells and Appendix I constituents will be compared to MCLs and statistical exceedances will be evaluated in accordance with 0400-11-01-.04 by updating constituent upper prediction limits (UPLs) with monitoring well data as required. Once a baseline dataset is established for background wells and additional parameters, statistical exceedances will be evaluated and incorporated into the same process described above. Laboratory reporting limits will be the lowest practical quantitation limits that can be reliably achieved within specified limits of precision and accuracy. The target reporting limit will be at least two times below maximum contaminant levels listed in Appendix III of Rule 0400-11-01-.04 or other GWPS approved by Division of Solid Waste Management (SWM).

4.2 Monitoring Report

Within sixty (60) days following the last day of each assessment monitoring event, TVA will submit to SWM the groundwater sampling and analysis results, statistical determinations, and associated recordings of the groundwater surface elevations. The groundwater monitoring report will provide the following.

- A description of the sampling procedures performed (including field measurements of pH, specific conductivity, temperature, turbidity, dissolved oxygen, oxygen reduction potential, pump depth, and calculations/measurements of purge volumes), the date(s) and time(s) of field activities (including field instrument calibration and decontamination), and the weather conditions at the site when the activities were performed.

- The mean sea level (MSL) elevation of the top of the casing for each monitoring well, the location and the groundwater surface elevations for each monitoring well, and the groundwater flow direction and rate.

- A description of the results of the inspections of monitoring well pads, above ground casings, locking caps, and locks.

- A scaled map of the facility showing the locations of monitoring wells, the elevation of the groundwater surface determined from water level measurements collected during the event, groundwater flow directions, the property boundaries, and CCR disposal areas.

- A list of the monitoring parameters and the methods used to analyze the samples.

- Copies of the chain-of-custody forms and the laboratory analytical reports.

- Tables listing each monitoring well, including the results of the most recent sampling event, background groundwater quality concentrations and groundwater protection standards for the parameters listed in Section 4.1.

- The statistical method established in accordance with Rule 0400-11-01-.04(7)(a)4(v) used in evaluating monitoring data.

- Comparisons of groundwater sample constituent data to facility GWPS derived in accordance with 0400-11-01-.04(7)(a)1(i).

- A conclusion section that summarizes the results of the groundwater sampling event, notes anything unusual, and provides the appropriate sampling/analyses determinations (based on the appropriate groundwater monitoring program) and the approximate start date for the next planned sampling event. The conclusion will also provide a summary of constituents that exceed established GWPS.

- Certification by a person representing TVA as described in Rule 0400-11-01.02(3)(a)7, 8 and 10.

4.3 Record Keeping

TVA Cumberland Fossil Plant will maintain records of groundwater monitoring events that are conducted at the CCR disposal areas, including monitoring reports, laboratory analytical data, and groundwater level elevation data. These records will be maintained throughout the active life of the disposal facility and throughout the post-closure care period.

TVA will retain the relevant and appropriate project information in project files including field notes, correspondence, reference information, and copies of analytical reports throughout the active life of the facility and throughout the post-closure care period.

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APPENDIX A

TVA Technical Instruction ENV-TI-05.80.42 Groundwater Sampling

Environmental Operations

Technical Instruction

ENV-TI-05.80.42

Groundwater Sampling

Revision 0002

Level of Use: Reference Use

Effective Date: 07-18-2017

Responsible Organization: Environmental Compliance and Operations

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Revision Log

Revision or Change Number	Effective Date	Affected Page Numbers	Description of Revision/Change
0001	03/31/2017	All	Align with other environmental TIs and to incorporate specifics on Coal Combustion Residual (CCR) compliance activities.
0002	7/14/17	All	Includes section on sampling well pump calibration; Adds wording in General Consideration section on recording requirements in order to reduce redundant wording throughout the document.

Table of Contents

Table of Contents (continued)

1.0 PURPOSE

This Technical Instruction (TI) provides the general technical requirements and operational guidelines for collecting groundwater samples from monitoring wells for field screening or laboratory analysis.

2.0 SCOPE

A. This TI applies to TVA field sampling personnel and TVA contractors who collect routine groundwater samples for TVA's regional water management program, for the assessment of groundwater quality, and for various regulatory and operational purposes.

B. This document is applicable to groundwater sampling, using bailers, and low-flow pumps.

C. This TI does not include detailed procedures for collecting water for chemical analysis of volatile organic compounds or for low-level mercury analysis. These are detailed in ENV-TI-05.80.43, Water Sampling for Volatile Organic Compounds Analysis, and ENV-TI-05.80.68, Low-Level Mercury Sampling. Refer to these TIs when sampling for the respective parameter(s).

D. Groundwater sampling guidance can be found in the Environmental Protection Agency (EPA) Region 4, SESDPROC-301, Groundwater Sampling Operating Procedure, and Region 1, Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

Review Cadence: This TI will be reviewed every four years, with the review documented in the Revision Log.

3.0 PRECAUTIONS/LIMITATIONS

3.1 Precautions

None

3.2 Limitations

None

4.0 REFERENCES

4.1 Performance References

A. ENV-TI-05.80.01, Planning Sampling Events

B. ENV-TI-05.80.02, Sample Labeling and Custody

C. ENV-TI-05.80.03, Field Record Keeping

D. ENV-TI-05.80.04, Field Sampling Quality Control

E. ENV-TI-05.80.05, Field Sampling Equipment Cleaning and Decontamination

F. ENV-TI-05.80.06, Handling and Shipping of Samples

G. ENV-TI-05-80.21, Monitoring Well Inspection and Maintenance

H. ENV-TI-05.80.43, Water Sampling for Volatile Organic Compounds Analysis

I. ENV-TI-05.80.44, Groundwater Level and Well-Depth Measurement

J. ENV-TI-05.80.68, Low-Level Mercury Sampling

K. EPA, Region 1, Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells

L. EPA, Region 4, SESDPROC-301, Groundwater Sampling Operating Procedure

M. TVA-SPP-18.005, Plan Jobs Safely

4.2 Developmental References

A. American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 22nd Ed., Washington, DC, 2011

B. ASTM D6771-02, Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (Withdrawn 2011), ASTM International , West Conshohocken, PA, 2002, www.astm.org.2002

C. ENV-TI-05.80.40, Surface Water Sampling

4.2 Developmental References (continued)

D. EPA, Office of Research and Development, Office of Solid Waste and Emergency Response. Ground Water Issue, Low-Flow (Minimal Drawdown Sampling Procedures), Document Number EPA/540/S-95/504," April 1996

E. US Geological Survey (USGS), National Field Manual for the Collection of Water-Quality Data: Techniques of Water-Resources Investigations, Book 9, Handbooks for Water-Resources Investigations, http://pubs.water.usgs.gov/twri9A

4.3 Commitments

None

5.0 PREREQUISITE ACTIONS

None

6.0 PERFORMANCE

6.1 General Considerations

A. Field personnel conducting groundwater sampling are required to be familiar with the procedures in this TI, as well as standard industry practices.

B. Field work must be properly documented. Depending on the requirements of your organization, there are different mechanisms for recording. You must meet the requirements for your specific organization.

1. Groundwater Inspection Application (electronic)
2. Field logbooks
3. Field worksheets (see Attachment 1, Example - Preliminary Groundwater Data Field Worksheet)
4. Field notebooks
5. Data sheets

C. Potential hazards associated with the planned groundwater sampling activities are to be thoroughly evaluated prior to conducting field activities. During planning and sampling activities, procedures to ensure safety will be incorporated according to the TVA Standard Programs and Processes (SPP), TVA-SPP-18.005, Plan Jobs Safely, which provides information on using job safety analyses (JSAs) and pre-job briefings (PJB).

6.1 General Considerations (continued)

D. Great care must be taken to avoid and prevent sample contamination. Sampling personnel must wear powder-free nitrile or latex gloves, as appropriate, while preparing sample containers, preparing and decontaminating sampling equipment, and at all times while collecting and packing samples. At a minimum, gloves must be changed prior to the collection of each sample, or, as necessary, to prevent the possibility of cross-contamination with the sample, the sample containers, and/or the sampling equipment. Other type polymer gloves may be used when not sampling for organic analytes, provided they are powder-free. Samples should not be allowed to contact gloves and flow into the sample container. Gloves should be changed any time during sample collection when their cleanliness is suspected or demonstrated to have been compromised.

E. Sample bottles usually contain preservative when procured from the laboratory for groundwater analysis. If verifying that samples are preserved to less than pH 2, pour a drop of sample from the container onto pH test paper. Never dip the test paper into the sample container. More preservative may be added to the sample vial if the pH is above 2. If additional preservative is added, appropriately record the lot number and amount added.

F. Do not attempt to check the pH of samples collected for volatile organic analysis.

6.2 Pre-Field Sampling Preparation

Prior to leaving for the collection site, the Field Team Lead is responsible for ensuring that the following activities have been completed:

A. Prepare, or obtain and review, a sampling diagram, chart, or plan, such as a facility-specific Sampling and Analysis Plan (SAP) or Quality Assurance Plan (QAP), that designates the monitoring wells to be sampled and their location, the number of samples to be collected, a list of the analytical requirements for each sampling location, and number of quality control (QC) samples needed. Refer to ENV-TI-05.80.01, Planning Sampling Events. QC samples may include, but are not limited to, rinsate/filter/equipment blanks, laboratory blanks, field blanks, field duplicate samples, and matrix spike/matrix spike duplicate samples. Refer to ENV-TI-05.80.04, Field Sampling Quality Control. Identify tools, instruments, sample containers, preservatives, quantity of ice, number of coolers, relevant logbooks, worksheets, custody paperwork, and other items needed for the groundwater sampling event.

B. Review JSA and identify needed safety equipment. Conduct a PJB.

6.2 Pre-Field Sampling Preparation (continued)

C. If available, review boring logs, well construction details, and survey data that identify the documented point of reference (benchmark) for collection of depth-to-groundwater, as well as total well-depth information, previous depth-to-groundwater measurements, previous pump placement depths for each sampling location, previous pump settings and pumping and drawdown rates, and previous analytical results for each monitoring well.

D. Obtain equipment necessary for completing the groundwater sampling. See Attachment 2, Example - Groundwater Sampling Equipment and Materials Checklist for an example checklist of equipment and materials, including site-specific maps or Global Positioning System (GPS) coordinates showing clearly marked monitoring well locations or groundwater sample points. It is important to note that the items on the checklist are not intended to be all-inclusive and the preparation of an event-specific checklist of equipment and materials is highly recommended.

E. Obtain distilled or deionized (DI) water for decontamination. Record the water source. Ensure and document that all sampling equipment has been cleaned in accordance with ENV-TI-05.80.05, Field Equipment Cleaning and Decontamination.

F. Verify that legal right-of-entry has been obtained and site access has been granted, where required. Notice of planned sampling events should be provided to the property owner and/or appropriate plant personnel. Pre-identify any potential site access logistical issues and take actions to address them.

6.3 Water-Level Measurements (Well Preparation)

A. All water levels at a given site should be obtained within a 24-hour period. Alternately, an independent round of water levels could be measured at the beginning of the sampling event, in addition to water levels at each well at the time of sampling.

B. Approach the monitoring well with caution, particularly in warm weather, watching for snakes, fire ants, wasp nests (may be inside well cover), and other hazards.

C. Inspect the wellhead area for evidence of damage or disturbance, in accordance with ENV-TI-05-80.21, Monitoring Well Inspection and Maintenance. Record notable observations.

D. To minimize contamination of sampling equipment, place new plastic sheeting on the ground at each sample location where sampling equipment or tubing may contact the ground surface around wells. A wind block or other configuration may be needed to maintain the plastic sheet in place.

6.3 Water-Level Measurements (Well Preparation) (continued)

E. Open the protective outer cover of the monitoring well. Remove any debris that has accumulated around the riser near the well plug. If water is present above the top of the riser and well plug, document this observation and remove the water prior to opening the well plug. Do not open the well until the water above the well head has been removed. When present, sealing well plugs should be left open for five minutes to allow the water level to equilibrate before measuring the water level.

F. For wells in which unknown levels of volatile organic vapors may be expected or if specified in the work planning documents, monitor and record the headspace in the well with a volatile organic compound (VOC) detector, equipped with a photoionization detector (PID), immediately after opening the well plug.

G. If the monitoring well has the potential to contain non-aqueous phase liquids (NAPLs) probe the well for these materials using an optical interface probe. If NAPLs are present, consult the TVA Project Manager for direction on collecting samples for analysis. In general, do not collect groundwater samples from monitoring wells containing NAPLs.

H. Prior to energizing the dedicated pump, or pump placement of non-dedicated pump, measure the initial depth-to-water level according to ENV-TI-05.80.44, Groundwater Level and Well-Depth Measurement, using a clean, properly decontaminated water-level indicator, and interface probe, if applicable.

I. For monitoring wells without dedicated pumps and screened across the water table, use this measurement to determine the required depth-to-pump intake (typically, mid-point of the saturated screen length for low-flow purging and sampling), unless otherwise directed by the TVA Project Manager; record the measurement.

6.4 Sampling Pump Calibration

A. Dedicated sampling pumps may be calibrated, when installed, in order to facilitate purging prior to sample collection. Prior to energizing the dedicated pump, measure the initial depth-to-water level as specified by ENV-TI-05.80.44, Groundwater Level and Well-Depth Measurement, using a clean, properly decontaminated water-level indicator (and interface probe, if applicable).

B. Lower the electronic water-level probe into the well until the probe contacts the groundwater. Allow sufficient time for the static groundwater level to equilibrate with atmospheric pressure. Once the water level has reached equilibrium, record the initial water level.

6.4 Sampling Pump Calibration (continued)

C. Begin purging the well at the minimum pumping rate of 0.1 liter per minute (L/min). Slowly increase the pumping rate to a level that does not cause the well to draw down more than about 0.3 feet (10 cm), if possible. Never increase the pumping rate to a level in excess of 0.5 L/min (approximately 0.13 gallon per minute [gpm]). If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue the purging (EPA 2010).

D. Record stabilized flow rate, drawdown, and time.

E. Monitor and record the pump rate using a graduated cylinder or other measuring device periodically throughout the pump calibration activities. Record fluctuations of pump rate and subsequent adjustments.

NOTE
For wells that have very slow recharge rates or that drawdown excessively at the minimum pumping rate of 0.1 L/min or 0.026 gpm, the procedures described below may not apply. For these wells, the Field Team Lead shall seek guidance from the Project Manager and TVA Project Manager about the appropriate purging and sampling methodologies to be employed.

F. Once an acceptable drawdown has been established and maintained, begin monitoring the designated indicator field parameters. The initial and periodic calibration checks of the meter(s) used to measure the indicator parameters are to be performed and documented, in accordance with ENV-TI-05.80.46, Field Measurement Using a Multi-parameter Sonde. These indicator parameters include pH, oxidation-reduction potential (ORP measured as Eh), dissolved oxygen (DO), specific conductance, temperature, and turbidity. ORP and temperature are to be measured and recorded but are not evaluated to determine stabilization, as described below. The water level in the well is to be measured to monitor drawdown during purging activities. Base the frequency of the measurements on the time required to completely evacuate one volume of the flow through cell to ensure that independent and representative measurements are made. For example, a 500-mL cell in a system pumped at a rate of 100 mL/min is evacuated in five minutes. Record measurements at least five minutes apart.

6.4 Sampling Pump Calibration (continued)

G. Indicator parameters are deemed stabilized when three consecutive readings, taken at three- to five-minute intervals, meet the criteria (EPA, 2010) in Table 1, Indicator Parameters:

Turbidity	Below 10 NTUs or ± 10% for values above 10 NTUs and stable
pH	± 0.1 standard pH unit
Specific Conductance	± 3% in μS/cm
DO	Below 0.5 mg/L or ± 10% for values greater than 0.5 mg/L

Table 1, Indicator Parameters

H. The target for turbidity is readings less than or equal to 10 NTUs, but this value may not be achievable in some instances. Turbidity levels may exceed the desired turbidity level due to natural aquifer conditions (EPA, 2010). When these conditions are encountered, purging will continue until turbidity has stabilized, even if that is at a level above 10 NTUs.

I. If critical indicator field parameters have not stabilized after two hours of documented purging, discontinue purging. Fully document efforts used to stabilize the parameters, such as modified pumping rates, and notify the TVA Project Manager.

J. Where turbidity is greater than 10 NTUs, the integrity of the monitoring well may be inspected using a downhole video camera. The video inspection will include documentation of the condition of the well screen and blank casing above the screen.

6.5 Well Purging

Wells must be purged prior to sampling to ensure that representative groundwater is obtained from the water-bearing unit. If the well has been previously sampled, in accordance with this TI, then the depth-to-pump intake and the pumping rates are to be duplicated to the maximum extent practical during subsequent sampling events; information is recorded. Section 6.5.1 provides a description of low-flow well purging, which is the preferred well purging and sampling method. Section 6.5.2 provides a description of purging, using disposable or dedicated, bailers. Section 6.5.3 provides a description of volume-averaged well purging. These sections are provided as a contingency in the event low-flow purging and sampling are not possible. Do not proceed with purging, using disposable bailers or volume-averaged purging, without TVA written approval.

6.5.1 Low-Flow Well Purging (Micro-Purging)

A. EPA guidance documents (EPA 1996) states that suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds. Accordingly, peristaltic pumps (suction) are not recommended for use in low-flow purging and sampling for dissolved gases and VOCs. Adjustable-rate bladder or centrifugal submersible pumps are preferred for use during low-flow purging and sampling activities. The low-flow purging and sampling technique is described in this section.

B. Measure and record the air temperature.

C. Using the specific details of well construction and current water-level measurement, determine the pump set depth (typically the mid-point of the saturated well screen or other target sample collection depth adjacent to specific high-yield zones). If the well has been previously sampled in accordance with this TI, then the depth-to-pump intake and the pumping rates should be duplicated to the extent practical, provided requirements for pump rates and drawdown are met. Energize and document that the dedicated pumps are at the previous settings.

NOTE

If a portable pump is needed, the non-working dedicated pump must be removed prior to deployment of the new pump. If using new tubing, use new, certified clean, disposable Silastic®, Teflon®, Tygon®, or equivalent tubing, during well purging.

D. Lower the electronic water-level probe into the well until the probe contacts the groundwater. Allow sufficient time for the static groundwater level to equilibrate with atmospheric pressure. Once the water level has reached equilibrium, record the initial water level.

6.5.1 Low-Flow Well Purging (Micro-Purging) (continued)

E. If it is necessary to deploy a non-dedicated pump (e.g.; due to dedicated pump malfunction), use the specific details of previous pump placement depth to determine the deployment depth of the new pump. Attach tubing and supporting line, such as rope, wire, or shrouded electrical cable bonded to sample tubing, to the pump and slowly lower the unit until the targeted pump intake depth is reached. Measure and record the length of supporting line required, taking into account the pump length, to attain the required depth. Record the depth-to-pump intake.

F. Connect the pump discharge to a flow-through cell equipped with a multi-parameter sonde for measurement of field parameters. If necessary, turbidity may be measured in a static sample collected from the discharge of the flow-through cell after other field parameter readings are taken.

G. If the well has been previously sampled, using low-flow purging and sampling methods, begin purging at the rate known to induce minimal drawdown. Frequently check the drawdown rate to verify that the maximum drawdown criteria are not being exceeded. If results from the previous sampling event are not known, begin purging the well at the minimum pumping rate of 0.1 liter per minute (L/min). Slowly increase the pumping rate to a level that does not cause the well to drawdown more than about 0.3 feet (10 cm), if possible. The pumping rate should not be increased to a level in excess of 0.5 L/min (approximately 0.13 gallon per minute [gpm]). If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging (EPA 2010). Record stabilized flow rate, drawdown, and time.

H. Monitor the pump rate, using a graduated cylinder measuring device, periodically throughout the well purging activities, and record this check. Record fluctuations of pump rate and subsequent adjustments.

6.5.1 Low-Flow Well Purging (Micro-Purging) (continued)

NOTE

For wells that have very slow recharge rates or that drawdown excessively at the minimum pumping rate of 0.1 L/min or 0.026 gpm, the procedures described in Steps 6.5.1I and 6.5.1J may not apply. For these wells, the Field Team Lead shall seek guidance from the TVA Project Manager, or designee, about the appropriate purging and sampling methodologies to be employed, such as volume-averaged purging and sampling.

I. For wells screened below the static water level, if the drawdown does not stabilize at a minimum pumping rate of 0.1 L/min (0.026 gpm), continue pumping until the drawdown reaches the top of the well screen (EPA 2010). If this occurs, stop pumping and collect a groundwater sample, once the well has recovered sufficiently, to prevent drawdown of the water level below the top of the well screen during sample collection. Allow the pump to remain undisturbed in the well, during this recovery period to minimize the turbidity of the water samples. Document the details of purging, including the purge start time, rate, and drawdown.

J. For wells screened across the static water level, if the drawdown does not stabilize at a minimum pumping rate of 0.1 L/min (0.026 gpm),.continue pumping. However, in general, do not draw down the water level more than 25 percent of the distance between the top of the well screen and pump intake depth (American Society for Testing and Materials [ASTM], 2002). If the recharge rate of the well is lower than the minimum pumping rate, and the drawdown has reached 25 percent of the distance between the top of the well screen and the pump intake depth, discontinue pumping. Once the water level has recovered sufficiently to prevent drawdown of the water level from reaching 25 percent of the distance between the top of the well screen and the pump intake depth, commence with sample collection, even though indicator field parameters have not stabilized (EPA 2012). Allow the pump to remain undisturbed in the well during this recovery period to minimize the turbidity of the water samples. Fully document the pump settings, pumping rate, drawdown, and field parameter readings.

6.5.1 Low-Flow Well Purging (Micro-Purging) (continued)

K. Once an acceptable drawdown has been established and maintained, begin monitoring designated indicator field parameters. The initial and periodic calibration checks of the meter(s) used to measure the indicator parameters are to be performed and documented, in accordance with ENV-TI-05.80.46, Field Measurement Using a Multi-Parameter Sonde. Indicator parameters include pH, oxidation-reduction potential (ORP measured as Eh), dissolved oxygen (DO), specific conductance, temperature, and turbidity. It is recommended that ORP and temperature are to be measured and recorded during micro-purging, but are not evaluated to determine stabilization, as described in Step 6.5.1K.1. The water level in the well is to be measured to monitor drawdown during purging activities. Base the frequency of the measurements on the time required to completely evacuate one volume of the flow through cell to ensure that independent and representative measurements are made. For example, a 500-mL cell in a system pumped at a rate of 100 mL/min is evacuated in five minutes. Measurements are to be recorded at three- to five-minute intervals at the time of measurement.

1. Indicator parameters are deemed stabilized when three consecutive readings, taken at three- to five-minute intervals, meet the criteria in Table 2, Indicator Parameters, (EPA 2013):

Turbidity	Below 10 NTUs or ± 10% for values above 10 NTUs and stable (refer to 6.5.1K.2)
pH	± 0.1 standard pH unit
Specific Conductance	± 3% in μS/cm
DO	Below 0.5 mg/L or ± 10% for values greater than 0.5 mg/L

Table 2, Indicator Parameters

2. The target for turbidity is readings less than or equal to 10 NTUs, but this value may not be achievable, and in some instances, turbidity levels may exceed the desired turbidity level due to natural aquifer conditions (EPA 2010). When these conditions are encountered, the following guidelines shall be considered:

   a. If turbidity readings are slightly above 10 NTUs, but trending downward, continue purging and monitoring.

   b. If turbidity readings are 10 NTUs or less and have stabilized, begin sampling.

6.5.1 Low-Flow Well Purging (Micro-Purging) (continued)

c. If turbidity readings are greater than 10 NTUs and are not stable, well sampling may be based upon stabilization of more critical indicator parameters, such as DO for VOC analysis, without attainment of the targeted turbidity.

Step 6.5.1K.3 Applies to CCR Only

3. Where turbidity is greater than 10 NTUs, a second sample will be field-filtered and submitted for dissolved metals analysis as detailed in Section 6.7.

NOTE

While every effort should be taken to ensure that indicator parameters stabilize, some indicator parameters are more critical with respect to certain contaminant types. It is important to identify which indicator parameters are most important to the project prior to commencement of field activities so that unnecessary protracted purge times can be avoided. For example, the critical indicator parameter associated with sampling for VOCs is DO, while the critical indicator parameter associated with metals is turbidity.

L. If critical indicator field parameters have not stabilized after two hours of documented purging, discontinue purging and collect samples, according to Section 6.6.1. Fully document efforts used to stabilize the parameters, such as modified pumping rates, and notify the TVA Project Manager, or customer.

6.5.1 Low-Flow Well Purging (Micro-Purging) (continued)

> **NOTE**
>
> Direct sunlight and hot ambient air temperatures may cause the groundwater in the tubing and flow-through cell to heat up. This may cause the groundwater to degas, which will result in the loss of VOCs and dissolved gases. When purging and sampling under these conditions, the sampler will need to shade the equipment from the sunlight with a tent or umbrella (EPA 2010).

M. There are a variety of water quality meters available that measure the water quality parameters identified in Section 6.5.1K.1. It is preferred, but not required, to utilize a water quality meter capable of measuring each of the water quality parameters, referenced in 6.5.1K.1 in one flow-through cell. If daily on-site calibration is recommended by the instrument manufacturer, the calibration procedures specified in the instruction manual shall be followed. ENV-TI-05.80.46, Field Measurement Using a Multi-Parameter Sonde, should also be reviewed. Calibration procedures shall be documented, including calibration solutions used, expiration date(s), lot numbers, and calibration results.

Step 6.5.1N Applies to CCR Only

N. Because turbidity is considered a critical field parameter for inorganics, the use of a turbidimeter is preferred when measuring turbidity.

6.5.2 Purging Using a Disposable Bailer

A. Wells may be purged using a disposable polymer bailer, such as the Aqua Bailer (Aqua Bailers, Inc.) or equivalent (Teflon® bailers are required when collecting samples for organic analysis). Bailers can be disposable or dedicated. Bailers may be assigned to a single well, making them dedicated equipment. If bailers are dedicated to a single well, the bailers will be visually inspected for discoloration and the presence of foreign material prior to use. If discoloration or foreign debris is observed, replace with a new bailer.

6.5.2 Purging Using a Disposable Bailer (continued)

B. Bailers may be used when water levels or volumes in a well are too low for the use of submersible pumps. Low-volume wells may be purged until dry or until three well volumes are removed. Bailers may be made of various materials, such as polyethylene or Teflon® contain check valves at the bottom, and may be weighted or non-weighted. As the bailer sinks in the water column, the check valve at the bottom allows water to fill the unit. As the bailer is withdrawn from the well, the weight of the water closes the check valve, thereby trapping water inside the bailer. The water in the bailer can either be poured out the top of the bailer or drained from the bottom, using a supplied hollow tip.

1. Select a new bailer sized to fit into well piping without binding on well casing.

2. Remove bailer from protective sleeve, while retaining the cover and removable drain tip.

3. Securely attach a new line (wire, cord, or rope) to the top of the bailer, ensuring that the line is of sufficient length for the bailer to reach the desired water level or the well bottom.

4. Lower the bailer into the well until the bailer contacts the surface of the water.

5. Allow the bailer to sink until the unit is filled with water. Avoid allowing the bailer to contact the well bottom.

6. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during the final stages of purging, to minimize turbidity and volatilization of volatile organic constituents.

7. Retrieve the bailer to the top of the well, while listening, to ensure the check valve is not leaking water back into the well. If the check valve is leaking, it may be necessary to bounce the unit up and down on the line to seal the valve.

8. Per site regulations, pour or drain the purge water into an appropriate waste container or onto the ground adjacent to the well.

9. Track and record the volume of purge water removed from the well. Additionally, record specific information about the bailers used (manufacturer, material, size) and the total volume of purge water removed.

6.5.2 Purging Using a Disposable Bailer (continued)

10. Once the purging process is complete, one or more additional full bailers will be collected from the well to measure and record field parameters. If the well has been purged dry, these measurements are to be made after the water level in the well has recovered sufficiently.

11. After sampling, place used bailer back into sleeve and dispose of properly. If bailers are to be dedicated, securely hang the bailer inside the well.

6.5.3 Volume-Averaged Well Purging

Volume-averaged sampling involves purging a specified volume of water, such as three to five well volumes, rather than basing purge completion on the stabilization of water quality indicator parameters. However, measuring and recording water-quality indicator parameters during purging provides information that can be used for assessment and remedial decision-making purposes. A minimum of three well volumes is purged from the well, using this method. Consult regulatory or site documents; e.g., SAP, QAP, for total purge volume guidance.

A. Calculate the length of the standing water column in the well by subtracting the depth-to-water (DTW) from the total depth (TD) measurement. DTW and TD measurements shall be determined in accordance with ENV-TI-05.80.44, Groundwater Level and Well Depth Measurement.

B. Multiply the length of the standing water column by the volume calculation (liters per linear meter of depth) based on the inner casing diameter (see Table 3, Water Conversion) to determine the total standing water volume; this represents one well volume. The conversion factors in Table 3, correspond to well diameters commonly seen at TVA. If the diameter of a well is not in Table 3, consult industry practices to determine the proper conversion factor. Record these calculations.

Inner Well Casing Diameter (inch)	Volume Multiplier (L/linear meter)	Volume Multiplier (gallon per linear foot)
0.5	0.127	0.0102
2	2.024	0.163
3	4.560	0.367
4	8.110	0.653
5	12.67	1.020
6	18.24	1.469

Table 3, Water Conversion

6.5.3 Volume-Averaged Well Purging (continued)

C. Multiply the well volume calculated in Step 6.5.3B by three or five to obtain the respective total purge volume. The target purge volume is between three and five standing well volumes. For wells with multiple casing diameters, such as open bedrock holes, calculate the volume for each segment. Take the sum of the values and multiply by three and five to determine the minimum and maximum purge volumes, respectively.

D. Fully document the volume calculation.

E. Use a variable-speed electric submersible pump or, when purging shallow wells with small purge volumes, use of a disposable or dedicated bailer may be appropriate (refer to Section 6.5.2).

NOTE

If replacing tubing, use new, certified clean disposable Silastic®, Teflon®, or equivalent tubing during well purging.

F. Set the pump/hose assembly immediately above the top of the well screen or within the top of the water column (EPA 2013). The intake should not be lowered more than three to five feet within the water column for conventional purging (not applicable to micro purging).

G. Begin purging and monitor the water level. If the recovery rate of the well is faster than the pump rate and no observable drawdown occurs, the pump shall be raised until the intake is within one foot of the top of the water column. If the pump rate exceeds the recovery rate of the well, the pump will have to be lowered, as needed, to accommodate the drawdown (EPA 2013). Document pump depth adjustments.

H. Monitor the discharge rate, using a graduated cylinder or other measuring device, water-quality indicator parameters, if desired, and depth-to-water (DTW):

1. Initially, within three minutes of startup
2. On a periodic basis, such as every five minutes, or after each well volume is purged
3. Immediately before purge completion

I. Record pump discharge rates (L/ min or gpm) and pump settings. Also, record any changes in the pump settings and the time at which the changes were made.

6.5.3 Volume-Averaged Well Purging (continued)

J. Maintain low pumping rates to avoid over-pumping or pumping the well to dryness, if possible. If necessary, adjust pumping rates, pump set depth, or extend pumping times to remove the desired volume of water (EPA 2013).

NOTE

The removal of three to five well volumes may not be practical in wells with slow recovery rates. If a well is purged to near dryness, the well shall be allowed to completely recover prior to sampling. If necessary, the two-hour limit may be exceeded to allow for sufficient recovery, but samples must be collected within 24 hours of purge completion.

K. Upon reaching the desired purge water volume, proceed to Section 6.6 for collection of well samples.

6.6 Groundwater Sampling

6.6.1 Sampling after Low-Flow Purging

This section shall be followed for the collection of low-flow groundwater samples after completing purging, as defined in Section 6.5.1.

A. Arrange and label necessary sample bottles, and ensure that preservatives have been pre-added to the sample bottles, as required. Include a unique sample number, time and date of sampling, the initials of the sampler, and the requested analyses on the label. Additionally, record information pertinent to the preservation used in the sample. Consult the facility-specific SAP, QAP, and ENV-TI-05.80.04, Field Sampling Quality Control, to determine the appropriate QC samples to be collected.

B. Record the final pump settings immediately prior to sample collection.

C. Measure and record the indicator parameter readings immediately prior to sample collection.

D. Record comments pertinent to the color and obvious odors, such as sulfur odor or petroleum hydrocarbons odor, associated with the water.

E. Do not change the flow rate used during purging for sample collection. Disconnect the pump sampling tubing (tubing extending out of the well that is connected directly to the well pump) from the flow-through cell, and collect samples directly from the pump sampling tubing.

6.6.1 Sampling after Low-Flow Purging (continued)

F. Ensure that the sampling tubing remains filled during sampling and that the water does not descend back into the well. Minimize turbulence when filling sample containers by allowing the liquid to run gently down the inside of each sample bottle. If project-specific documents (Work Plan, SAPs, etc.) do not specify a sample collection order, the labeled sample bottles should be filled in the following order:

1. Volatile Organic Compounds (VOCs)
2. Semi-volatile Organic Compounds (SVOCs)
3. Pesticides/Polychlorinated Biphenlys (PCBs)
4. Total Petroleum Hydrocarbons (TPH)
5. Metals, Cyanide, and Radionuclides
6. Filtered Metals and Radionuclides, if required
7. Other water-quality parameters

G. When samples are to be analyzed for metals and the final turbidity is greater than 10 NTUs, samples will be submitted for analysis of both total (unfiltered) and dissolved (filtered) metals, as described in Section 6.7.

H. Immediately seal each sample bottle when full. When all bottles are filled, place the samples on ice in a cooler within 15 minutes of completing sample collection to maintain sample temperature preservation requirements in accordance with procedures outlined in the ENV-TI-05.80.02, Sample Labeling and Custody. Document the time that samples are placed on ice. Use of an ice bath may be considered during extremely hot sampling periods to maintain colder sample temperatures.

I. Document the sample identification and sample collection time before shipping on Chain of Custody (COC) record. Refer to ENV TI 05.80.03, Field Record Keeping.

J. Once sample collection is complete, measure and record turbidity and DTW.

K. Once sampling is complete, de-energize the dedicated sampling pump prior to capping the well, replace the sample tubing, evacuate the downhole tubing, and close the protective casing.

L. When using a non-dedicated sampling pump and the sampling is complete, retrieve the sample pump and associated sampling equipment and decontaminate in accordance with procedures outlined in the ENV-TI-05.80.05, Field Sampling Equipment Cleaning and Decontamination.

6.6.1 Sampling after Low-Flow Purging (continued)

M. Close and secure the well. Clean up and remove debris left from the sampling event. Be sure that investigation-derived wastes are properly containerized and labeled.

N. Review sampling records for completeness. Add additional notes, as necessary.

6.6.2 Sampling after Purging with a Bailer

This section is to be followed for collection of groundwater samples after a purging with a bailer has been conducted, according to Section 6.5.2.

A. Measure and record the indicator parameter readings immediately prior to sample collection.

B. Record comments pertinent to the color and obvious odors, such as sulfur odor or petroleum hydrocarbons odor, associated with the water.

C. Arrange and label necessary sample bottles and ensure that preservatives have been pre-added to the sample bottles, as required. Include a unique sample number, time and date of sampling, the initials of the sampler, and the requested analyses on the label. Additionally, record information pertinent to the preservation used in the sample. Consult the facility-specific SAP and ENV-TI-05.80.04, Field Sampling Quality Control, to determine the appropriate QC samples to be collected.

D. Using the same bailer to purge the monitoring well, securely attach a new line (wire, cord, or rope) to the top of the bailer, ensuring that the line is of sufficient length for the bailer to reach the desired water level.

E. Lower the bailer into the well until the bailer contacts the surface of the water.

F. Allow the bailer to sink until the unit is filled with water. Do not allow the bailer to contact the well bottom.

G. Retrieve the bailer to the top of the well, while listening, to ensure the check valve is not leaking water back into the well. If the check valve is leaking, it may be necessary to bounce the unit up and down on the line to seal the valve.

H. Pour or drain the groundwater into sample bottles. Minimize turbulence when filling sample containers, especially for samples for VOCs, by allowing the liquid to run gently down the inside of each sample bottle. If project-specific documents (Work Plans, SAPs, QAPs, etc.) do not specify a sample collection order, the labeled sample bottles are to be filled in the following order:

   1. Volatile Organic Compounds (VOCs)

6.6.2 Sampling after Purging with a Bailer (continued)

2. Semi-volatile Organic Compounds (SVOCs)
3. Pesticides/Polychlorinated Biphenlys (PCBs)
4. Total Petroleum Hydrocarbons (TPH)
5. Metals, Cyanide, and Radionuclides
6. Filtered Metals and radionuclides, if requiredR
7. Other water-quality parameters

I. Immediately seal each sample bottle when full. When all bottles are filled, place the samples on ice in a cooler within 15 minutes of completing sample collection, to maintain sample temperature preservation requirements in accordance with procedures outlined in the ENV-TI-05.80.02, Sample Labeling and Custody.

J. Record the sample identification appropriately and on the COC Record. Refer to ENV-TI-05.80.03, Field Record Keeping.

K. Once sampling is complete, place used bailer back into sleeve and dispose of properly.

L. Close and secure the well. Clean up and remove debris left from the sampling event. Be sure that investigation-derived wastes are properly containerized and labeled.

M. Review sampling records for completeness. Add additional notes, as necessary.

6.6.3 Sampling after Volume-Averaging Purge

This section is to be followed for collection of groundwater samples after a volume-averaged purge has been conducted. Volume-averaging purge methods are described in Section 6.5.3.

NOTE

Suction pumps (peristaltic pumps) may cause degassing, pH modification, and loss of VOCs; accordingly, peristaltic pumps (suction) are not recommended for use in collection of VOC samples (EPA 1996). Peristaltic pumps are acceptable for volume-averaged well purging and collection of groundwater samples for analyses other than VOCs. Samples analyzed for VOCs shall be collected with a bailer.

A. Measure and record the indicator parameter readings immediately prior to sample collection.

B. Record comments pertinent to the color and obvious odors, such as sulfur odor or petroleum hydrocarbons odor, associated with the groundwater.

C. Arrange and label necessary sample bottles and ensure that preservatives have been pre-added to the sample bottles, as required. Include a unique sample number, time and date of sampling, the initials of the sampler, and the requested analyses on the label. Additionally, record information pertinent to the preservation used in the sample. Consult the facility-specific SAP and ENV-TI-05.80.04, Field Sampling Quality Control, to determine the appropriate QC samples to be collected.

D. If sampling with a pump, take care to minimize purge water descending back into the well through the pump tubing. Minimize turbulence when filling sample containers by allowing the liquid to run gently down the inside of the bottle. Labeled sample bottles should be filled in the following order:

1. Volatile Organic Compounds (VOCs)
2. Semi-volatile Organic Compounds (SVOCs)
3. Pesticides/PCBs
4. Total Petroleum Hydrocarbons (TPH)
5. Metals, Cyanide, and Radionuclides
6. Filtered Metals and Radionuclides, if required
7. Other water-quality parameters

6.6.3 Sampling after Volume-Averaging Purge (continued)

E. If sampling with a bailer, refer to Section 6.6.2 for sample collection requirements. Refer to Step 6.6.3D of this section for bottle filling order. Minimize sample disturbance during collection.

F. Immediately seal each sample bottle, when full. When all bottles are filled place the samples on ice in a cooler within 15 minutes to maintain sample temperature preservation requirements in accordance with procedures outlined in the ENV-TI-05.80.02, Sample Labeling and Custody.

G. Record the sample identification and sample collection time appropriately and on the COC Record. Refer to ENV-TI-05.80.03, Field Record Keeping.

H. Once sampling is complete, retrieve the sample pump and associated sampling equipment and decontaminate, in accordance with procedures outlined in the ENV-TI-05.80.05, Field Sampling Equipment Cleaning and Decontamination. If using a bailer, place used bailer back into sleeve and dispose of properly.

I. Close and secure the well. Clean up and remove debris left from the sampling event. Be sure that investigation-derived wastes are properly containerized and labeled as specified in Section 6.10.

J. Review sampling records for completeness. Add additional notes, as necessary.

6.7 Filtration of Groundwater Samples

It will be necessary to collect filtered (dissolved) inorganic constituent samples in addition to unfiltered (total) inorganic constituent samples if the final turbidity value prior to sampling exceeds 10 NTU and/or if requested by the customer and/or required by the facility-specific SAP and QAP. Dissolved sample collection is accomplished by filtering the sample, as follows:

A. When collecting samples, utilizing a pump (either low flow or submersible pump) as described in Section 6.6, attach a new certified-clean disposable in line 0.45 μm filter to the tubing.

B. Allow groundwater to run through the filter for two minutes. Either containerize the filter purge water or let it run on the ground, in accordance with the facility-specific SAP and QAP. Document performance of the filter rinse/flush.

C. After the two-minute tube/filter flush, fill sample bottle(s) for dissolved inorganic constituents.

D. Ensure bottle(s) is labeled correctly and marked as a filtered sample.

6.7 Filtration of Groundwater Samples (continued)

E. After filtered samples have been collected, remove the in-line filter and continue filling remaining sample containers, if necessary.

F. Close and secure well as detailed in Section 6.6.

6.8 Processing Field Samples

A. Once the investigatory and required QC samples are collected, ensure they are labeled correctly and that COC records are completed. See ENV-TI-05.80.02, Sample Labeling and Custody.

NOTE
Some concerns have arisen concerning the use of Sharpie-brand markers to label sample bottles. Caution should be used when using Sharpie-brand markers, especially when collecting samples for analysis of VOCs.

B. Procure laboratory-preserved sample containers, when possible. Handling of preservatives in the field poses health and safety, cross contamination and sample integrity concerns. If field preservation cannot be avoided, preserve samples that require preservation, as soon as practically possible, following sample collection, using traceable chemical preservatives obtained from the laboratory performing the sample analysis.

C. Complete the appropriate field documentation. Review sampling records for completeness and add notes, as needed.

D. Mark, package, and ship the samples to the designated laboratory for analysis, in accordance with the ENV-TI-05.80.06, Handling and Shipping of Samples.

6.9 Decontamination

Dedicated groundwater sampling equipment (submersible adjustable rate bladder pumps and sample tubing) will not require decontamination during each sampling event. Dedicated sampling equipment is to be decontaminated before deployment into the monitoring well when:

A. The pump is first deployed into the monitoring well.

B. The dedicated sampling pump is removed for routine, as described in the facility-specific SAP and ENV-TI-05.80.21, Monitoring Well Inspection and Maintenance, or non-routine maintenance.

6.9 Decontamination (continued)

C. Evaluation of analytical data reveals unusual or unexpected trending and sampling equipment is determined to be a potential cause.

D. As directed in writing by TVA and/or specified in the facility-specific SAP.

E. Sampling equipment that is not dedicated is to be decontaminated, as described in ENV-TI-05.80.05, Field Sampling Equipment Cleaning and Decontamination.

F. Dedicated sample tubing is to be changed at the frequency stated in the facility-specific SAP, ENV-TI-05.80.21, Monitoring Well Inspection and Maintenance, or as directed by TVA.

6.10 Investigation-Derived Waste

Investigation-derived wastes, such as personal protective equipment (PPE), purged groundwater, waste media, and decontamination fluids are managed in accordance with Table 4, Investigative-Derived Wastes. Coordinate with appropriate TVA facility personnel to arrange for disposal of investigation-derived waste based on results of analytical data or in accordance with the facility-specific waste management plan.

Investigation-Derived Waste Stream	Disposition Pathway
General refuse (such as paper, plastic bags, and cardboard)	Dispose as municipal trash or recycle, as appropriate.
PPE (such as nitrile gloves and Tyvek®)	Dispose as municipal trash for routine activities. If expected to be contaminated with hazardous materials, containerize pending analytical results of associated samples.
Non-hazardous and potable groundwater	Release onto the ground down gradient of the monitoring well or based on TVA facility waste management requirements. Do not return water to the monitoring well.
Decontamination fluids	Containerize in appropriate containers dependent on user's knowledge and dispose of appropriately, based on TVA facility waste management requirements.

Table 4, Investigative-Derived Wastes

6.11 Field Logbooks and Data Sheets

Field logbooks, data sheets, and other appropriate field notebooks for recording daily activities are maintained by the Field Team Lead, or designee. Information is entered by the appropriate field team member using indelible ink. In addition to the minimum requirements discussed in ENV-TI-05.80.03, Field Record Keeping, document those sampling characteristics specific to this TI and as defined in the applicable planning documents.

7.0 POST PERFORMANCE ACTIVITY

None

8.0 RECORDS

Records generated in the process of performing the activities in this TI must be processed and maintained as stated in the Environmental Records Matrix, in accordance with the TVA Document Services Records Management procedures.

8.1 Quality Assurance Records

A. Field logbooks, data sheets

B. Chain of Custody Records

8.2 Non-Quality Assurance Records

Groundwater Sampling Equipment and Materials Checklist

Attachment 1
(Page 1 of 1)

Example - Preliminary Groundwater Data Field Worksheet

Preliminary Groundwater Data Field Worksheet Sheet of

Project/Site	Well Number 84068	Purge Date	Year	Month	Day

Depth to Water (ft) 4195	Bottom of Well (ft) 4194	Well Diameter (in) 4188	Survey Leader	Field Crew
☐ Depth of Screen (ft) 4191	To	☐ Open Bore Hole (ft) 4190	Sample Label	☐ Unfiltered ☐ Filtered ☐ Both Filter Type and Size:

[Bottom of Well	-	Depth to Water]	x	Volume Factor	=	Well Volume	Target Purge Volume	Actual Purge Volume
[( )ft	-	( )ft]	x	( )Gal/ft	=	(Gal)	(Gal)	(Gal) 4186

Purge Pump: ☐ Bladder ☐ Centrifugal ☐ Peristaltic ☐ Dedicated Other (list):

Sample Pump: ☐ Bladder ☐ Centrifugal ☐ Peristaltic ☐ Dedicated Other (list):

Notes and WQ Observations	Time ET CT	Pump Rate (Gal/min)	Depth to Water (ft)	Pump Depth (ft)	Temp °C	pH (s.u.)	DO (mg/L)	COND (umhos/cm)	(+/-) ORP (mV)	Turbidity (NTU)
Begin Purge →										
Readings After Sampling										

Remarks:

Reviewed By:

Survey Leader	Date	Project Leader	Date

Sample Collector:

Sample Date			Time
Year	Month	Day	ET CT

Pump Duration: min 72004 "999" = 2 days

Sample Readings

Analysis Time ET CT	Pump Rate (Gal/min)	[redacted]	Pump Depth (ft)	Temp °C EPA 170.1	pH (s.u.) EPA 150.1	DO (mg/L) EPA 360.1	COND (umhos/cm) EPA 120.1	(+/-) ORP (mv) SM 2580B	Turbidity (NTU) EPA 180.1
	4193		4192	10	400	300	94	90	

Additional Sample Data

Analyst:	415 Phenol Alkalinity mg/L (EPA 310.1)	431 Total Alk. mg/L (EPA 310.1)	436 Mineral Acidity mg/L (EPA 305.1)	437 CO_2 Acidity mg/L (EPA 305.1)
Date Analyzed: Year Month Day	Time:	Time:	Time:	Time:
Turbidity 1350 ☐ Clear ☐ Slightly Turbid ☐ Turbid ☐ Highly Turbid	Initial:	Initial:	Initial:	Initial:

Well Diameter (in)	Vol. Factor (Gal/ft)
1 in	0.041
2 in	0.163
3 in	0.367
4 in	0.653
5 in	1.020
6 in	1.469

Color:

Odor:

Bottles Required ☐ BOD ☐ COD ☐ TOC ☐ TIC ☐ Ferrous ☐ Metals ☐ Dis. Metals ☐ Mineral ☐ Dis. Mineral ☐ Nutrient ☐ Phenol ☐ Filt TIC ☐ TSS/TDS

Others (list):

Attachment 2
(Page 1 of 1)

Example - Groundwater Sampling Equipment and Materials Checklist

Item Description	Check
Health & Safety	
Non-powdered nitrile or latex gloves	
Safety glasses	
Hard hat and steel-toed boots, as appropriate	
High-visibility vest, as needed	
Hearing protection	
Field first-aid kit	
Eyewash	
Respirator and cartridges (if necessary)	
Saranex™/Tyvek suits and booties (if necessary)	
Paperwork	
JSA	
Pre-Job Briefing Form	
Sample planning documents	
Well construction data, location map, field data from previous sampling events	
Chain-of-Custody forms and custody seals	
Field logbook or data sheets	
Measuring Equipment	
Flow measurement supplies (for example, graduated cylinder and stop watch)	
Electronic water-level tape or sounder with or without the capability of detecting non-aqueous phase liquid	
Detector for detecting water/oil interface	
VOC detector equipped with photoionization detector (PID)	
Groundwater Sampling Equipment	
Conductivity meter and probe	
GPS device	
Monitoring well keys	
Plastic sheeting for ground cover	
Tools for well access (for example, socket set, wrench, screw driver, T-wrench)	
Laboratory-supplied certified-clean sample bottles, preserved by laboratory (as necessary)	
Appropriate trip blanks and high-quality blank water (deionized water from a known source)	
Sample filtration device and filters	
Submersible pump, peristaltic pump, centrifugal, or other appropriate pump	
Appropriate sample and air line tubing (Silastic, Teflon, Tygon, or equivalent)	
Stainless steel clamps to attach sample lines to pump	
Pump controller and power supply	
Oil-less air compressor, air line leads, and end fittings (if using bladder pump)	
Generator (as needed)	
Multiparameter sonde with flow-through cell	
Turbidity meter	
Bailer	
Calibration standards for monitoring devices	
Decontamination materials and supplies, as needed	

APPENDIX B

CHEMICAL CHARACTERISTICS OF GYPSUM AND BOTTOM ASH BYPRODUCTS

Client: AECOM
Project/Site: TVA Ash Characterization Proj 31853372

TestAmerica Job ID: 180-54589-1

Client Sample ID: CUF-DRY FLY ASH - SILO-A

Lab Sample ID: 180-54589-1

Date Collected: 05/06/16 08:30
Date Received: 05/07/16 09:20

Matrix: Solid

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	150	F1	10	3.1	mg/L			05/13/16 14:11	10
Fluoride	5.2		1.0	0.29	mg/L			05/13/16 14:11	10
Sulfate	920		100	25	mg/L			05/13/16 14:59	100

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	0.098	B	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 15:35	1
Barium	0.11	J	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 15:35	1
Cadmium	0.13		0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 15:35	1
Chromium	1.3		0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 15:35	1
Lead	0.052	J	0.10	0.0042	mg/L		05/18/16 09:44	05/20/16 19:20	2
Selenium	0.31	B	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 15:35	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 15:35	1

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		100	15	ug/L		05/10/16 13:56	05/16/16 10:02	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:56	05/16/16 10:02	1
Aluminum	ND		200	37	ug/L		05/10/16 13:56	05/16/16 10:02	1
Arsenic	40		10	3.7	ug/L		05/10/16 13:56	05/16/16 10:02	1
Boron	3200	B	200	2.0	ug/L		05/10/16 13:56	05/16/16 10:02	1
Barium	2700		200	0.14	ug/L		05/10/16 13:56	05/16/16 10:02	1
Beryllium	ND		4.0	0.15	ug/L		05/10/16 13:56	05/16/16 10:02	1
Calcium	1400000		25000	420	ug/L		05/10/16 13:56	05/16/16 16:02	5
Cadmium	ND		5.0	0.26	ug/L		05/10/16 13:56	05/16/16 10:02	1
Cobalt	ND		50	0.55	ug/L		05/10/16 13:56	05/16/16 10:02	1
Chromium	87		5.0	0.97	ug/L		05/10/16 13:56	05/16/16 10:02	1
Copper	18	J	25	0.97	ug/L		05/10/16 13:56	05/16/16 10:02	1
Magnesium	ND		5000	25	ug/L		05/10/16 13:56	05/16/16 10:02	1
Lithium	490		50	3.5	ug/L		05/10/16 13:56	05/16/16 10:02	1
Manganese	ND		15	0.19	ug/L		05/10/16 13:56	05/16/16 10:02	1
Molybdenum	4600		40	0.99	ug/L		05/10/16 13:56	05/16/16 10:02	1
Nickel	5.0	J	40	0.89	ug/L		05/10/16 13:56	05/16/16 10:02	1
Lead	90		10	2.1	ug/L		05/10/16 13:56	05/16/16 10:02	1
Antimony	ND		50	18	ug/L		05/10/16 13:56	05/16/16 16:02	5
Selenium	280	B	10	2.5	ug/L		05/10/16 13:56	05/16/16 10:02	1
Tin	ND		100	2.2	ug/L		05/10/16 13:56	05/16/16 10:02	1
Strontium	1000		50	8.0	ug/L		05/10/16 13:56	05/16/16 10:02	1
Thallium	ND		20	1.4	ug/L		05/10/16 13:56	05/16/16 10:02	1
Titanium	ND		50	0.24	ug/L		05/10/16 13:56	05/16/16 10:02	1
Vanadium	110		50	4.7	ug/L		05/10/16 13:56	05/16/16 10:02	1
Zinc	90	B	20	2.9	ug/L		05/10/16 13:56	05/16/16 10:02	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00030	B	0.00020	0.000052	mg/L		05/11/16 07:51	05/12/16 13:24	1

Method: 7470A - Mercury (CVAA) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.052	ug/L		05/10/16 14:13	05/11/16 13:14	1

TestAmerica Pittsburgh

Client Sample Results

Client: AECOM
Project/Site: TVA Ash Characterization Proj 31853372

TestAmerica Job ID: 180-54589-1

Client Sample ID: CUF-DRY FLY ASH - SILO-A

Lab Sample ID: 180-54589-1
Date Collected: 05/06/16 08:30
Matrix: Solid
Date Received: 05/07/16 09:20

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	0.0		0.1	0.1	%			05/12/16 10:51	1

Client Sample ID: CUF-DRY FLY ASH - SILO-A

Lab Sample ID: 180-54589-1
Date Collected: 05/06/16 08:30
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 100.0

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	0.072	J	0.44	0.059	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Aluminum	13000		18	2.3	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Arsenic	34		0.88	0.50	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Boron	450		18	0.27	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Barium	260		18	0.036	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Beryllium	3.4		0.35	0.025	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Calcium	31000		440	14	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Cadmium	3.6	B	0.44	0.025	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Cobalt	12		4.4	0.063	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Chromium	110	B	0.44	0.038	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Copper	35		2.2	0.14	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Iron	32000		8.8	1.9	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Magnesium	2400		440	3.2	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Lithium	15		4.4	0.17	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Manganese	78		1.3	0.025	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Molybdenum	97		3.5	0.14	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Nickel	43		3.5	0.11	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Lead	65		0.88	0.16	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Antimony	2.4	F1	0.88	0.24	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Selenium	12		0.88	0.28	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Tin	5.0	J B F1	8.8	2.8	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Strontium	79		4.4	0.84	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Thallium	3.6		1.8	0.24	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Titanium	640		4.4	0.068	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Vanadium	250		4.4	0.25	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1
Zinc	180		1.8	0.38	mg/Kg	☼	05/09/16 15:00	05/17/16 13:23	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.045	B	0.031	0.0070	mg/Kg	☼	05/09/16 11:46	05/10/16 10:32	1

Client Sample ID: CUF-DRY FLY ASH - SILO-B

Lab Sample ID: 180-54589-2
Date Collected: 05/06/16 08:30
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	140		10	3.1	mg/L			05/13/16 11:00	10
Fluoride	4.8		1.0	0.29	mg/L			05/13/16 11:00	10
Sulfate	910		100	25	mg/L			05/13/16 11:16	100

Client: AECOM
TestAmerica Job ID: 180-54589-1
Project/Site: TVA Ash Characterization Proj 31853372

Client Sample ID: CUF-DRY FLY ASH - SILO-B
Lab Sample ID: 180-54589-2
Date Collected: 05/06/16 08:30
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.10**	**B**	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 16:05	1
Barium	**0.12**	**J**	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 16:05	1
Cadmium	**0.14**		0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 16:05	1
Chromium	**1.4**		0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 16:05	1
Lead	**0.048**	**J**	0.10	0.0042	mg/L		05/18/16 09:44	05/20/16 19:55	2
Selenium	**0.33**	**B**	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 16:05	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 16:05	1

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		100	15	ug/L		05/10/16 13:57	05/12/16 16:09	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:57	05/12/16 16:09	1
Aluminum	ND		200	37	ug/L		05/10/16 13:57	05/12/16 16:09	1
Arsenic	**23**		10	3.7	ug/L		05/10/16 13:57	05/12/16 16:09	1
Boron	**3300**		200	2.0	ug/L		05/10/16 13:57	05/12/16 16:09	1
Barium	**2300**	**B**	200	0.14	ug/L		05/10/16 13:57	05/12/16 16:09	1
Beryllium	ND		4.0	0.15	ug/L		05/10/16 13:57	05/12/16 16:09	1
Calcium	**1300000**		25000	420	ug/L		05/10/16 13:57	05/13/16 09:28	5
Cadmium	ND		5.0	0.26	ug/L		05/10/16 13:57	05/12/16 16:09	1
Cobalt	ND		50	0.55	ug/L		05/10/16 13:57	05/12/16 16:09	1
Chromium	**87**		5.0	0.97	ug/L		05/10/16 13:57	05/12/16 16:09	1
Copper	**15**	**J**	25	0.97	ug/L		05/10/16 13:57	05/12/16 16:09	1
Magnesium	ND		5000	25	ug/L		05/10/16 13:57	05/12/16 16:09	1
Lithium	**400**		50	3.5	ug/L		05/10/16 13:57	05/12/16 16:09	1
Manganese	ND		15	0.19	ug/L		05/10/16 13:57	05/12/16 16:09	1
Molybdenum	**4200**		40	0.99	ug/L		05/10/16 13:57	05/12/16 16:09	1
Nickel	**5.5**	**J**	40	0.89	ug/L		05/10/16 13:57	05/12/16 16:09	1
Lead	**39**		10	2.1	ug/L		05/10/16 13:57	05/12/16 16:09	1
Antimony	ND		50	18	ug/L		05/10/16 13:57	05/13/16 09:28	5
Selenium	**270**		10	2.5	ug/L		05/10/16 13:57	05/12/16 16:09	1
Tin	ND		100	2.2	ug/L		05/10/16 13:57	05/12/16 16:09	1
Strontium	**910**		50	8.0	ug/L		05/10/16 13:57	05/12/16 16:09	1
Thallium	ND		20	1.4	ug/L		05/10/16 13:57	05/12/16 16:09	1
Titanium	ND		50	0.24	ug/L		05/10/16 13:57	05/12/16 16:09	1
Vanadium	**61**		50	4.7	ug/L		05/10/16 13:57	05/12/16 16:09	1
Zinc	**41**	**B**	20	2.9	ug/L		05/10/16 13:57	05/12/16 16:09	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.00024**	**B**	0.00020	0.000052	mg/L		05/11/16 07:51	05/12/16 13:30	1

Method: 7470A - Mercury (CVAA) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.052	ug/L		05/10/16 14:13	05/11/16 13:20	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**0.0**		0.1	0.1	%			05/12/16 10:51	1

Client Sample Results

Client: AECOM — TestAmerica Job ID: 180-54589-1
Project/Site: TVA Ash Characterization Proj 31853372

Client Sample ID: CUF-DRY FLY ASH - SILO-B

Lab Sample ID: 180-54589-2

Date Collected: 05/06/16 08:30 — **Matrix: Solid**
Date Received: 05/07/16 09:20 — **Percent Solids: 100.0**

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	**0.081**	**J**	0.44	0.059	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Aluminum	**12000**		18	2.3	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Arsenic	**32**		0.88	0.50	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Boron	**410**		18	0.27	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Barium	**240**		18	0.036	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Beryllium	**3.0**		0.35	0.025	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Calcium	**30000**		440	14	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Cadmium	**3.3**	**B**	0.44	0.025	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Cobalt	**10**		4.4	0.064	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Chromium	**100**	**B**	0.44	0.038	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Copper	**33**		2.2	0.14	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Iron	**28000**		8.8	1.9	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Magnesium	**2300**		440	3.2	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Lithium	**14**		4.4	0.17	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Manganese	**73**		1.3	0.025	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Molybdenum	**91**		3.5	0.15	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Nickel	**38**		3.5	0.12	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Lead	**58**		0.88	0.16	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Antimony	**1.8**		0.88	0.24	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Selenium	**10**		0.88	0.28	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Tin	**5.4**	**J B**	8.8	2.8	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Strontium	**72**		4.4	0.85	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Thallium	**3.5**		1.8	0.24	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Titanium	**540**		4.4	0.068	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Vanadium	**230**		4.4	0.25	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1
Zinc	**170**		1.8	0.38	mg/Kg	☼	05/09/16 15:00	05/17/16 13:49	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.046**	**B**	0.030	0.0067	mg/Kg	☼	05/09/16 11:46	05/10/16 10:38	1

Client Sample ID: CUF-DEWATERED FGD GYPSUM-A

Lab Sample ID: 180-54589-3

Date Collected: 05/06/16 10:25 — **Matrix: Solid**
Date Received: 05/07/16 09:20

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**5.2**		2.5	0.77	mg/L			05/13/16 16:50	2.5
Fluoride	**1.2**		0.25	0.072	mg/L			05/13/16 16:50	2.5
Sulfate	**1500**	**F1**	25	6.3	mg/L			05/16/16 08:52	25

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.015**	**J B**	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 16:10	1
Barium	**0.065**	**J B**	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 16:10	1
Cadmium	**0.0031**	**J**	0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 16:10	1
Chromium	**0.0040**	**J B**	0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 16:10	1
Lead	ND		0.10	0.0042	mg/L		05/18/16 09:44	05/20/16 20:01	2
Selenium	**0.025**	**J B**	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 16:10	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 16:10	1

Client: AECOM
Project/Site: TVA Ash Characterization Proj 31853372

TestAmerica Job ID: 180-54589-1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: CUF-DEWATERED FGD GYPSUM-A

Lab Sample ID: 180-54589-3
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		100	15	ug/L		05/10/16 13:56	05/16/16 09:32	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:56	05/16/16 09:32	1
Aluminum	ND		200	37	ug/L		05/10/16 13:56	05/16/16 09:32	1
Arsenic	ND		10	3.7	ug/L		05/10/16 13:56	05/16/16 09:32	1
Boron	**290**	**B**	200	2.0	ug/L		05/10/16 13:56	05/16/16 09:32	1
Barium	**27**	**J**	200	0.14	ug/L		05/10/16 13:56	05/16/16 09:32	1
Beryllium	ND		4.0	0.15	ug/L		05/10/16 13:56	05/16/16 09:32	1
Calcium	**600000**		5000	84	ug/L		05/10/16 13:56	05/16/16 09:32	1
Cadmium	ND		5.0	0.26	ug/L		05/10/16 13:56	05/16/16 09:32	1
Cobalt	ND		50	0.55	ug/L		05/10/16 13:56	05/16/16 09:32	1
Chromium	ND		5.0	0.97	ug/L		05/10/16 13:56	05/16/16 09:32	1
Copper	**7.8**	**J**	25	0.97	ug/L		05/10/16 13:56	05/16/16 09:32	1
Magnesium	**2700**	**J**	5000	25	ug/L		05/10/16 13:56	05/16/16 09:32	1
Lithium	ND		50	3.5	ug/L		05/10/16 13:56	05/16/16 09:32	1
Manganese	**6.5**	**J**	15	0.19	ug/L		05/10/16 13:56	05/16/16 09:32	1
Molybdenum	ND		40	0.99	ug/L		05/10/16 13:56	05/16/16 09:32	1
Nickel	**3.6**	**J**	40	0.89	ug/L		05/10/16 13:56	05/16/16 09:32	1
Lead	ND		10	2.1	ug/L		05/10/16 13:56	05/16/16 09:32	1
Antimony	ND		10	3.5	ug/L		05/10/16 13:56	05/16/16 09:32	1
Selenium	**18**	**B**	10	2.5	ug/L		05/10/16 13:56	05/16/16 09:32	1
Tin	ND		100	2.2	ug/L		05/10/16 13:56	05/16/16 09:32	1
Strontium	**800**		50	8.0	ug/L		05/10/16 13:56	05/16/16 09:32	1
Thallium	ND		20	1.4	ug/L		05/10/16 13:56	05/16/16 09:32	1
Titanium	ND		50	0.24	ug/L		05/10/16 13:56	05/16/16 09:32	1
Vanadium	ND		50	4.7	ug/L		05/10/16 13:56	05/16/16 09:32	1
Zinc	**3.9**	**J B**	20	2.9	ug/L		05/10/16 13:56	05/16/16 09:32	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.000084**	**J B**	0.00020	0.000052	mg/L		05/11/16 07:49	05/11/16 14:16	1

Method: 7470A - Mercury (CVAA) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.052	ug/L		05/10/16 14:13	05/11/16 13:21	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**22.9**		0.1	0.1	%			05/12/16 10:51	1

Client Sample ID: CUF-DEWATERED FGD GYPSUM-A

Lab Sample ID: 180-54589-3
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 77.1

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	ND		0.65	0.087	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Aluminum	**62**		26	3.4	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Arsenic	**0.81**	**J**	1.3	0.74	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Boron	**27**		26	0.39	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Barium	**23**	**J**	26	0.053	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1

Client Sample ID: CUF-DEWATERED FGD GYPSUM-A

Lab Sample ID: 180-54589-3
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 77.1

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Beryllium	ND		0.52	0.037	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Calcium	**250000**		3200	100	mg/Kg	☼	05/09/16 15:00	05/18/16 12:17	5
Cadmium	**0.096**	**J B**	0.65	0.037	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Cobalt	ND		6.5	0.093	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Chromium	**1.7**	**B**	0.65	0.056	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Copper	**3.5**		3.2	0.20	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Iron	**290**	**F1**	13	2.8	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Magnesium	**2700**		650	4.7	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Lithium	**1.5**	**J**	6.5	0.25	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Manganese	**2.9**		1.9	0.036	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Molybdenum	**0.22**	**J**	5.2	0.21	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Nickel	**1.6**	**J**	5.2	0.17	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Lead	**1.6**	**J**	6.5	1.2	mg/Kg	☼	05/09/16 15:00	05/18/16 12:17	5
Antimony	ND		6.5	1.8	mg/Kg	☼	05/09/16 15:00	05/18/16 12:17	5
Selenium	**2.6**		1.3	0.41	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Tin	**4.3**	**J B**	13	4.1	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Strontium	**280**	**F1**	6.5	1.2	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Thallium	ND		2.6	0.35	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Titanium	**0.96**	**J**	6.5	0.10	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Vanadium	**0.47**	**J**	6.5	0.37	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1
Zinc	**12**		2.6	0.56	mg/Kg	☼	05/09/16 15:00	05/17/16 14:10	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.15**	**B**	0.036	0.0081	mg/Kg	☼	05/09/16 11:46	05/10/16 10:44	1

Client Sample ID: CUF-DEWATERED FGD GYPSUM-B

Lab Sample ID: 180-54589-4
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**4.6**		2.5	0.77	mg/L			05/13/16 11:32	2.5
Fluoride	**0.97**		0.25	0.072	mg/L			05/13/16 11:32	2.5
Sulfate	**1500**		25	6.3	mg/L			05/13/16 11:48	25

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.016**	**J B**	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 16:30	1
Barium	**0.068**	**J B**	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 16:30	1
Cadmium	**0.0030**	**J**	0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 16:30	1
Chromium	**0.0039**	**J B**	0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 16:30	1
Lead	ND		0.10	0.0042	mg/L		05/18/16 09:44	05/20/16 20:27	2
Selenium	**0.027**	**J B**	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 16:30	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 16:30	1

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		100	15	ug/L		05/10/16 13:57	05/12/16 16:14	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:57	05/12/16 16:14	1

Client Sample Results

Client: AECOM
Project/Site: TVA Ash Characterization Proj 31853372

TestAmerica Job ID: 180-54589-1

Client Sample ID: CUF-DEWATERED FGD GYPSUM-B

Lab Sample ID: 180-54589-4
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 6010C - Metals (ICP) - ASTM Leach (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		200	37	ug/L		05/10/16 13:57	05/12/16 16:14	1
Arsenic	ND		10	3.7	ug/L		05/10/16 13:57	05/12/16 16:14	1
Boron	**280**		200	2.0	ug/L		05/10/16 13:57	05/12/16 16:14	1
Barium	**19**	**J B**	200	0.14	ug/L		05/10/16 13:57	05/12/16 16:14	1
Beryllium	ND		4.0	0.15	ug/L		05/10/16 13:57	05/12/16 16:14	1
Calcium	**590000**		5000	84	ug/L		05/10/16 13:57	05/12/16 16:14	1
Cadmium	ND		5.0	0.26	ug/L		05/10/16 13:57	05/12/16 16:14	1
Cobalt	ND		50	0.55	ug/L		05/10/16 13:57	05/12/16 16:14	1
Chromium	ND		5.0	0.97	ug/L		05/10/16 13:57	05/12/16 16:14	1
Copper	**8.0**	**J**	25	0.97	ug/L		05/10/16 13:57	05/12/16 16:14	1
Magnesium	**1900**	**J**	5000	25	ug/L		05/10/16 13:57	05/12/16 16:14	1
Lithium	ND		50	3.5	ug/L		05/10/16 13:57	05/12/16 16:14	1
Manganese	**1.9**	**J B**	15	0.19	ug/L		05/10/16 13:57	05/12/16 16:14	1
Molybdenum	**12**	**J**	40	0.99	ug/L		05/10/16 13:57	05/12/16 16:14	1
Nickel	**3.9**	**J**	40	0.89	ug/L		05/10/16 13:57	05/12/16 16:14	1
Lead	ND		10	2.1	ug/L		05/10/16 13:57	05/12/16 16:14	1
Antimony	ND		10	3.5	ug/L		05/10/16 13:57	05/12/16 16:14	1
Selenium	**13**		10	2.5	ug/L		05/10/16 13:57	05/12/16 16:14	1
Tin	ND		100	2.2	ug/L		05/10/16 13:57	05/12/16 16:14	1
Strontium	**740**		50	8.0	ug/L		05/10/16 13:57	05/12/16 16:14	1
Thallium	ND		20	1.4	ug/L		05/10/16 13:57	05/12/16 16:14	1
Titanium	ND		50	0.24	ug/L		05/10/16 13:57	05/12/16 16:14	1
Vanadium	ND		50	4.7	ug/L		05/10/16 13:57	05/12/16 16:14	1
Zinc	ND		20	2.9	ug/L		05/10/16 13:57	05/12/16 16:14	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.00020	0.000052	mg/L		05/11/16 07:49	05/11/16 16:30	1

Method: 7470A - Mercury (CVAA) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.052	ug/L		05/10/16 14:13	05/11/16 13:31	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**22.9**		0.1	0.1	%			05/12/16 10:51	1

Client Sample ID: CUF-DEWATERED FGD GYPSUM-B

Lab Sample ID: 180-54589-4
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 77.1

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	ND		0.65	0.087	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Aluminum	**56**		26	3.4	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Arsenic	**0.92**	**J**	1.3	0.74	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Boron	**29**		26	0.39	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Barium	**21**	**J**	26	0.053	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Beryllium	ND		0.52	0.037	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Calcium	**260000**		3200	100	mg/Kg	☼	05/09/16 15:00	05/18/16 13:26	5

Client: AECOM
Project/Site: TVA Ash Characterization Proj 31853372

TestAmerica Job ID: 180-54589-1

Client Sample ID: CUF-DEWATERED FGD GYPSUM-B

Lab Sample ID: 180-54589-4
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 77.1

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cadmium	0.11	J B	0.65	0.037	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Cobalt	ND		6.5	0.093	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Chromium	1.6	B	0.65	0.056	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Copper	3.6		3.2	0.20	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Iron	310		13	2.8	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Magnesium	2900		650	4.7	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Lithium	1.4	J	6.5	0.25	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Manganese	3.1		1.9	0.036	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Molybdenum	ND		5.2	0.21	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Nickel	1.6	J	5.2	0.17	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Lead	1.8	J	6.5	1.2	mg/Kg	☼	05/09/16 15:00	05/18/16 13:26	5
Antimony	ND		6.5	1.8	mg/Kg	☼	05/09/16 15:00	05/18/16 13:26	5
Selenium	2.6		1.3	0.41	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Tin	ND		13	4.1	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Strontium	300		6.5	1.2	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Thallium	ND		2.6	0.35	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Titanium	0.77	J	6.5	0.10	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Vanadium	1.1	J	6.5	0.37	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1
Zinc	14		2.6	0.56	mg/Kg	☼	05/09/16 15:00	05/17/16 14:30	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.14	B	0.041	0.0091	mg/Kg	☼	05/09/16 11:46	05/10/16 10:50	1

Client Sample ID: CUF-BOTTOM ASH (BA STOCKPILE)-A

Lab Sample ID: 180-54589-7
Date Collected: 05/06/16 10:40
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.31	mg/L			05/13/16 10:13	1
Fluoride	0.032	J	0.10	0.029	mg/L			05/13/16 10:13	1
Sulfate	4.8		1.0	0.25	mg/L			05/13/16 10:13	1

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	0.022	J B	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 16:46	1
Barium	0.46	B	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 16:46	1
Cadmium	0.0058	J	0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 16:46	1
Chromium	0.0050	J B	0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 16:46	1
Lead	0.12		0.050	0.0021	mg/L		05/18/16 09:44	05/19/16 16:46	1
Selenium	0.013	J B	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 16:46	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 16:46	1

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	800		100	15	ug/L		05/10/16 13:55	05/16/16 09:12	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:55	05/16/16 09:12	1
Aluminum	870	B	200	37	ug/L		05/10/16 13:55	05/16/16 09:12	1
Arsenic	15		10	3.7	ug/L		05/10/16 13:55	05/16/16 09:12	1

Client: AECOM | TestAmerica Job ID: 180-54589-1
Project/Site: TVA Ash Characterization Proj 31853372

Client Sample ID: CUF-BOTTOM ASH (BA STOCKPILE)-B
Lab Sample ID: 180-54589-8
Date Collected: 05/06/16 10:40
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 89.0

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	7300		11	2.4	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Magnesium	360	J	560	4.1	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Lithium	1.9	J	5.6	0.22	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Manganese	25		1.7	0.032	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Molybdenum	3.6	J	4.5	0.19	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Nickel	6.1		4.5	0.15	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Lead	8.4		1.1	0.20	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Antimony	0.32	J	1.1	0.31	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Selenium	0.92	J	1.1	0.36	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Tin	4.0	J B	11	3.5	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Strontium	13		5.6	1.1	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Thallium	ND		2.2	0.31	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Titanium	110		5.6	0.087	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Vanadium	21		5.6	0.32	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1
Zinc	36		2.2	0.49	mg/Kg	☼	05/09/16 15:00	05/17/16 15:20	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.036	0.0082	mg/Kg	☼	05/09/16 11:46	05/10/16 11:03	1

Client Sample ID: CUF-FGD GYPSUM FINES (DIPPING POND) -A
Lab Sample ID: 180-54589-9
Date Collected: 05/06/16 11:30
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	25		2.5	0.77	mg/L			05/13/16 13:39	2.5
Fluoride	4.7		0.25	0.072	mg/L			05/13/16 13:39	2.5
Sulfate	1400		25	6.3	mg/L			05/13/16 13:55	25

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	0.017	J B	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 17:22	1
Barium	0.056	J B	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 17:22	1
Cadmium	0.030	J	0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 17:22	1
Chromium	0.0061	J B	0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 17:22	1
Lead	ND		0.10	0.0042	mg/L		05/18/16 09:44	05/20/16 20:53	2
Selenium	1.3	B	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 17:22	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 17:22	1

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		100	15	ug/L		05/10/16 13:57	05/12/16 16:45	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:57	05/12/16 16:45	1
Aluminum	ND		200	37	ug/L		05/10/16 13:57	05/12/16 16:45	1
Arsenic	ND		10	3.7	ug/L		05/10/16 13:57	05/12/16 16:45	1
Boron	1400		200	2.0	ug/L		05/10/16 13:57	05/12/16 16:45	1
Barium	23	J B	200	0.14	ug/L		05/10/16 13:57	05/12/16 16:45	1
Beryllium	ND		4.0	0.15	ug/L		05/10/16 13:57	05/12/16 16:45	1

Client: AECOM
Project/Site: TVA Ash Characterization Proj 31853372

TestAmerica Job ID: 180-54589-1

Client Sample ID: CUF-FGD GYPSUM FINES (DIPPING POND) -A

Lab Sample ID: 180-54589-9

Date Collected: 05/06/16 11:30
Date Received: 05/07/16 09:20

Matrix: Solid

Method: 6010C - Metals (ICP) - ASTM Leach (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Calcium	**630000**		10000	170	ug/L		05/10/16 13:57	05/13/16 09:38	2
Cadmium	ND		5.0	0.26	ug/L		05/10/16 13:57	05/12/16 16:45	1
Cobalt	ND		50	0.55	ug/L		05/10/16 13:57	05/12/16 16:45	1
Chromium	ND		5.0	0.97	ug/L		05/10/16 13:57	05/12/16 16:45	1
Copper	**8.5**	**J**	25	0.97	ug/L		05/10/16 13:57	05/12/16 16:45	1
Magnesium	**20000**		5000	25	ug/L		05/10/16 13:57	05/12/16 16:45	1
Lithium	**3.9**	**J**	50	3.5	ug/L		05/10/16 13:57	05/12/16 16:45	1
Manganese	**460**	**B**	15	0.19	ug/L		05/10/16 13:57	05/12/16 16:45	1
Molybdenum	**25**	**J**	40	0.99	ug/L		05/10/16 13:57	05/12/16 16:45	1
Nickel	**7.0**	**J**	40	0.89	ug/L		05/10/16 13:57	05/12/16 16:45	1
Lead	ND		20	4.2	ug/L		05/10/16 13:57	05/13/16 09:38	2
Antimony	ND		10	3.5	ug/L		05/10/16 13:57	05/12/16 16:45	1
Selenium	**570**		10	2.5	ug/L		05/10/16 13:57	05/12/16 16:45	1
Tin	ND		100	2.2	ug/L		05/10/16 13:57	05/12/16 16:45	1
Strontium	**1000**		50	8.0	ug/L		05/10/16 13:57	05/12/16 16:45	1
Thallium	ND		20	1.4	ug/L		05/10/16 13:57	05/12/16 16:45	1
Titanium	ND		50	0.24	ug/L		05/10/16 13:57	05/12/16 16:45	1
Vanadium	ND		50	4.7	ug/L		05/10/16 13:57	05/12/16 16:45	1
Zinc	ND		20	2.9	ug/L		05/10/16 13:57	05/12/16 16:45	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.0015**	**B**	0.00020	0.000052	mg/L		05/11/16 07:52	05/12/16 13:10	1

Method: 7470A - Mercury (CVAA) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.052	ug/L		05/10/16 14:13	05/11/16 13:45	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**38.8**		0.1	0.1	%			05/12/16 10:51	1

Client Sample ID: CUF-FGD GYPSUM FINES (DIPPING POND) -A

Lab Sample ID: 180-54589-9

Date Collected: 05/06/16 11:30
Date Received: 05/07/16 09:20

Matrix: Solid
Percent Solids: 61.2

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	ND		0.70	0.095	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Aluminum	**2000**		28	3.7	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Arsenic	**5.6**		1.4	0.80	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Boron	**42**		28	0.43	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Barium	**200**		28	0.058	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Beryllium	**0.17**	**J**	0.56	0.040	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Calcium	**190000**		3500	110	mg/Kg	☼	05/09/16 15:00	05/18/16 13:42	5
Cadmium	**2.0**	**B**	0.70	0.040	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Cobalt	**0.92**	**J**	7.0	0.10	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Chromium	**43**	**B**	0.70	0.061	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1

Client Sample Results

Client: AECOM
Project/Site: TVA Ash Characterization Proj 31853372

TestAmerica Job ID: 180-54589-1

Client Sample ID: CUF-FGD GYPSUM FINES (DIPPING POND) -A

Lab Sample ID: 180-54589-9

Date Collected: 05/06/16 11:30
Date Received: 05/07/16 09:20

Matrix: Solid
Percent Solids: 61.2

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Copper	**13**		3.5	0.22	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Iron	**7100**		14	3.0	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Magnesium	**8400**		700	5.1	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Lithium	**7.6**		7.0	0.27	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Manganese	**58**		2.1	0.040	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Molybdenum	**5.3**	**J**	5.6	0.23	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Nickel	**9.8**		5.6	0.18	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Lead	**7.7**		1.4	0.25	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Antimony	ND		7.0	1.9	mg/Kg	☼	05/09/16 15:00	05/18/16 13:42	5
Selenium	**41**		1.4	0.45	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Tin	**5.4**	**J B**	14	4.4	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Strontium	**220**		7.0	1.3	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Thallium	ND		2.8	0.38	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Titanium	**28**		7.0	0.11	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Vanadium	**19**		7.0	0.41	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1
Zinc	**190**		2.8	0.61	mg/Kg	☼	05/09/16 15:00	05/17/16 15:25	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**8.4**	**B**	1.1	0.24	mg/Kg	☼	05/09/16 11:46	05/10/16 11:25	25

Client Sample ID: CUF-FGD GYPSUM FINES (DIPPING POND) -B

Lab Sample ID: 180-54589-10

Date Collected: 05/06/16 11:30
Date Received: 05/07/16 09:20

Matrix: Solid

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**23**		2.5	0.77	mg/L			05/13/16 16:18	2.5
Fluoride	**4.5**		0.25	0.072	mg/L			05/13/16 16:18	2.5
Sulfate	**1400**		25	6.3	mg/L			05/13/16 16:34	25

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.015**	**J B**	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 17:27	1
Barium	**0.041**	**J B**	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 17:27	1
Cadmium	**0.026**	**J**	0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 17:27	1
Chromium	**0.0042**	**J B**	0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 17:27	1
Lead	ND		0.10	0.0042	mg/L		05/18/16 09:44	05/20/16 20:58	2
Selenium	**1.4**	**B**	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 17:27	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 17:27	1

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		100	15	ug/L		05/10/16 13:57	05/12/16 16:50	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:57	05/12/16 16:50	1
Aluminum	ND		200	37	ug/L		05/10/16 13:57	05/12/16 16:50	1
Arsenic	ND		10	3.7	ug/L		05/10/16 13:57	05/12/16 16:50	1
Boron	**1100**		200	2.0	ug/L		05/10/16 13:57	05/12/16 16:50	1

Client Sample ID: CUF-FGD GYPSUM FINES (DIPPING POND) -B

Lab Sample ID: 180-54589-10

Date Collected: 05/06/16 11:30
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 6010C - Metals (ICP) - ASTM Leach (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Barium	**21**	**J B**	200	0.14	ug/L		05/10/16 13:57	05/12/16 16:50	1
Beryllium	ND		4.0	0.15	ug/L		05/10/16 13:57	05/12/16 16:50	1
Calcium	**570000**		5000	84	ug/L		05/10/16 13:57	05/12/16 16:50	1
Cadmium	ND		5.0	0.26	ug/L		05/10/16 13:57	05/12/16 16:50	1
Cobalt	ND		50	0.55	ug/L		05/10/16 13:57	05/12/16 16:50	1
Chromium	**1.1**	**J**	5.0	0.97	ug/L		05/10/16 13:57	05/12/16 16:50	1
Copper	**8.0**	**J**	25	0.97	ug/L		05/10/16 13:57	05/12/16 16:50	1
Magnesium	**17000**		5000	25	ug/L		05/10/16 13:57	05/12/16 16:50	1
Lithium	ND		50	3.5	ug/L		05/10/16 13:57	05/12/16 16:50	1
Manganese	**450**	**B**	15	0.19	ug/L		05/10/16 13:57	05/12/16 16:50	1
Molybdenum	**20**	**J**	40	0.99	ug/L		05/10/16 13:57	05/12/16 16:50	1
Nickel	**6.3**	**J**	40	0.89	ug/L		05/10/16 13:57	05/12/16 16:50	1
Lead	ND		10	2.1	ug/L		05/10/16 13:57	05/12/16 16:50	1
Antimony	ND		10	3.5	ug/L		05/10/16 13:57	05/12/16 16:50	1
Selenium	**350**		10	2.5	ug/L		05/10/16 13:57	05/12/16 16:50	1
Tin	ND		100	2.2	ug/L		05/10/16 13:57	05/12/16 16:50	1
Strontium	**890**		50	8.0	ug/L		05/10/16 13:57	05/12/16 16:50	1
Thallium	ND		20	1.4	ug/L		05/10/16 13:57	05/12/16 16:50	1
Titanium	ND		50	0.24	ug/L		05/10/16 13:57	05/12/16 16:50	1
Vanadium	ND		50	4.7	ug/L		05/10/16 13:57	05/12/16 16:50	1
Zinc	ND		20	2.9	ug/L		05/10/16 13:57	05/12/16 16:50	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.0018**	**B**	0.00020	0.000052	mg/L		05/11/16 07:52	05/12/16 13:12	1

Method: 7470A - Mercury (CVAA) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.052	ug/L		05/10/16 14:13	05/11/16 13:47	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**38.8**		0.1	0.1	%			05/12/16 10:51	1

Client Sample ID: CUF-FGD GYPSUM FINES (DIPPING POND) -B

Lab Sample ID: 180-54589-10

Date Collected: 05/06/16 11:30
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 61.2

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	ND		0.70	0.094	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Aluminum	**1900**		28	3.7	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Arsenic	**5.3**		1.4	0.79	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Boron	**44**		28	0.42	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Barium	**190**		28	0.058	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Beryllium	**0.16**	**J**	0.56	0.040	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Calcium	**210000**		3500	110	mg/Kg	☼	05/09/16 15:00	05/18/16 13:58	5
Cadmium	**1.9**	**B**	0.70	0.040	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1

Client Sample ID: CUF-FGD GYPSUM FINES (DIPPING POND) -B

Lab Sample ID: 180-54589-10

Date Collected: 05/06/16 11:30
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 61.2

Method: 6010C - Metals (ICP) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	0.98	J	7.0	0.10	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Chromium	42	B	0.70	0.060	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Copper	12		3.5	0.22	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Iron	6900		14	3.0	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Magnesium	8000		700	5.1	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Lithium	7.8		7.0	0.27	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Manganese	82		2.1	0.039	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Molybdenum	5.3	J	5.6	0.23	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Nickel	9.7		5.6	0.18	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Lead	6.9		1.4	0.25	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Antimony	2.1	J	7.0	1.9	mg/Kg	☼	05/09/16 15:00	05/18/16 13:58	5
Selenium	38		1.4	0.45	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Tin	5.3	J B	14	4.4	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Strontium	230		7.0	1.3	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Thallium	ND		2.8	0.38	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Titanium	26		7.0	0.11	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Vanadium	18		7.0	0.40	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1
Zinc	180		2.8	0.60	mg/Kg	☼	05/09/16 15:00	05/17/16 15:30	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	8.0	B	1.1	0.26	mg/Kg	☼	05/09/16 11:46	05/10/16 11:27	25

TestAmerica Pittsburgh
301 Alpha Drive
Pittsburgh, PA 15238
Phone: 412.963.7058 Fax: 412.963.2470

Chain of Custody Record

131057

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING
TestAmerica Laboratories, Inc.
TAL-8210 (0713)

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☒ Other: N/A

Client Contact	Project Manager: Sherry Bugg	Site Contact: Peggy Schuler	Date: 5/6/2016	COC No:
Company Name: AECOM	Tel/Fax: 330-800-2768	Lab Contact: Carrie Gamber	Carrier: FedEx Express	1 of 1 COCs
Address: 564 White Pond Drive	Analysis Turnaround Time			Sampler:
City/State/Zip: Akron / OH	☐ CALENDAR DAYS ☐ WORKING DAYS			For Lab Use Only:
Phone: 330-836-9111	TAT if different from Below: Standard			Walk-in Client:
Fax: 330-836-9115	☒ 2 weeks			Lab Sampling:
Project Name: TVA Material Characterization	☐ 1 week			
Site: Cumberland - CUF	☐ 2 days			Job / SDG No.:
PO# 60489851	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	TCLP Metals	SGLP Metals	Anions (Chloride, Fluoride, Sulfate)	Sample Specific Notes:
CUF-Dry Fly Ash - Silo	5/6/16	0830	G	Soil	1	N		X	X	X	- See List of metals
CUF-Dewatered FGD Gypsum	↓	1025	G	↓	1	N		X	X	X	on AECOM proposal
CUF-Dewatered FGD Gypsum FD	↓	1025	G	↓	1	N		X	X	X	
CUF-Bottom Ash (BA Stockpile)	↓	1040	C	↓	1	N		X	X	X	Level 4 Data
CUF-FGD Gypsum Fines (Dipping Pond)	↓	1130	G	↓	1	N		X	X	X	Package
											- Hold "FD" duplicate
											sample until clear
											for analysis

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other

180-54589 Chain of Custody

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be ... **nth)**

☐ Return to Client ☒ Disposal by Lab ☐ Archive for ______ Months

Special Instructions/QC Requirements & Comments: Level 4 Data Package, Send Results to peggy.schuler@aecom.com and sherry.bugg@aecom.com

Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:		Cooler Temp. (°C): Obs'd: ______ Corr'd: ______		Therm ID No.: ______
Relinquished by: Anton Heitger	Company: AECOM	Date/Time: 5/6/16 1630	Received by:	Company: TA	Date/Time: 5/7/16 0920
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Client Sample ID: CUF FGD GYPSUM FINES (DIPPING POND) FD – A
Lab Sample ID: 180-54589-5
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	16		2.5	0.77	mg/L			05/13/16 12:04	2.5
Fluoride	3.8		0.25	0.072	mg/L			05/13/16 12:04	2.5
Sulfate	1500		25	6.3	mg/L			05/13/16 12:20	25

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	0.012	J B	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 16:36	1
Barium	0.041	J B	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 16:36	1
Cadmium	0.019	J	0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 16:36	1
Chromium	0.0046	J B	0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 16:36	1
Lead	ND		0.10	0.0042	mg/L		05/18/16 09:44	05/20/16 20:32	2
Selenium	0.96	B	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 16:36	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 16:36	1

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		100	15	ug/L		05/10/16 13:57	05/12/16 16:20	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:57	05/12/16 16:20	1
Aluminum	ND		200	37	ug/L		05/10/16 13:57	05/12/16 16:20	1
Arsenic	ND		10	3.7	ug/L		05/10/16 13:57	05/12/16 16:20	1
Boron	950		200	2.0	ug/L		05/10/16 13:57	05/12/16 16:20	1
Barium	22	J B	200	0.14	ug/L		05/10/16 13:57	05/12/16 16:20	1
Beryllium	ND		4.0	0.15	ug/L		05/10/16 13:57	05/12/16 16:20	1
Calcium	640000		10000	170	ug/L		05/10/16 13:57	05/13/16 09:33	2
Cadmium	ND		5.0	0.26	ug/L		05/10/16 13:57	05/12/16 16:20	1
Cobalt	ND		50	0.55	ug/L		05/10/16 13:57	05/12/16 16:20	1
Chromium	1.0	J	5.0	0.97	ug/L		05/10/16 13:57	05/12/16 16:20	1
Copper	8.8	J	25	0.97	ug/L		05/10/16 13:57	05/12/16 16:20	1
Magnesium	13000		5000	25	ug/L		05/10/16 13:57	05/12/16 16:20	1
Lithium	4.4	J	50	3.5	ug/L		05/10/16 13:57	05/12/16 16:20	1
Manganese	370	B	15	0.19	ug/L		05/10/16 13:57	05/12/16 16:20	1
Molybdenum	20	J	40	0.99	ug/L		05/10/16 13:57	05/12/16 16:20	1
Nickel	6.1	J	40	0.89	ug/L		05/10/16 13:57	05/12/16 16:20	1
Lead	ND		10	2.1	ug/L		05/10/16 13:57	05/12/16 16:20	1
Antimony	ND		10	3.5	ug/L		05/10/16 13:57	05/12/16 16:20	1
Selenium	240		10	2.5	ug/L		05/10/16 13:57	05/12/16 16:20	1
Tin	ND		100	2.2	ug/L		05/10/16 13:57	05/12/16 16:20	1
Strontium	900		50	8.0	ug/L		05/10/16 13:57	05/12/16 16:20	1
Thallium	ND		20	1.4	ug/L		05/10/16 13:57	05/12/16 16:20	1
Titanium	ND		50	0.24	ug/L		05/10/16 13:57	05/12/16 16:20	1
Vanadium	ND		50	4.7	ug/L		05/10/16 13:57	05/12/16 16:20	1
Zinc	ND		20	2.9	ug/L		05/10/16 13:57	05/12/16 16:20	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.0010	B	0.00020	0.000052	mg/L		05/11/16 07:52	05/12/16 13:04	1

Client Sample Results

Client: AECOM
TestAmerica Job ID: 180-54589-2
Project/Site: TVA Ash Characterization Proj 31853372

Client Sample ID: CUF FGD GYPSUM FINES (DIPPING POND) FD – A

Lab Sample ID: 180-54589-5
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20

Method: 7470A - Mercury (CVAA) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.052	ug/L		05/10/16 14:13	05/11/16 13:33	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**37.6**		0.1	0.1	%			05/12/16 10:51	1

Client Sample ID: CUF FGD GYPSUM FINES (DIPPING POND) FD – A

Lab Sample ID: 180-54589-5
Date Collected: 05/06/16 10:25
Matrix: Solid
Date Received: 05/07/16 09:20
Percent Solids: 62.4

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	ND		0.68	0.092	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Aluminum	**1900**		27	3.6	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Arsenic	**5.2**		1.4	0.78	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Boron	**48**		27	0.42	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Barium	**200**		27	0.056	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Beryllium	**0.15**	**J**	0.55	0.039	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Calcium	**230000**		3400	110	mg/Kg	☼	05/09/16 15:00	05/18/16 13:31	5
Cadmium	**1.9**	**B**	0.68	0.039	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Cobalt	**0.91**	**J**	6.8	0.099	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Chromium	**42**	**B**	0.68	0.059	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Copper	**13**		3.4	0.22	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Iron	**6800**		14	2.9	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Magnesium	**8500**		680	5.0	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Lithium	**7.7**		6.8	0.26	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Manganese	**63**		2.1	0.038	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Molybdenum	**5.1**	**J**	5.5	0.23	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Nickel	**9.6**		5.5	0.18	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Lead	**6.8**		1.4	0.25	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Antimony	ND		6.8	1.9	mg/Kg	☼	05/09/16 15:00	05/18/16 13:31	5
Selenium	**39**		1.4	0.44	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Tin	**4.5**	**J B**	14	4.3	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Strontium	**260**		6.8	1.3	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Thallium	ND		2.7	0.37	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Titanium	**26**		6.8	0.11	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Vanadium	**19**		6.8	0.39	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1
Zinc	**180**		2.7	0.59	mg/Kg	☼	05/09/16 15:00	05/17/16 14:35	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**6.1**	**B**	1.0	0.23	mg/Kg	☼	05/09/16 11:46	05/10/16 11:21	20

Client Sample Results

Client: AECOM
Project/Site: TVA Ash Characterization Proj 31853372

TestAmerica Job ID: 180-54589-2

Client Sample ID: CUF FGD GYPSUM FINES (DIPPING POND) FD – B

Lab Sample ID: 180-54589-6

Date Collected: 05/06/16 10:25
Date Received: 05/07/16 09:20

Matrix: Solid

Method: 9056A - Anions, Ion Chromatography - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**21**		2.5	0.77	mg/L			05/13/16 13:07	2.5
Fluoride	**4.5**		0.25	0.072	mg/L			05/13/16 13:07	2.5
Sulfate	**1700**		25	6.3	mg/L			05/13/16 13:23	25

Method: 6010C - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.013**	**J B**	0.050	0.0037	mg/L		05/18/16 09:44	05/19/16 16:41	1
Barium	**0.043**	**J B**	0.20	0.00014	mg/L		05/18/16 09:44	05/19/16 16:41	1
Cadmium	**0.019**	**J**	0.050	0.00026	mg/L		05/18/16 09:44	05/19/16 16:41	1
Chromium	**0.0047**	**J B**	0.050	0.00097	mg/L		05/18/16 09:44	05/19/16 16:41	1
Lead	ND		0.10	0.0042	mg/L		05/18/16 09:44	05/20/16 20:37	2
Selenium	**0.98**	**B**	0.050	0.0025	mg/L		05/18/16 09:44	05/19/16 16:41	1
Silver	ND		0.050	0.00069	mg/L		05/18/16 09:44	05/19/16 16:41	1

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	ND		100	15	ug/L		05/10/16 13:57	05/12/16 16:25	1
Silver	ND		5.0	0.69	ug/L		05/10/16 13:57	05/12/16 16:25	1
Aluminum	ND		200	37	ug/L		05/10/16 13:57	05/12/16 16:25	1
Arsenic	ND		10	3.7	ug/L		05/10/16 13:57	05/12/16 16:25	1
Boron	**1100**		200	2.0	ug/L		05/10/16 13:57	05/12/16 16:25	1
Barium	**22**	**J B**	200	0.14	ug/L		05/10/16 13:57	05/12/16 16:25	1
Beryllium	ND		4.0	0.15	ug/L		05/10/16 13:57	05/12/16 16:25	1
Calcium	**600000**		5000	84	ug/L		05/10/16 13:57	05/12/16 16:25	1
Cadmium	ND		5.0	0.26	ug/L		05/10/16 13:57	05/12/16 16:25	1
Cobalt	ND		50	0.55	ug/L		05/10/16 13:57	05/12/16 16:25	1
Chromium	**1.2**	**J**	5.0	0.97	ug/L		05/10/16 13:57	05/12/16 16:25	1
Copper	**8.3**	**J**	25	0.97	ug/L		05/10/16 13:57	05/12/16 16:25	1
Magnesium	**15000**		5000	25	ug/L		05/10/16 13:57	05/12/16 16:25	1
Lithium	ND		50	3.5	ug/L		05/10/16 13:57	05/12/16 16:25	1
Manganese	**440**	**B**	15	0.19	ug/L		05/10/16 13:57	05/12/16 16:25	1
Molybdenum	**20**	**J**	40	0.99	ug/L		05/10/16 13:57	05/12/16 16:25	1
Nickel	**6.5**	**J**	40	0.89	ug/L		05/10/16 13:57	05/12/16 16:25	1
Lead	ND		10	2.1	ug/L		05/10/16 13:57	05/12/16 16:25	1
Antimony	ND		10	3.5	ug/L		05/10/16 13:57	05/12/16 16:25	1
Selenium	**390**		10	2.5	ug/L		05/10/16 13:57	05/12/16 16:25	1
Tin	ND		100	2.2	ug/L		05/10/16 13:57	05/12/16 16:25	1
Strontium	**870**		50	8.0	ug/L		05/10/16 13:57	05/12/16 16:25	1
Thallium	ND		20	1.4	ug/L		05/10/16 13:57	05/12/16 16:25	1
Titanium	ND		50	0.24	ug/L		05/10/16 13:57	05/12/16 16:25	1
Vanadium	ND		50	4.7	ug/L		05/10/16 13:57	05/12/16 16:25	1
Zinc	**2.9**	**J B**	20	2.9	ug/L		05/10/16 13:57	05/12/16 16:25	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.00099**	**B**	0.00020	0.000052	mg/L		05/11/16 07:52	05/12/16 13:06	1

Client Sample ID: CUF FGD GYPSUM FINES (DIPPING POND) FD – B

Lab Sample ID: 180-54589-6

Date Collected: 05/06/16 10:25
Date Received: 05/07/16 09:20
Matrix: Solid

Method: 7470A - Mercury (CVAA) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.074	J B	0.20	0.052	ug/L		05/10/16 14:13	05/11/16 13:35	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	37.6		0.1	0.1	%			05/12/16 10:51	1

Client Sample ID: CUF FGD GYPSUM FINES (DIPPING POND) FD – B

Lab Sample ID: 180-54589-6

Date Collected: 05/06/16 10:25
Date Received: 05/07/16 09:20
Matrix: Solid
Percent Solids: 62.4

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	ND		0.67	0.090	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Aluminum	2000		27	3.5	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Arsenic	5.5		1.3	0.76	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Boron	48		27	0.41	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Barium	200		27	0.055	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Beryllium	0.16	J	0.53	0.038	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Calcium	240000		3300	110	mg/Kg	☼	05/09/16 15:00	05/18/16 13:36	5
Cadmium	1.9	B	0.67	0.038	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Cobalt	0.89	J	6.7	0.096	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Chromium	42	B	0.67	0.058	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Copper	13		3.3	0.21	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Iron	6800		13	2.8	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Magnesium	8800		670	4.8	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Lithium	7.8		6.7	0.26	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Manganese	72		2.0	0.038	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Molybdenum	5.1	J	5.3	0.22	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Nickel	9.5		5.3	0.17	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Lead	6.7		1.3	0.24	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Antimony	ND		6.7	1.8	mg/Kg	☼	05/09/16 15:00	05/18/16 13:36	5
Selenium	39		1.3	0.43	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Tin	ND		13	4.2	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Strontium	270		6.7	1.3	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Thallium	ND		2.7	0.36	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Titanium	26		6.7	0.10	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Vanadium	19		6.7	0.38	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1
Zinc	180		2.7	0.58	mg/Kg	☼	05/09/16 15:00	05/17/16 14:40	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	5.8	B	0.92	0.21	mg/Kg	☼	05/09/16 11:46	05/10/16 11:23	20

July 06, 2016 Service Request No:T1600763

Sherry Bugg
AECOM/URS Corporation
564 White Pond Drive
Akron, OH 44320

Laboratory Results for: CUF - TVA Material Characterization

Dear Sherry,

Enclosed are the results of the sample(s) submitted to our laboratory May 10, 2016
For your reference, these analyses have been assigned our service request number **T1600763.**

All analyses were performed according to our laboratory's quality assurance program. All results are intended to be considered in their entirety, and ALS Environmental is not responsible for use of less than the complete report. Results
apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please contact me if you have any questions. My extension is 7102. You may also contact me via email at Wendy.Hyatt@alsglobal.com.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

Wendy Hyatt
Client Services
Manager

ADDRESS 3860 S. Palo Verde Road, Suite 302, Tucson, AZ 85714
PHONE +1 520 573 1061 | FAX +1 520 573 1063
ALS Group USA, Corp.
dba ALS Environmental

Client: AECOM/URS Corporation
Project: CUF - TVA Material Characterization
Sample Matrix: Ash

Service Request: T1600763
Date Received: 5/10/16

CASE NARRATIVE

Sample Receipt

Five samples were received in good condition unless noted in the attached COC documents and Sample Receipt Form. The samples were received as collected in one gal heavy duty freezer bags. The samples were split into A & B fractions (see Sample Preparation) and logged into the ALS LIMS (Laboratory Information Management System) as two separate samples.

Splits of each prepared sample were forwarded to ALS Ft. Collins, CO to be analyzed for Radiochemical analyses. This data will be reported in a separate report package.

Sample Preparation

· Each sample in the 1 gal plastic freezer bag (approximately 2 to 3 Kg) was poured into a plastic drying bin, mixed, and then split using the cone and quartering method into the two separate sub-samples. Larger pieces, if any were broken by hand to ensure representative splits were obtained.

· Each sub-sample was air dried at 40°C and then further split down to several hundred grams for grinding and pulverizing to < 100 mesh. Samples with coarse material were crushed before the split was taken to be pulverized.

· Each pulverized sample was split into two sub-samples, each weighing approximately 100 g. One sub-sample was kept for the Tucson analyses while the second sub-sample was shipped to ALS in Ft, Collins, CO for radiochemistry analyses.

· Unused portions of raw and prepped samples were saved.

Analyses

The following analyses were performed on the samples after going through the sample preparation process. Only gypsum samples were analyzed for the Gypsum Purity Test.

Proximate Analyses

· Moisture @ 105°C

· Volatile Matter @ 900°C

· Ash @ 750°C

· Calculated Fixed Carbon

Ultimate Analyses

· Carbon, Hydrogen, and Nitrogen (Total) by ASTM D5373 - Combustion IR / TCD

· Sulfur (Total) by ASTM D4239 - Combustion IR / TCD

Approved by R.V. Poulsen Date 7/6/2016

Gypsum Purity Test

· Includes Free Water @ 45°C Combined Water @ 220°C. These Moisture tests were added to the Proximate analysis in place of the standard Moisture determined at 105°C. The Total Moisture value for the Gypsum includes both Free and Combined Water. The Gypsum Purity is calculated by multiplying the Combined Water wt% by a factor of 4.778.

Ash Mineral Analyses

· HF, HNO3, and HCl acids and analyses by ICP-OES. Major and minor metals reported as their oxides.

Quality Control and Analytical Issues

No analytical problems were encountered and no QC data was out of acceptance criteria unless noted below. Duplicate RPD acceptance criteria of ±20% apply only to sample and duplicate values that are greater than 10 times the reporting limit (RL) for the sample.

Approved by R.V. Poulsen Date 7/6/2016

SAMPLE CROSS-REFERENCE

SAMPLE #	CLIENT SAMPLE ID	DATE	TIME
T1600763-001	CUF Bottom Ash - A	5/6/2016	1040
T1600763-002	CUF Bottom Ash - B	5/6/2016	1040
T1600763-003	CUF Dry Fly Ash - A	5/6/2016	0830
T1600763-004	CUF Dry Fly Ash - B	5/6/2016	0830
T1600763-005	CUF Dewatered FGD Gypsum - A	5/6/2016	1025
T1600763-006	CUF Dewatered FGD Gypsum - B	5/6/2016	1025
T1600763-007	CUF FGD Gypsum Fines - A	5/6/2016	1130
T1600763-008	CUF FGD Gypsum Fines - B	5/6/2016	1130
T1600763-009	CUF FGD Gypsum Fines-FD - A	5/6/2016	1130
T1600763-010	CUF FGD Gypsum Fines-FD - B	5/6/2016	1130

Data Qualifiers

Lab Standard

+	Possible Tedlar bag artifact.
A	TIC is a suspected aldol-condensation product
B	Analyte found in the associated method blank as well as in the sample.
BC	Reported results are not blank corrected.
BH	The back section of the tube yielded higher results than the front.
BT	Results indicated possible breakthrough; back section >=10% front section.
C	Result identification confirmed.
D	Compound identified in an analysis at a secondary dilution factor
D	Spike was diluted out
DE	Reported results are corrected for desorption efficiency.
E	Estimated value. Concentration above calibration range
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
H1	Sample analysis performed past holding time. See case narrative.
H2	Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
H3	Sample was received and analyzed past holding time.
H4	Sample was extracted past required extraction holding time, but analyzed within analysis holding time. See case narrative.
I	Internal standard not within the specified limits. See case narrative.
J	Estimated Value. Concentration found below MRL.
K	A deflection in the QC ion may indicate interference with the quantitation of this ion. The concentration of this analyte should be considered as an estimate.
K	Analyte was detected above the method reporting limit prior to normalization.
L1	Laboratory control sample recovery outside the specified limits; results may be biased high.
L2	Laboratory control sample recovery outside the specified limits; results may be biased low.
L3	Laboratory control sample recovery outside the specified limits.
M	Matrix interference; results may be biased high.
M	The duplicate injection precision not met.
M1	Matrix interference due to coelution with a non-target compound; results may be biased high.
N	Presumptive evidence of a compound for TICs that have been identified based on a mass spectral library search.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
P	Indicates chlorodiphenyl ether interference present at the retention time of the target compound.
P	Pesticide/Aroclor target analyte > 40% difference for detected concentrations between GC columns
Q	Indicates as estimated value because the P and P + 2 theoretical abundance ratio does not meet method criteria.
R	Duplicate Precision not met.
R1	Duplicate precision not within the specified limits; however, the results are below the MRL and considered estimated.
S	Surrogate recovery not within specified limits.

Data Qualifiers

Lab Standard

S	The reported value was determined by the Method of Standard Additions (MSA).
T	Analyte is a tentatively identified compound, result is estimated.
U	Compound was analyzed for, but was not detected (ND).
V1	The continuing calibration verification standard was outside (biased high) the specified limits for this compound.
V2	The continuing calibration verification standard was outside (biased low) the specified limits for this compound.
W	Result quantified, but the corresponding peak was detected outside the generated retention time window.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
X	See case narrative.
Y	Recovery outside limits
Y	The chromatogram resembles a petroleum product but does not match the calibration standard.
Z	The chromatogram does not resemble a petroleum product.
i	The MRL/MDL has been elevated due to a matrix interference.

Chain of Custody

ALS Environmental - Tucson
ADDRESS 3860 S. Palo Verde Road, Suite 302, Tucson, AZ 85714
PHONE +1 520 573 1061 FAX +1 520 573 1063
ALS Group

Work Order No.: T1600763 5
URS Corporation
TVA Material Characterization

Project Manager:	Sherry Bugg	Bill to:	Sherry Bugg / Accounts Receiving
Client Name:	AECom	Company:	AECom
Address:	564 White Pond Drive	Address:	564 White Pond Drive
City, State ZIP:	Akron, Ohio 44320	City, State ZIP:	Akron, Ohio 44320
Email:	Sherry.Bugg@aecom.com Phone: 330-800-2768	Email:	USAImagingC@aecom.com Phone: 330-800-2768
Project Name:	TVA Material Characterization		
Project Number:	60489851		
P.O. Number:	" "		
Sampler's Name:	Anton Heitger		

SAMPLE RECEIPT

Temperature (°C):		Temp Blank Present	
Received Intact:	Yes No N/A	Wet Ice / Blue Ice	
Cooler Custody Seals:	Yes No N/A	Total Containers:	
Sample Custody Seals:	Yes No N/A		

REQUESTED ANALYSIS

	Sample Identification	Matrix	Date Sampled	Time Sampled	Lab ID	No. of Containers	Proximate Analysis	Ultimate Analysis	Oxides Analysis	Trace Elements Analysis	Radium 226 + 228 (ALS SOP 724#713)	Gypsum Purity Testing
003/004	CUF Dry Fly Ash	Soil	5/6/16	0830		1	X	X	X	X	X	
005/006	CUF Dewatered FGD Gypsum			1025		1	X	X	X	X	X	X
	~~CUF Dewatered FGD Gypsum FD~~			~~1025~~	NS dele	1	X	X	X	X	X	X
001/002	CUF Bottom Ash			1040		1	X	X	X	X	X	
007/008	CUF FGD Gypsum Fines			1130		1	X	X	X	X	X	X
009/010	CUF FGD Gypsum Fines FD			1130								

TAT
☒ Routine
☐ Same Day *
☐ Next Day *
☐ 3 Day*
☐ 6 Day*
* Please call for availability. Rush charges will apply.

Due Date:

Comments
LEVEL 4 DATA PACKAGE

*Hold FD duplicate sample until cleared for analysis

Please Send results to Peggy.Schuler@aecom.com + Sherry.bugg@aecom.com

Additional Methods Available Upon Request

RELINQUISHED BY			RECEIVED BY		
Print Name	Signature	Date/Time	Print Name	Signature	Date/Time
Anton Heitger	[signature]	5/6/16 1630	Only Gypsum Fines - Sonia N. Gonzalez	[signature]	5/9/16 (0947)

Revised: 2/22/2016

3860 S. Palo Verde Road, Suite 302
Tucson, AZ 85714
T: +1 520 573 1061
F: +1 520 573 1063
www.alsglobal.com

Sample Receipt Form

T1600763 5
URS Corporation
TVA Material Characterization

Client/Project: AECOM

Work Order Number:

Received by: Sonia Gonzalez   Date & Time: 5/9/16 0947   Matrix: Solid

Samples were received via?: FedEx   Samples were received in: Cooler

Were custody seals on containers? (●) Yes ( ) No ( ) NA   If yes, how many and where? 2 Front & Back

If present were custody seals intact? (●) Yes ( ) No   If present, were they signed and dated? (●) Yes ( ) No

Cooler Temp C	Temp Blank C	Tracking Number
Ambient	n/a	7830 1004 0375

Packing material used? Bubble Wrap

Did all the bottles arrive in good condition (unbroken)? (●) Yes ( ) No ( ) NA   If No, record comments below

Did all sample labels and tags agree with COC? (●) Yes ( ) No ( ) NA   If No, record discrepancies below

Were all the appropriate containers and volumes received for the tests indicated? (●) Yes ( ) No ( ) NA

Are samples received deemed acceptable? (●) Yes ( ) No

Comments:
2 ziploc bags (both same sample Gypsum Fines but one is FD)

Notes, discrepancies, & resolutions:
COC shows other samples not included and shipping label shows this is package 2 of 2. Missing package 1 of 2. Will make 2nd SRF when rest of samples are received.

As a part of ISO 17025 protocols, ALS must notify clients that the quoted analytical methods performed by ALS may have minor modifications from the methods as published. These modifications are written into our Standard Operating Procedures and do not impact the quality of the data. Receipt of this document will be considered an acceptance of the procedures used by the laboratory for analysis unless notified by the client.
Modifications may include, but are not limited to:

- The analysis of a sample matrix that differs from that stated in the published method (example - ASTM D5865 Standard Test Method for Gross Calorific Value of Coal and Coke is used for other matrices such as biomass, Tire Derived Fuel, etc.).
- Analyzing a sample mass that differs from those in the published method (example - to accommodate samples with high concentrations of analyte, samples of limited volume, or to comply with the instrument manufacturer's operating guidelines).
- Instruments used for the analysis may differ from those listed in the published method (example - using ICP- OES when the method references flame Atomic Absorption Spectroscopy)

Chain of Custody

ALS Environmental - Tucson
ADDRESS 3860 S. Palo Verde Road, Suite 302, Tucson, AZ 85714
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ALS Group

Work Order No.:

Project Manager:	Sherry Bugg	**Bill to:**	Sherry Bugg / Accounts Receiving
Client Name:	AECom	**Company:**	AECom
Address:	564 White Pond Drive	**Address:**	564 White Pond Drive
City, State ZIP:	Akron, Ohio 44320	**City, State ZIP:**	Akron, Ohio 44320
Email:	Sherry.Bugg@aecom.com	**Email:**	USAimaging@aecom.com
Phone:	330-800-2768	**Phone:**	330-800-2768
Project Name:	TVA Material Characterization		
Project Number:	60489851		
P.O. Number:	" "		
Sampler's Name:	Anton Heitger		

SAMPLE RECEIPT

Temperature (°C):		Temp Blank Present			
Received Intact:	Yes	No	N/A	Wet Ice / Blue Ice	
Cooler Custody Seals:	Yes	No	N/A	Total Containers:	
Sample Custody Seals:	Yes	No	N/A		

TAT

- [x] Routine
- [ ] Same Day *
- [ ] Next Day *
- [ ] 3 Day*
- [ ] 6 Day*

* **Please call for availability. Rush charges will apply.**

Due Date:

REQUESTED ANALYSIS

Sample Identification	Matrix	Date Sampled	Time Sampled	Lab ID	No. of Containers	Proximate Analysis	Ultimate Analysis	Oxides Analysis	Trace Elements Analysis	Radium 226 + 228 (ALS SOP 724#713)	Gypsum Purity Testing	Comments
CUF Dry Fly Ash	Soil	5/6/16	0830		1	X	X	X	X	X		
CUF Dewatered FGD Gypsum			1025		1	X	X	X	X	X	X	LEVEL 4
~~CUF Dewatered FGD Gypsum FD~~			~~1025~~	ABS 11/4/16	1	X	X	X	X	X	X	DATA
CUF Bottom Ash			1040		1	X	X	X	X	X		PACKAGE
CUF FGD Gypsum Fines			1130		1	X	X	X	X	X	X	
CUF FGD Gypsum Fines FD			1130									
			5/10/16									*Hold FD duplicate sample until cleared for analysis

Please Send results to Peggy.Schuler@aecom.com + Sherry.bugg@aecom.com

Additional Methods Available Upon Request

RELINQUISHED BY			**RECEIVED BY**		
Print Name	Signature	Date/Time	Print Name	Signature	Date/Time
Anton Heitger	[signature]	5/6/16 1630	Andrea Barton	[signature]	5/10/16 0909

Revised: 2/22/2016

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Sample Receipt Form

Client/Project: **AECOM** Work Order Number:

Received by: Andi Barton Date & Time: 5/10/16 0909 Matrix: Solid

Samples were received via?: FedEx Samples were received in: Cooler

Were custody seals on containers? ○ Yes ◉ No ○ NA If yes, how many and where?

If present were custody seals intact? ○ Yes ○ No If present, were they signed and dated? ○ Yes ○ No

Cooler Temp C	Temp Blank C	Tracking Number
N/A	N/A	8092 0783 3930

Packing material used? Bubble Wrap

Did all the bottles arrive in good condition (unbroken)? ◉ Yes ○ No ○ NA If No, record comments below

Did all sample labels and tags agree with COC? ○ Yes ○ No ◉ NA If No, record discrepancies below

Were all the appropriate containers and volumes received for the tests indicated? ◉ Yes ○ No ○ NA

Are samples received deemed acceptable? ◉ Yes ○ No

Comments:
3 - Ziplock bags

Notes, discrepancies, & resolutions:
Cooler 1 of 2 received. COC lists one sample as CUF Dewatered FGD Gypsum FD. By process of deduction, that particular sample is labeled CUF FDG Gypsum Fines FD.

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Modifications may include, but are not limited to:

- The analysis of a sample matrix that differs from that stated in the published method (example - ASTM D5865 Standard Test Method for Gross Calorific Value of Coal and Coke is used for other matrices such as biomass, Tire Derived Fuel, etc.).
- Analyzing a sample mass that differs from those in the published method (example - to accommodate samples with high concentrations of analyte, samples of limited volume, or to comply with the instrument manufacturer's operating guidelines).
- Instruments used for the analysis may differ from those listed in the published method (example - using ICP-OES when the method references flame Atomic Absorption Spectroscopy)

Certificate of Analysis

July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Bottom Ash - A**	**Sample Date & Time:**	**5/6/16 1040**
ALS Lab No.:	**T1600763-001**	**Date Received:**	**5/10/16**
Matrix:	**Bottom Ash**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	10.0		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	4.1		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	4.6		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.2		wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.3		wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	85.7		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	95.2		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	3.63		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.30	U	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.10	J	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	0.493		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)				wt%	0.1	0.1	AR		
Water, Combined (220C)				wt%	0.1	0.1	AR		
Gypsum Purity	calculated			wt%	calculated using combined water				

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Certificate of Analysis

July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Bottom Ash - A**	**Sample Date & Time:**	**5/6/16 1040**
ALS Lab No.:	**T1600763-001**	**Date Received:**	**5/10/16**
Matrix:	**Bottom Ash**		

Analyte Name	Analytical Method	Result	Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349							
Al2O3	ASTM D6349	19.06	wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.072	wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	4.06	wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	23.66	wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	1.07	wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.042	wt%	0.007	0.007	MF	05/31/16	
P2O5	ASTM D6349	0.1	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	2.06	wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	44.1	wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.61	wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.028	wt%	0.006	0.006	MF	05/31/16	
TiO2	ASTM D6349	0.95	wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	0.35	wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		96.1						

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Bottom Ash - B**	**Sample Date & Time:**	**5/6/16 1040**
ALS Lab No.:	**T1600763-002**	**Date Received:**	**5/10/16**
Matrix:	**Bottom Ash**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	10.3		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	4.2		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	4.6		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.6		wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.7		wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	85.0		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	94.7		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	3.94		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.32	J	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.10		wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	0.477		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)				wt%	0.1	0.1	AR		
Water, Combined (220C)				wt%	0.1	0.1	AR		
Gypsum Purity	calculated			wt%	calculated using combined water				

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Certificate of Analysis

July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Bottom Ash - B**	**Sample Date & Time:**	**5/6/16 1040**
ALS Lab No.:	**T1600763-002**	**Date Received:**	**5/10/16**
Matrix:	**Bottom Ash**		

Analyte Name	Analytical Method	Result	Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349							
Al2O3	ASTM D6349	19.13	wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.065	wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	4.04	wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	24.01	wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	1.07	wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.043	wt%	0.007	0.007	MF	05/31/16	
P2O5	ASTM D6349	0.2	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	2.07	wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	45.6	wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.64	wt%	0.07	0.07	MF	05/31/16	
SrO	ASTM D6349	0.028	wt%	0.006	0.006	MF	05/31/16	
TiO2	ASTM D6349	0.96	wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	0.30	wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		98.2						

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Dry Fly Ash - A**	**Sample Date & Time:**	**5/6/16 0830**
ALS Lab No.:	**T1600763-003**	**Date Received:**	**5/10/16**
Matrix:	**Fly Ash**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	0.1	U	wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	1.5		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	1.5		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.2		wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.2		wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	98.3		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	98.3		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	0.60		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.30	U	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.06	J	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	0.995		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)				wt%	0.1	0.1	AR		
Water, Combined (220C)				wt%	0.1	0.1	AR		
Gypsum Purity	calculated			wt%	calculated using combined water				

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Dry Fly Ash - A**	**Sample Date & Time:**	**5/6/16 0830**
ALS Lab No.:	**T1600763-003**	**Date Received:**	**5/10/16**
Matrix:	**Fly Ash**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349								
Al2O3	ASTM D6349	19.57		wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.081		wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	7.38		wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	18.97		wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	1.34		wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.035		wt%	0.007	0.007	MF	05/31/16	
P2O5	ASTM D6349	0.1	U	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	2.32		wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	40.9		wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.72		wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.034		wt%	0.006	0.006	MF	05/31/16	
TiO2	ASTM D6349	1.06		wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	2.67		wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		95.2							

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

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Certificate of Analysis

July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Dry Fly Ash - B**	**Sample Date & Time:**	**5/6/16 0830**
ALS Lab No.:	**T1600763-004**	**Date Received:**	**5/10/16**
Matrix:	**Fly Ash**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	0.1		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	1.2		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	1.2		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.3		wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.3		wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	98.5		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	98.6		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	0.59		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.30	U	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.02	J	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	1.025		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)				wt%	0.1	0.1	AR		
Water, Combined (220C)				wt%	0.1	0.1	AR		
Gypsum Purity	calculated			wt%	calculated using combined water				

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Certificate of Analysis

July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Dry Fly Ash - B**	**Sample Date & Time:**	**5/6/16 0830**
ALS Lab No.:	**T1600763-004**	**Date Received:**	**5/10/16**
Matrix:	**Fly Ash**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349								
Al2O3	ASTM D6349	19.48		wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.078		wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	7.40		wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	18.85		wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	1.34		wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.035		wt%	0.007	0.007	MF	05/31/16	
P2O5	ASTM D6349	0.1	U	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	2.30		wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	39.3		wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.70		wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.033		wt%	0.006	0.006	MF	05/31/16	
TiO2	ASTM D6349	1.05		wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	2.65		wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		93.3							

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Dewatered FGD Gypsum - A**	**Sample Date & Time:**	**5/6/16 1025**
ALS Lab No.:	**T1600763-005**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	25.3		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	2.2		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	3.0		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.3		wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.4		wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	72.2		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	96.6		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	0.54		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.30	U	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.02	U	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	21.466		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)		7.9		wt%	0.1	0.1	AR	05/26/16	
Water, Combined (220C)		20.0		wt%	0.1	0.1	AR	05/26/16	
Gypsum Purity	calculated	95.6		wt%	calculated using combined water				

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Certificate of Analysis

July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Dewatered FGD Gypsum - A**	**Sample Date & Time:**	**5/6/16 1025**
ALS Lab No.:	**T1600763-005**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349								
Al2O3	ASTM D6349	0.14		wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.005	U	wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	46.17		wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	0.06		wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	0.55		wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.007	U	wt%	0.007	0.007	MF	05/31/16	
P2O5	ASTM D6349	0.1	U	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	0.06	U	wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	0.3		wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.06		wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.046		wt%	0.006	0.006	MF	05/31/16	
TiO2	ASTM D6349	0.02	U	wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	48.89		wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		96.4							

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Dewatered FGD Gypsum - B**	**Sample Date & Time:**	**5/6/16 1025**
ALS Lab No.:	**T1600763-006**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	25.0		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	2.4		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	3.2		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.3		wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.4		wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	72.3		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	96.4		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	0.54		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.34	J	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.03	J	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	21.297		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)		7.8		wt%	0.1	0.1	AR	05/26/16	
Water, Combined (220C)		20.0		wt%	0.1	0.1	AR	05/26/16	
Gypsum Purity	calculated	95.8		wt%	calculated using combined water				

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF Dewatered FGD Gypsum - B**	**Sample Date & Time:**	**5/6/16 1025**
ALS Lab No.:	**T1600763-006**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349								
Al2O3	ASTM D6349	0.12		wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.005	U	wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	45.80		wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	0.06		wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	0.54		wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.007	U	wt%	0.007	0.007	MF	05/31/16	
P2O5	ASTM D6349	0.1	U	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	0.06	U	wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	0.1		wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.06	U	wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.045		wt%	0.006	0.006	MF	05/31/16	
TiO2	ASTM D6349	0.02	U	wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	52.84		wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		99.8							

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF FGD Gypsum Fines - A**	**Sample Date & Time:**	**5/6/16 1130**
ALS Lab No.:	**T1600763-007**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	35.9		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	3.7		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	5.8		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.1	U	wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.1		wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	60.3		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	94.1		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	1.53		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.33	J	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.07	J	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	16.985		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)		23.3		wt%	0.1	0.1	AR	05/26/16	
Water, Combined (220C)		17.1		wt%	0.1	0.1	AR	05/26/16	
Gypsum Purity	calculated	81.5		wt%	calculated using combined water				

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF FGD Gypsum Fines - A**	**Sample Date & Time:**	**5/6/16 1130**
ALS Lab No.:	**T1600763-007**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result	Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349							
Al_2O_3	ASTM D6349	1.89	wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.031	wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	42.18	wt%	0.01	0.01	MF	05/31/16	
Fe_2O_3	ASTM D6349	1.52	wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	2.03	wt%	0.08	0.08	MF	05/31/16	
Mn_3O_4	ASTM D6349	0.011	wt%	0.007	0.007	MF	05/31/16	
P_2O_5	ASTM D6349	0.2	wt%	0.1	0.1	MF	05/31/16	
K_2O	ASTM D6349	0.37	wt%	0.06	0.06	MF	05/31/16	
SiO_2	ASTM D6349	6.1	wt%	0.1	0.1	MF	05/31/16	
Na_2O	ASTM D6349	0.10	wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.045	wt%	0.006	0.006	MF	05/31/16	
TiO_2	ASTM D6349	0.10	wt%	0.02	0.02	MF	05/31/16	
SO_3	ASTM E1915	46.14	wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		100.7						

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF FGD Gypsum Fines - B**	**Sample Date & Time:**	**5/6/16 1130**
ALS Lab No.:	**T1600763-008**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	36.1		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	3.6		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	5.7		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.1	U	wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.1	U	wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	60.3		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	94.3		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	1.51		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.35	J	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.04	J	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	17.990		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)		23.5		wt%	0.1	0.1	AR	05/26/16	
Water, Combined (220C)		17.2		wt%	0.1	0.1	AR	05/26/16	
Gypsum Purity	calculated	82.0		wt%	calculated using combined water				

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF FGD Gypsum Fines - B**	**Sample Date & Time:**	**5/6/16 1130**
ALS Lab No.:	**T1600763-008**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result	Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349							
Al2O3	ASTM D6349	1.88	wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.030	wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	42.17	wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	1.48	wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	1.97	wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.010	wt%	0.006	0.006	MF	05/31/16	
P2O5	ASTM D6349	0.1	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	0.35	wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	5.8	wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.13	wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.045	wt%	0.005	0.005	MF	05/31/16	
TiO2	ASTM D6349	0.09	wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	45.68	wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		99.8						

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF FGD Gypsum Fines-FD - A**	**Sample Date & Time:**	**5/6/16 1130**
ALS Lab No.:	**T1600763-009**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	35.9		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	3.3		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	5.1		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.1	U	wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.1	U	wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	60.7		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	94.8		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	1.36		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.30	U	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.04	J	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	18.264		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)		22.8		wt%	0.1	0.1	AR	05/26/16	
Water, Combined (220C)		17.7		wt%	0.1	0.1	AR	05/26/16	
Gypsum Purity	calculated	84.4		wt%	calculated using combined water				

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF FGD Gypsum Fines-FD - A**	**Sample Date & Time:**	**5/6/16 1130**
ALS Lab No.:	**T1600763-009**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result	Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349							
Al2O3	ASTM D6349	1.64	wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.026	wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	42.44	wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	1.29	wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	1.71	wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.011	wt%	0.007	0.007	MF	05/31/16	
P2O5	ASTM D6349	0.3	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	0.33	wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	5.6	wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.14	wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.044	wt%	0.006	0.006	MF	05/31/16	
TiO2	ASTM D6349	0.08	wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	46.55	wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		100.1						

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF FGD Gypsum Fines-FD - B**	**Sample Date & Time:**	**5/6/16 1130**
ALS Lab No.:	**T1600763-010**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result		Units	MDL	MRL	Basis	Analysis Date	Q
Proximate Analyses	ASTM D7582								
Moisture, Total	ASTM D7582	35.6		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	3.5		wt%	0.1	0.1	AR	05/26/16	
Volatile Matter	ASTM D7582	5.4		wt%	0.1	0.1	MF	05/26/16	
Fixed Carbon	ASTM D7582	0.1	U	wt%	0.1	0.1	AR	05/26/16	
Fixed Carbon	ASTM D7582	0.1		wt%	0.1	0.1	MF	05/26/16	
Ash (750C)	ASTM D7582	60.9		wt%	0.1	0.1	AR	05/26/16	
Ash (750C)	ASTM D7582	94.5		wt%	0.1	0.1	MF	05/26/16	
Ultimate Analyses	ASTM D3176								
Carbon, Total	ASTM D5373	1.45		wt%	0.02	0.10	MF	05/25/16	
Hydrogen, Total	ASTM D5373	0.32	J	wt%	0.3	1.0	MF	05/25/16	
Nitrogen, Total	ASTM D5373	0.04	J	wt%	0.02	0.10	MF	05/25/16	
Sulfur, Total	ASTM D4239	18.249		wt%	0.005	0.02	MF	05/26/16	
Gypsum Purity Test	ASTM C471								
Water, Free (45C)		22.7		wt%	0.1	0.1	AR	05/26/16	
Water, Combined (220C)		17.3		wt%	0.1	0.1	AR	05/26/16	
Gypsum Purity	calculated	82.7		wt%	calculated using combined water				

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July 1, 2016

Client:	**AECOM/URS Corporation**	**ALS Project:**	**T1600763**
Project:	**TVA Material Characterization**	**Plant ID:**	**CUF**
Sample ID:	**CUF FGD Gypsum Fines-FD - B**	**Sample Date & Time:**	**5/6/16 1130**
ALS Lab No.:	**T1600763-010**	**Date Received:**	**5/10/16**
Matrix:	**Gypsum**		

Analyte Name	Analytical Method	Result	Units	MDL	MRL	Basis	Analysis Date	Q
Ash Mineral Analyses	ASTM D6349							
Al2O3	ASTM D6349	1.74	wt%	0.09	0.09	MF	05/31/16	
BaO	ASTM D6349	0.030	wt%	0.005	0.005	MF	05/31/16	
CaO	ASTM D6349	42.12	wt%	0.01	0.01	MF	05/31/16	
Fe2O3	ASTM D6349	1.42	wt%	0.01	0.01	MF	05/31/16	
MgO	ASTM D6349	1.87	wt%	0.08	0.08	MF	05/31/16	
Mn3O4	ASTM D6349	0.011	wt%	0.007	0.007	MF	05/31/16	
P2O5	ASTM D6349	0.1	wt%	0.1	0.1	MF	05/31/16	
K2O	ASTM D6349	0.37	wt%	0.06	0.06	MF	05/31/16	
SiO2	ASTM D6349	5.8	wt%	0.1	0.1	MF	05/31/16	
Na2O	ASTM D6349	0.10	wt%	0.06	0.06	MF	05/31/16	
SrO	ASTM D6349	0.044	wt%	0.006	0.006	MF	05/31/16	
TiO2	ASTM D6349	0.09	wt%	0.02	0.02	MF	05/31/16	
SO3	ASTM E1915	47.81	wt%	0.02	0.02	MF	05/27/16	
Summation of Oxides		101.6						

Summation of Oxides may not equal 100% due to analytical error and/or elements present in sample but not analyzed. Samples with high concentrations of Carbon (in the form of carbonates) and/or Sulfur can have significant impacts on the metal to oxide calculation and summation. Total Moisture for Gypsum samples based on drying at 220C.

ADDRESS 3860 S. Palo Verde Road, Suite 302, Tucson, AZ 85714
PHONE +1 520 573 1061
FAX +1 520 573 1063

Wednesday, June 29, 2016

Wendy Hyatt
ALS Environmental
3860 S. Palo Verde Rd.
Tucson, AZ 85714

Re: ALS Workorder: 1605472
Project Name: TVA Coal Combustion Product Samples
Project Number: T1600763

Dear Ms. Hyatt:

Ten ash samples were received from ALS Environmental, on 5/24/2016. The samples were scheduled for the following analyses:

Gamma Spectroscopy
Radium-226

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental
Jeff R. Kujawa
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Connecticut (CT)	PH-0232
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
L-A-B (DoD ELAP/ISO 170250)	L2257
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280

1605472

Gamma Spectroscopy:
The samples were analyzed for the presence of gamma emitting radionuclides according to the current revision of SOP 713.

Activity concentrations above the calculated MDC are reported in some instances where minimum nuclide identification criteria are not met. Such tentative identifications result when the software attempts to calculate net activity concentrations for analytes where either one or both of the following criteria are not satisfied: the 'diagnostic' peak for a nuclide must be identified above the critical level, or the minimum library peak abundance must be attained. Nuclides not meeting these requirements have been flagged with a "TI" qualifier.

All remaining acceptance criteria were met.

Radium-226:
The samples were analyzed for the presence of ^{226}Ra according to the current revision of SOP 724.

Laboratory control sample TR160531-1 has a chemical recovery of 65.9%, below the 75% lower control limit. The results are submitted without further qualification. This sample is flagged with an "L" flag on the final reports

All remaining acceptance criteria were met.

ALS Environmental -- FC

Sample Number(s) Cross-Reference Table

OrderNum: 1605472
Client Name: ALS Environmental
Client Project Name: TVA Coal Combustion Product Samples
Client Project Number: T1600763
Client PO Number: T1600763

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
CUF Bottom Ash - A	1605472-1		ASH	06-May-16	10:40
CUF Bottom Ash - B	1605472-2		ASH	06-May-16	10:40
CUF Dry Fly Ash - A	1605472-3		ASH	06-May-16	8:30
CUF Dry Fly Ash - B	1605472-4		ASH	06-May-16	8:30
CUF Dewatered FGD Gypsum -	1605472-5		ASH	06-May-16	10:25
CUF Dewatered FGD Gypsum -	1605472-6		ASH	06-May-16	10:25
CUF FGD Gypsum Fines - A	1605472-7		ASH	06-May-16	11:30
CUF FGD Gypsum Fines - B	1605472-8		ASH	06-May-16	11:30
CUF FGD Gypsum Fines-FD - A	1605472-9		ASH	06-May-16	11:30
CUF FGD Gypsum Fines-FD - B	1605472-10		ASH	06-May-16	11:30

ALS Environmental Chain of Custody

3860 S. Palo Verde Rd. • Tucson, AZ 85714 • 520-573-1061 • FAX 520-573-1063

ALS Contact: Ralph Poulsen

1605472

Project Number: T1600763
Project Manager: Ralph Poulsen
QAP: LAB QAP

Lab Code	Sample ID	# of Cont.	Matrix	Sample Date	Sample Time	Lab ID	Misc Out 1 None
T1600763-001	CUF Bottom Ash - A (1)	1	Ash	5/6/16	1040	Fort Collins ALS	X
T1600763-002	CUF Bottom Ash - B (2)		Ash	5/6/16	1040	Fort Collins ALS	X
T1600763-003	CUF Dry Fly Ash - A (3)		Ash	5/6/16	0830	Fort Collins ALS	X
T1600763-004	CUF Dry Fly Ash - B (4)		Ash	5/6/16	0830	Fort Collins ALS	X
T1600763-005	CUF Dewatered FGD Gupsum - A (5)		Ash	5/6/16	1025	Fort Collins ALS	X
T1600763-006	CUF Dewatered FGD Gupsum - B (6)		Ash	5/6/16	1025	Fort Collins ALS	X
T1600763-007	CUF FGD Gypsum Fines - A (7)		Ash	5/6/16	1130	Fort Collins ALS	X
T1600763-008	CUF FGD Gypsum Fines - B (8)		Ash	5/6/16	1130	Fort Collins ALS	X
T1600763-009	CUF FGD Gypsum Fines-FD - A (9)		Ash	5/6/16	1130	Fort Collins ALS	~~X (H)~~ X
T1600763-010	CUF FGD Gypsum Fines-FD - B (10)		Ash	5/6/16	1130	Fort Collins ALS	~~X (H)~~ X

Test Comments

Misc Out 1 - None T1600763-001,2,3,4,5,6,7,8,9,10 Radium 226 & 228

Special Instructions/Comments	Turnaround Requirements	Report Requirements	Invoice Information
H - Test is On Hold P - Test is Authorized for Prep Only	____ **RUSH** (Surcharges Apply) **PLEASE CIRCLE WORK DAYS** 1 2 3 4 5 X **STANDARD** Requested FAX Date: ____ Requested Report Date: ~~05/23/16~~	____ I. Results Only ____ II. Results + QC Summaries ____ III. Results + QC and Calibration Summaries ____ IV. Data Validation Report with Raw Data PQL/MDL/J N EDD Y	PO# 56T1600763 Bill to

Relinquished By: Andi Barton 5/20/16 Received By: [signature] 5-24-16 / 0950 Airbill Number:

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: AlS AZ   Workorder No: 1605472

Project Manager: JIZU   Initials: SOM   Date: 5-24-16

1. Does this project require any special handling in addition to standard ALS procedures?		YES	NO
2. Are custody seals on shipping containers intact?	NONE	YES	NO
3. Are Custody seals on sample containers intact?	NONE	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		YES	NO
5. Are the COC and bottle labels complete and legible?		YES	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		YES	NO
7. Were airbills / shipping documents present and/or removable?	DROP OFF	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	YES	NO
9. Are all aqueous non-preserved samples pH 4-9?	N/A	YES	NO
10. Is there sufficient sample for the requested analyses?		YES	NO
11. Were all samples placed in the proper containers for the requested analyses?		YES	NO
12. Are all samples within holding times for the requested analyses?		YES	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		YES	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: ____ < green pea ____ > green pea	N/A	YES	NO
15. Do any water samples contain sediment? Amount. Amount of sediment: ____ dusting ____ moderate ____heavy	N/A	YES	NO
16. Were the samples shipped on ice?		YES	NO
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	RAD ONLY	YES	NO

Cooler #:	1							
Temperature (°C):	Amb							
No. of custody seals on cooler:	0							
External µR/hr reading:	11							
Background µR/hr reading:	12							

DOT Survey/ Acceptance Information

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / NA (If no, see Form 008.)

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

If applicable, was the client contacted? **YES / NO / NA** Contact: ____ Date/Time: ____

Project Manager Signature / Date: 5-24-16

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

ORIGIN ID:PGAA (250) 573-1061
SAMPLE MANAGEMENT
3860 S PALO VERDE RD
302
TUCSON, AZ 85714
UNITED STATES US

SHIP DATE: 20MAY16
ACTWGT: 19.45 LB
CAD: 104583340/INET3730
DIMS: 16x11x13 IN
BILL SENDER

1605472

TO SAMPLE RECEIPT
ALS FORT COLLINS
225 COMMERCE DRIVE
FORT COLLINS CO 80524
(800) 443-1511 REF: T1301705
INV:
PO: DEPT:

540J1/6323/727F

11-0

FedEx Express

E

Am6

TUE - 24 MAY 4:30P
** 2DAY **

TRK# 0201 7831 7221 5109

ST FTCA 80524 CO-US DEN

After printing this label:
1. Use the 'Print' button on this page to print your label to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

Warning: Use only the printed original label for shipping. Using a photocopy of this label for shipping purposes is fraudulent and could result in additional billing charges, along with the cancellation of your FedEx account number.
Use of this system constitutes your agreement to the service conditions in the current FedEx Service Guide, available on fedex.com.FedEx will not be responsible for any claim in excess of $100 per package, whether the result of loss, damage, delay, non-delivery,misdelivery,or misinformation, unless you declare a higher value, pay an additional charge, document your actual loss and file a timely claim.Limitations found in the current FedEx Service Guide apply. Your right to recover from FedEx for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental,consequential, or special is limited to the greater of $100 or the authorized declared value. Recovery cannot exceed actual documented loss.Maximum for items of extraordinary value is $1,000, e.g. jewelry, precious metals, negotiable instruments and other items listed in our ServiceGuide. Written claims must be filed within strict time limits, see current FedEx Service Guide.

Client:	ALS Environmental	**Date:**	*29-Jun-16*
Project:	T1600763 TVA Coal Combustion Product Samples	**Work Order:**	1605472
Sample ID:	CUF Bottom Ash - A	**Lab ID:**	1605472-1
Legal Location:		**Matrix:**	ASH
Collection Date:	5/6/2016 10:40	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	**1.75 (+/- 0.6)**	G,TI	**0.96**	**pCi/g**	NA	6/10/2016 07:50
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	**11.1 (+/- 3.1)**		**0.5**	**pCi/g**	NA	6/21/2016 10:45
Carr: BARIUM	*83.3*		*40-110*	*%REC*	DL = NA	6/21/2016 10:45

Client:	ALS Environmental	**Date:**	*29-Jun-16*
Project:	T1600763 TVA Coal Combustion Product Samples	**Work Order:**	1605472
Sample ID:	CUF Bottom Ash - B	**Lab ID:**	1605472-2
Legal Location:		**Matrix:**	ASH
Collection Date:	5/6/2016 10:40	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	**1.23 (+/- 0.47)**	M3,G	**1.06**	**pCi/g**	NA	6/10/2016 09:06
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	**7.9 (+/- 2.3)**		**0.5**	**pCi/g**	NA	6/21/2016 14:07
Carr: BARIUM	*88.5*		*40-110*	*%REC*	DL = NA	6/21/2016 14:07

Client:	ALS Environmental	**Date:**	*29-Jun-16*
Project:	T1600763 TVA Coal Combustion Product Samples	**Work Order:**	1605472
Sample ID:	CUF Dry Fly Ash - A	**Lab ID:**	1605472-3
Legal Location:		**Matrix:**	ASH
Collection Date:	5/6/2016 08:30	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	**1.82 (+/- 0.49)**	G	**0.97**	**pCi/g**	NA	6/10/2016 09:06
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	**11.4 (+/- 3.2)**		**0.5**	**pCi/g**	NA	6/21/2016 14:07
Carr: BARIUM	*87.7*		*40-110*	*%REC*	DL = NA	6/21/2016 14:07

Client:	ALS Environmental	**Date:**	*29-Jun-16*
Project:	T1600763 TVA Coal Combustion Product Samples	**Work Order:**	1605472
Sample ID:	CUF Dry Fly Ash - B	**Lab ID:**	1605472-4
Legal Location:		**Matrix:**	ASH
Collection Date:	5/6/2016 08:30	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	**1 (+/- 0.51)**	G	**0.92**	**pCi/g**	NA	6/10/2016 09:06
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	**8.2 (+/- 2.3)**		**0.4**	**pCi/g**	NA	6/21/2016 14:07
Carr: BARIUM	*91.8*		*40-110*	*%REC*	DL = NA	6/21/2016 14:07

Client:	ALS Environmental	**Date:**	*29-Jun-16*
Project:	T1600763 TVA Coal Combustion Product Samples	**Work Order:**	1605472
Sample ID:	CUF Dewatered FGD Gypsum - A	**Lab ID:**	1605472-5
Legal Location:		**Matrix:**	ASH
Collection Date:	5/6/2016 10:25	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	ND (+/- 0.34)	U,G	0.63	pCi/g	NA	6/10/2016 09:06
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	ND (+/- 0.22)	U	0.52	pCi/g	NA	6/21/2016 14:07
Carr: BARIUM	*70.1*		*40-110*	*%REC*	DL = NA	6/21/2016 14:07

SAMPLE SUMMARY REPORT

Client: ALS Environmental
Date: *29-Jun-16*
Project: T1600763 TVA Coal Combustion Product Samples
Work Order: 1605472
Sample ID: CUF Dewatered FGD Gypsum - B
Lab ID: 1605472-6
Legal Location:
Matrix: ASH
Collection Date: 5/6/2016 10:25
Percent Moisture:

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	ND (+/- 0.57)	U,G	0.98	pCi/g	NA	6/10/2016 09:06
Radium-226 by GFPC		**PAI 724**			Prep Date: **6/14/2016**	PrepBy: **JKB**
Ra-226	ND (+/- 0.17)	U	0.38	pCi/g	NA	6/29/2016 08:07
Carr: BARIUM	*97.7*		*40-110*	*%REC*	DL = NA	6/29/2016 08:07

Client:	ALS Environmental	**Date:**	*29-Jun-16*
Project:	T1600763 TVA Coal Combustion Product Samples	**Work Order:**	1605472
Sample ID:	CUF FGD Gypsum Fines - A	**Lab ID:**	1605472-7
Legal Location:		**Matrix:**	ASH
Collection Date:	5/6/2016 11:30	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	ND (+/- 0.57)	U,G	0.99	pCi/g	NA	6/10/2016 09:06
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	**1.87 (+/- 0.75)**		**0.47**	**pCi/g**	NA	6/21/2016 14:07
Carr: BARIUM	*70.9*		*40-110*	*%REC*	DL = NA	6/21/2016 14:07

Client: ALS Environmental
Date: *29-Jun-16*
Project: T1600763 TVA Coal Combustion Product Samples
Work Order: 1605472
Sample ID: CUF FGD Gypsum Fines - B
Lab ID: 1605472-8
Legal Location:
Matrix: ASH
Collection Date: 5/6/2016 11:30
Percent Moisture:

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	ND (+/- 0.49)	U,G	0.76	pCi/g	NA	6/10/2016 09:07
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	**2.7 (+/- 1)**		**0.5**	**pCi/g**	NA	6/21/2016 14:07
Carr: BARIUM	*67.5*		*40-110*	*%REC*	DL = NA	6/21/2016 14:07

SAMPLE SUMMARY REPORT

Client: ALS Environmental
Date: *29-Jun-16*
Project: T1600763 TVA Coal Combustion Product Samples
Work Order: 1605472
Sample ID: CUF FGD Gypsum Fines-FD - A
Lab ID: 1605472-9
Legal Location:
Matrix: ASH
Collection Date: 5/6/2016 11:30
Percent Moisture:

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	ND (+/- 0.51)	U,G	0.95	pCi/g	NA	6/10/2016 09:07
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	**1.42 (+/- 0.65)**		**0.54**	**pCi/g**	NA	6/21/2016 14:07
Carr: BARIUM	*67.9*		*40-110*	*%REC*	DL = NA	6/21/2016 14:07

Client: ALS Environmental **Date:** *29-Jun-16*
Project: T1600763 TVA Coal Combustion Product Samples **Work Order:** 1605472
Sample ID: CUF FGD Gypsum Fines-FD - B **Lab ID:** 1605472-10
Legal Location: **Matrix:** ASH
Collection Date: 5/6/2016 11:30 **Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gamma Spectroscopy Results		**PAI 713**			Prep Date: **6/7/2016**	PrepBy: **MSH2**
Ra-228	ND (+/- 0.51)	U,G	0.97	pCi/g	NA	6/10/2016 10:22
Radium-226 by GFPC		**PAI 724**			Prep Date: **5/31/2016**	PrepBy: **JKB**
Ra-226	**1.75 (+/- 0.72)**		**0.5**	**pCi/g**	NA	6/21/2016 14:07
Carr: BARIUM	*78.3*		*40-110*	*%REC*	DL = NA	6/21/2016 14:07

Client:	ALS Environmental	**Date:**	*29-Jun-16*
Project:	T1600763 TVA Coal Combustion Product Samples	**Work Order:**	1605472
Sample ID:	CUF FGD Gypsum Fines-FD - B	**Lab ID:**	1605472-10
Legal Location:		**Matrix:**	ASH
Collection Date:	5/6/2016 11:30	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed

Explanation of Qualifiers

Radiochemistry:

U or ND - Result is less than the sample specific MDC.
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
Y2 - Chemical Yield outside default limits.
W - DER is greater than Warning Limit of 1.42
* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.
# - Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.
G - Sample density differs by more than 15% of LCS density.
D - DER is greater than Control Limit
M - Requested MDC not met.
LT - Result is less than requested MDC but greater than achieved MDC.
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
L - LCS Recovery below lower control limit.
H - LCS Recovery above upper control limit.
P - LCS, Matrix Spike Recovery within control limits.
N - Matrix Spike Recovery outside control limits
NC - Not Calculated for duplicate results less than 5 times MDC
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.

Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).
U or ND - Indicates that the compound was analyzed for but not detected.
E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.
M - Duplicate injection precision was not met.
N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.
Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.
* - Duplicate analysis (relative percent difference) not within control limits.
S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

Organics:

U or ND - Indicates that the compound was analyzed for but not detected.
B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.
E - Analyte concentration exceeds the upper level of the calibration range.
J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).
A - A tentatively identified compound is a suspected aldol-condensation product.
X - The analyte was diluted below an accurate quantitation level.
* - The spike recovery is equal to or outside the control criteria used.
+ - The relative percent difference (RPD) equals or exceeds the control criteria.
G - A pattern resembling gasoline was detected in this sample.
D - A pattern resembling diesel was detected in this sample.
M - A pattern resembling motor oil was detected in this sample.
C - A pattern resembling crude oil was detected in this sample.
4 - A pattern resembling JP-4 was detected in this sample.
5 - A pattern resembling JP-5 was detected in this sample.
H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.
L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.
Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
- gasoline
- JP-8
- diesel
- mineral spirits
- motor oil
- Stoddard solvent
- bunker C

APPENDIX C

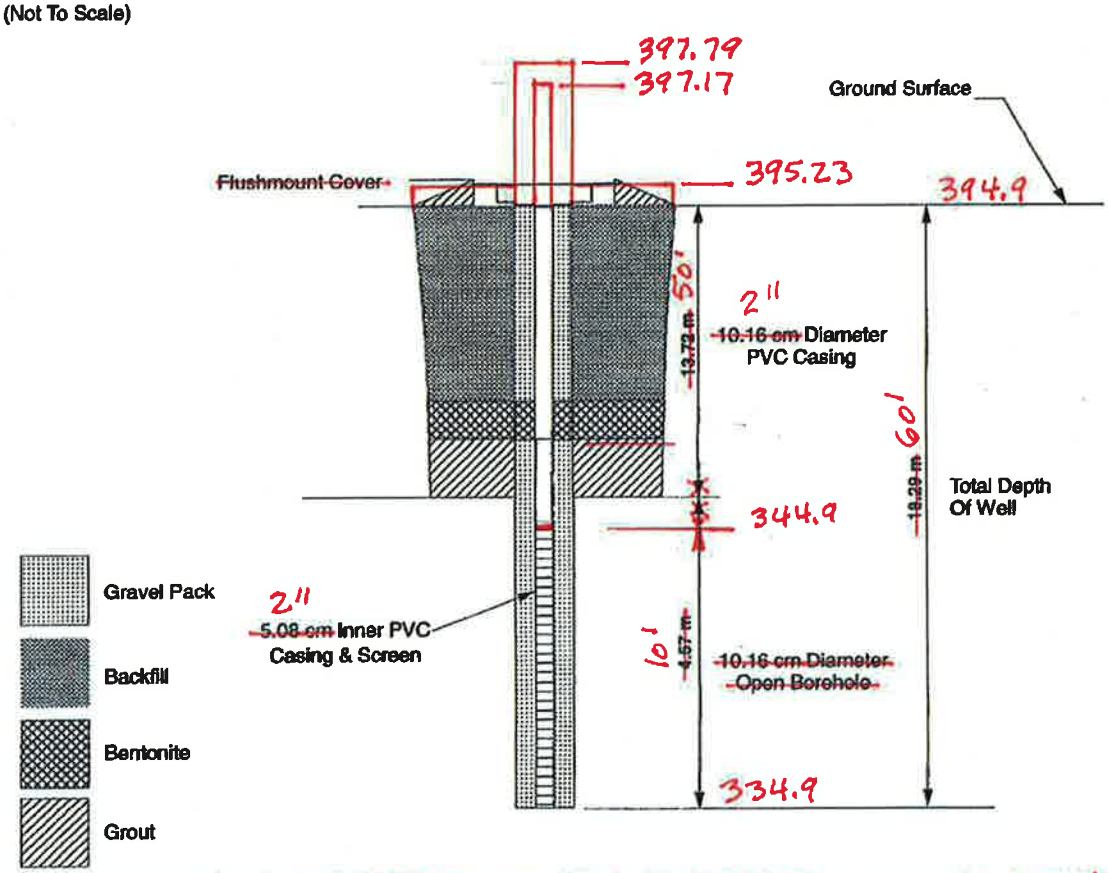
Boring Logs and Well Construction Diagrams

MONITORING WELL INSTALLATION RECORD

Project	Cumberland Fossil Plant		
Well Number	93-1	Installation Date	2/19/93
~~Plant~~ Coordinates	~~East~~ WEST 87° 39' 52.95"	North	36° 23' 10.14"
Ground Surface Elevation	~~120.44 m~~ 394.9'	Top Of Inner Casing	~~121.16 m~~ 397.17'
Backfill Material	Bentonite and Grout	Slot Size	~~Open Borehole/0.025 cm~~ 0.010"
Screen Material	Schedule 40 PVC	Riser Diameter	~~10.2 cm~~ 4" Outer/ ~~5.08 cm~~ 2" Inner
Drilling Technique In Soil	Auger	Drilling Technique in Rock	HQ
Outer Borehole Diameter	~~26.98 cm~~ 10 5/8"	Drilling Contractor	Law Engineering
Logger/Engineer	Scott McGilvray		

Remarks: SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 11/9/16)

(Not To Scale)



 REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

Boring Log

Project:	TVA's Cumberland Fossil Plant Cumberland City, Tennessee			BORING	93-2R 93-2R
Project No.:	1432-05-673	Elevation:	Unknown	Notes:	
Logged by:	R.L. Russell, R.G. (TN Reg. Geo. Lic. #4979)	Depth:	70'	Descriptions based on visual observation of obtained samples.	
Drillers:	S&ME, Inc. (Tim Hall - TN Driller #813)	Start:	September 26, 2005		
Equipment:	CME 55 with 4 1/4" and 6 5/8" augers	Complete:	September 29, 2005		

Depth (ft)	Elevation (ft)	Lithology	Boring	Run Length	Recovered	% Recovered	RQD	Lithologic Description
								Top of 8" vertical well box - ~~3~~ 2.9 feet above ground surface 398.21
1								Top of 2" dia. PVC casing - ~~2.5~~ 2.6 feet above ground surface 397.88
0	Unknown		395.36					Ground Surface 395.3
			TOP CONC					Clay - Fill material (0.0' - 38.0')
1								
2								Saturated Conditions at 2'
3								LOCATION: N36°22'58.67" W87°39'42.29" (NAD 83)
4								
5								
6								
7								
8								
9			2" dia. PVC casing					
10			Grout					
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/7/16)
26								
27								
28								
29								
30								

REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

S&ME

Boring Log

Project:	TVA's Cumberland Fossil Plant Cumberland City, Tennessee	BORING	93-2R

Project No.:	1432-05-673	Elevation:	Unknown	Notes:	
·ged by:	R.L. Russell, R.G. (TN Reg. Geo. Lic. #4979)	Depth:	70'	Descriptions based on visual	
ws:	S&ME, Inc. (Tim Hall - TN Driller #813)	Start:	September 26, 2005	observation of obtained samples.	
Equipment:	CME 55 with 4 1/4" and 6 5/8" augers	Complete:	September 29, 2005		

Depth (ft)	Elevation (ft)	Lithology	Boring	Run Length	Recovered	% Recovered	RQD	Lithologic Description
31								Clay - Fill material (0.0' - 38.0')
32								
33								
34								
35								
36								
37								
38								Boulders and gravel - Intermixed with redsidual clay, sand and river cobbles (alluvial material) (38.0' - 41.0')
39								
40								
41								Clay - Intermixed with sands and river cobbles (alluvial material) (41.0' - 73.0')
42								
43								
44								
45								
46								
47								
48			Grout					
49			2" dia. PVC casing					
50								
51								
52			Hydrated bentonite seal					
53								
54								
55								
56								
57			Sand filter					
58								
59								
60			335.6 2" dia. PVC screen with pre-pack sand filter					

S&ME

Boring Log

Project:	TVA's Cumberland Fossil Plant Cumberland City, Tennessee	BORING	93-2R
Project No.:	1432-05-673	Elevation: Unknown	Notes:
Logged by:	R.L. Russell, R.G. (TN Reg. Geo. Lic. #4979)	Depth: 70'	Descriptions based on visual observation of obtained samples.
Driller:	S&ME, Inc. (Tim - TN Driller #813)	Start: September 26, 2005	
Equipment:	CME 55 with 4 1/4" and 6 5/8" augers	Complete: September 29, 2005	

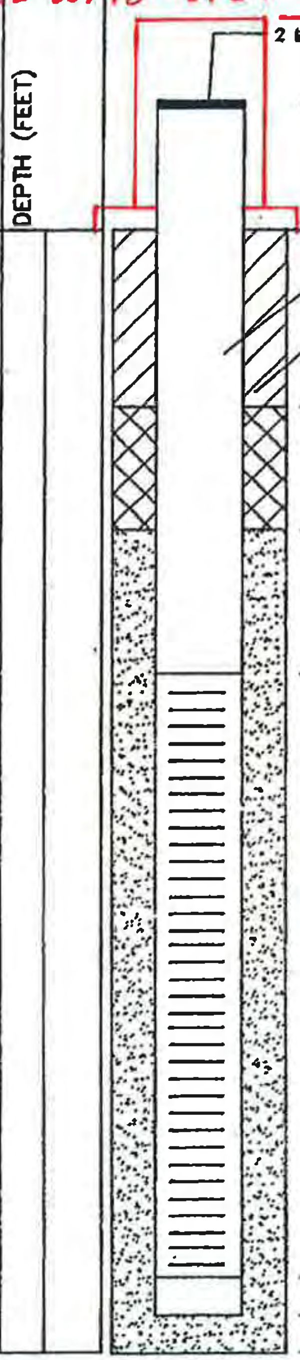
Depth (ft)	Elevation (ft)	Lithology	Boring	Run Length	Recovered	% Recovered	RQD	Lithologic Description
61								Clay - intermixed with sands and river cobbles (residual alluvial material) (41.0' - 73.0')
62								
63								2" dia. PVC screen with pre-pack sand filter
64								
65								Sand filter
66								
67								
68								
69								325.9 325.
70								Boring Terminated - bottom of boring at 70.0'
71								
72								
73								
74								
75								
76								
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								
87								
88								
89								
90								

S&ME

MONITOR WELL INSTALLATION REPORT
LOG OF BORING AND MONITOR WELL

LOCATION: N 36°22'50.93" W 87°39'11.76" (NAD83)

DEPTH (FEET)	STRATIGRAPHIC DESCRIPTION	OVA (PPM)
0.0		
35	Ash	
	Clay	
46.6	REFUSAL ENCOUNTERED	



TYPE II MONITOR WELL

	DEPTH (FEET)	ELEV. (FEET,MSL)
398.20 2 INCH ø WELL CAP		
TOP OF WELL	+2.30	397.50 ~~397.89~~
395.64 GROUND SURFACE	0.0	395.2 ~~395.59~~
2 INCH ø SOLID PVC RISER		
CONCRETE GROUT		
TOP OF BENTONITE SEAL	-39.0	356.59
TOP OF SILICA SAND FILTER PACK	-41.0	354.59
TOP OF 2 INCH ø 0.010 SLOT SCREEN	42.7 ~~-42.5~~	352.5 ~~353.09~~
BOTTOM OF SCREEN	52.7 ~~-52.5~~	342.5 ~~343.09~~
BOTTOM OF WELL	52.8 ~~-53.0~~	342.4 ~~342.59~~
BOTTOM OF BORING	-53.0	342.2 ~~342.59~~

SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 11/9/16)

MONITOR WELL NO. 93-3
START DATE: 2/18/93
COMPLETION DATE: 2/18/93
DRILLED BY: LAW NASHVILLE
DRILLING METHOD: HSA
LAW ENGINEERING PROFESSIONAL: C. K. LATHAM
NOTES: N728035.32, E1513325.09

CUMBERLAND STEAM PLANT
CUMBERLAND CITY, TENNESSEE
LAW ENGINEERING PROJECT NO. 417.93368.01

LAW ENGINEERING, INC.
NASHVILLE, TENNESSEE

REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
395.2 395.6	0.0	N 36° 22' 50.93" W 87° 39' 11.76" (NAD 83)							
395	0.1	GRAVEL							
		CLAY (CH), stiff to very stiff, reddish-brown to brown, with some chert (FILL)	1.0	8		11			SURFACE COVER: Gravel DRILLED BY: G. Powers DRILLING METHOD: HSA LOGGED BY: K. Latham
			5.0	18		14			N 728035.32 E 1513325.09
390									
			10.0	12		12			
385									
			15.0	18		13			
380									
			20.0	14		15			Water level on 2/19/93 Water level at TOB
375									
	23.0	ASH, black							
			25.0	18		18			
370									
			30.0	0		1			
365									

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

BORING NUMBER	93-3
DATE DRILLED	February 18, 1993
PROJECT NUMBER	417.93368.01
PROJECT	CUMBERLAND STEAM
PAGE 1 OF 2	

LAW ENGINEERING

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
360	35.2	CLAY (CH), soft, reddish-brown (FILL)	35.0	18		6			
	39.0	CLAY (CH), firm, grey (CALLUVIUM)							
355			40.0	18		9			
350			45.0	18		9			
345			50.0	18		8			
	53.0	342.2 AUGER REFUSAL AT 53 FEET; BORING TERMINATED	53.0	0		*			* 50/0,-,-
340									
335									
330									

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
- Standard Pen. Test
- Undisturbed Sample
- Water level, time of drilling
- Water level
- C Caved depth of boring
- Rock Core
- Loss of Water

TEST BORING RECORD

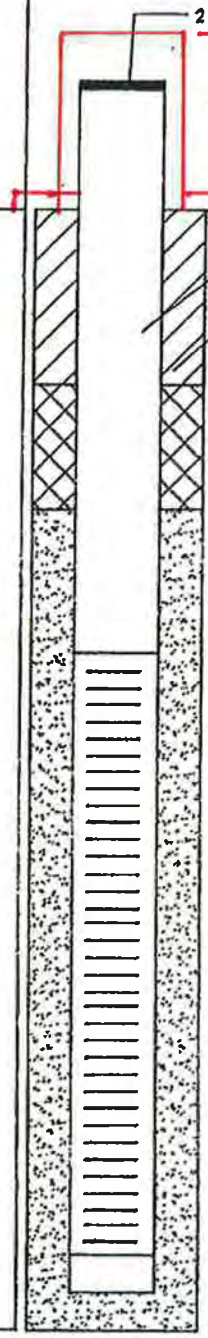
BORING NUMBER	93-3
DATE DRILLED	February 18, 1993
PROJECT NUMBER	417.93368.01
PROJECT	CUMBERLAND STEAM
PAGE 2 OF 2	

LAW ENGINEERING

MONITOR WELL INSTALLATION REPORT
LOG OF BORING AND MONITOR WELL

LOCATION: N 36° 23' 32.36" W87° 39' 36.63" (NAD83)

DEPTH (FEET)	STRATIGRAPHIC DESCRIPTION	OVA (PPM)	TYPE II MONITOR WELL	DEPTH (FEET)	ELEV. (FEET,MSL)
			2 INCH ø WELL CAP 397.52		
			TOP OF WELL	2.7 ~~+2.01~~	397.34 ~~396.64~~
0.0		DEPTH (FEET)	394.60 GROUND SURFACE	0.0	394.6 ~~394.63~~
			2 INCH ø SOLID PVC RISER		
			CONCRETE GROUT		
			TOP OF BENTONITE SEAL	-20.0	374.63
			TOP OF SILICA SAND FILTER PACK	-22.0	372.63
23	clay / ls.				
			TOP OF 2 INCH ø 0.010 SLOT SCREEN	24.5 ~~-24.0~~	370.1 ~~370.63~~
			SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 11/9/16)		
			BOTTOM OF SCREEN	33.9 ~~-34.0~~	360.7 ~~360.63~~
			BOTTOM OF WELL	33.9 ~~-34.5~~	~~360.13~~ 360.7
	REFUSAL ENCOUNTERED		BOTTOM OF BORING	-34.5	~~360.13~~ 360.1



MONITOR WELL NO. 93-4
START DATE: 2/17/93
COMPLETION DATE: 2/17/93
DRILLED BY: LAW NASHVILLE
DRILLING METHOD: HSA
LAW ENGINEERING PROFESSIONAL: C. K. LATHAM
NOTES: N732258.78, E1511362.87

CUMBERLAND STEAM PLANT
CUMBERLAND CITY, TENNESSEE
LAW ENGINEERING PROJECT NO. 417.93368.01

LAW ENGINEERING, INC.
NASHVILLE, TENNESSEE

REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

N36° 23' 32.36" W87° 39' 36.63" (NAD83)

ELEV.	STRATUM DEPTH	VISUAL SOIL DESCRIPTION	D	SR	K	N	CR	RQD	REMARKS
394.6	0.0								
	0.1	GRAVEL							SURFACE COVER: Gravel
		CLAY (CH), stiff to very stiff, reddish-brown, with chert (FILL)	1.0	12		10			DRILLED BY: G. Powers
									DRILLING METHOD: HSA
									LOGGED BY: K. Latham
390			4.5	8		5			N 732258.78 E 1511362.87
385			9.8	6		9			
380			14.5	12		24			
	17.0	AUGER REFUSAL AT 17.0 FEET; MOVE BORING 5 FEET AND AUGER TO 18.5 FEET							Water level at TOB
375		LIMESTONE, weathered	19.5	3		*			Water level on 2/19/93 * 50/3",-,-
	23.5	AUGER REFUSAL AT 23.3 FEET; CHANGE TO WASH DRILL	23.5	0		*			* 50/0,-,-
370									
365									
	31.0								
	31.4	VOID, clay filled							
	34.5	ROLLER CONE TERMINATION; BORING TERMINATED							
360									

D - Sample depth (Ft.)
SR - Sample recovery (In.)
K - Soil Symbols
N - Penetration (Blows/Ft.)
CR - Core Recovery (percent)
RQD - Rock Quality Designation

D	SR	K	N	CR	RQD
5	18		10		
10	15		23		
				100	80

SYMBOLS:
Standard Pen. Test
Undisturbed Sample
Water level, time of drilling
Water level
C Caved depth of boring
Rock Core
Loss of Water

TEST BORING RECORD

BORING NUMBER	93-4
DATE DRILLED	February 17, 1993
PROJECT NUMBER	417.93368.01
PROJECT	CUMBERLAND STEAM
PAGE 1 OF 1	

LAW ENGINEERING

AECOM

Boring Log

BORING #: CUF-101

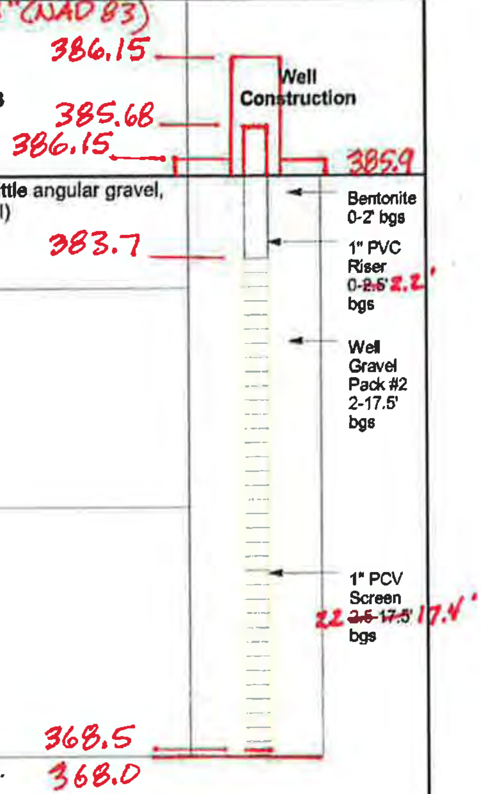
Client: Tennessee Valley Authority		**Logged By:** Phillip Van Winkle
Location: 815 Cumberland City Rd, Cumberland City, TN 37050		**Drilling Company:** Delta Well & Pump
Project #: 60436800	**Ground Elevation (msl):** ~~386.25~~ 385.9	**Well Screen Interval (ft):** 2.5-17.5'
Start Date: 11/23/2015	**Drilling Method:** CME 55 HSA / Air Hammer	**Water Level (ft btoc):** 12/28/15: 0.8'
Finish Date: 11/24/2015	~~**Northing:** 731680.705 **Easting:** 1513783.33~~	**Total Depth (ft):** 17.5

N 36°23'27.11" W87°39'06.98" (NAD 83)

Depth (ft bgs)	Recovery Length (Inches)	PID (ppm)	USCS Code	Graphic	Soil and Rock Description Classification Scheme: USCS
0–3.4			FILL		Brown, SILTY CLAY with Cobbles, some Sand, little angular gravel, moist, petroleum odor. Bolder at 3.4' (fill material)
3.4–10.0			CH		Brown, fat CLAY, wet
10.0–17.5			CH		Dark brown fat CLAY, wet

End of boring at ~~17.5~~ 17.9 ft. bgs.

Well Construction



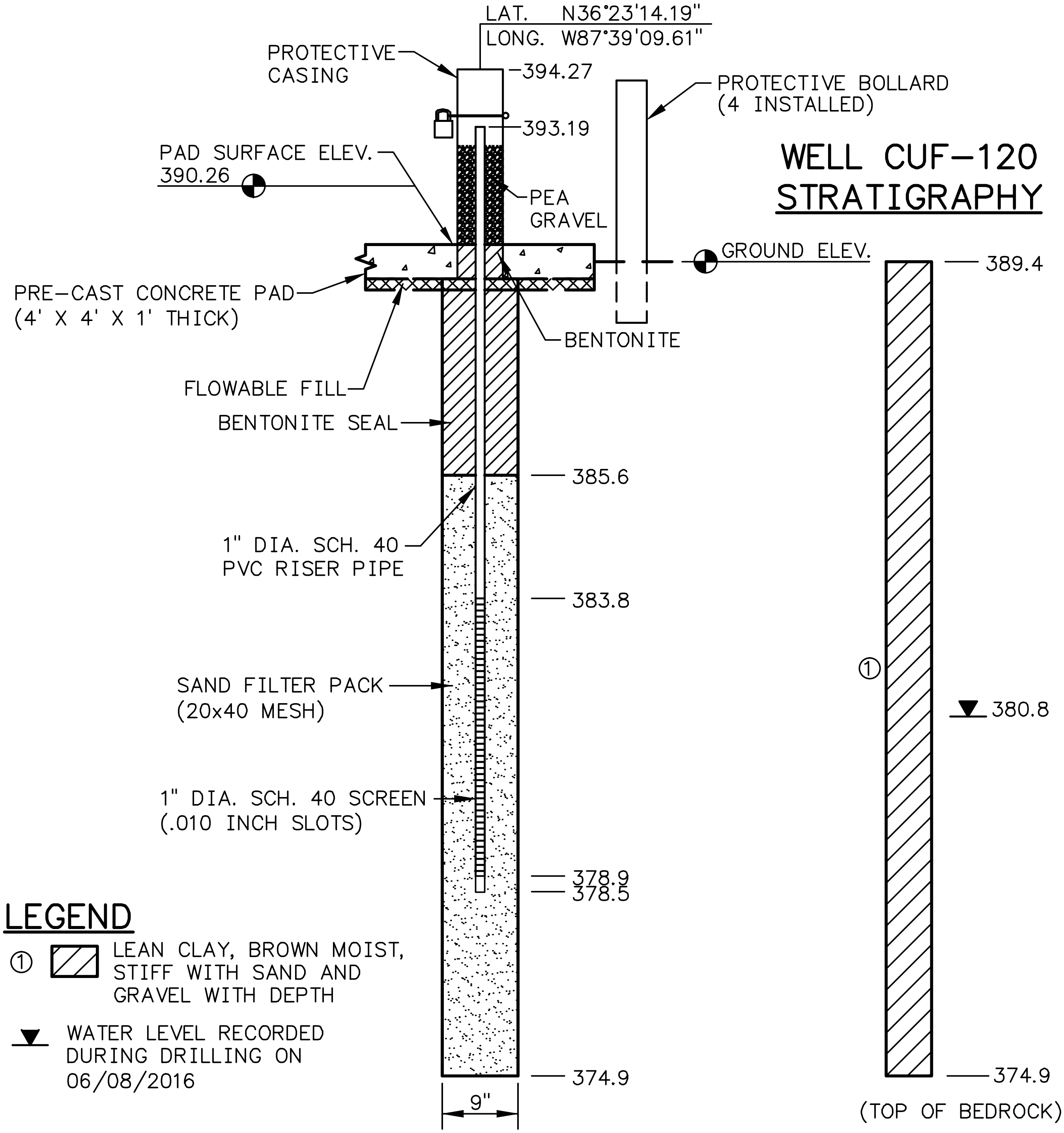
SCREEN INTERVAL AND CASING DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/16)

REVIEWED: JGB CHECKED: MSJ REVD: 1/28/17

Remarks: Boring Terminated (ft): 17.5

1" Piezometer installed

AECOM
500 Enterprise Drive Suite 1A
Rocky Hill, CT 06067



LEGEND

① LEAN CLAY, BROWN MOIST, STIFF WITH SAND AND GRAVEL WITH DEPTH

▼ WATER LEVEL RECORDED DURING DRILLING ON 06/08/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 06/08/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/2016).

PLOT DATE: 01/30/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_120.DWG

CUF-120 OBSERVATION WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

Stantec

Stantec Consulting Services Inc.
3052 Beaumont Centre Circle
Lexington, Kentucky
40513
859-422-3000
www.stantec.com

DRAWN BY	RWE	DATE JAN., 2017	REVISED			SHEET
CHECKED BY	DRP	PROJ. NO. 175565299	1.	3.		1 of 1
CHECKED BY	BLB	SCALE NTS	2.	4.		

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'14.19", W87°39'09.61" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-120** Total Depth 14.5 ft
County	Stewart, TN	Surface Elevation	389.4 ft (NGVD29)
Project Type	Piezometer Installation	Date Started	6/8/16 Completed 6/8/16
Supervisor	D. Pleiman Driller T. Caudill	Depth to Water	8.6 ft Date/Time 6/8/16
Logged By	B. Rosen	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
389.4	0.0	Top of Hole							
		Lean Clay, brown, moist, stiff, with sand and gravels with the depth (Drilled without sampling)							1" diameter piezometer installed Becomes wet @ 8.6'
374.9	14.5								
		Auger Refusal / Bottom of Hole							

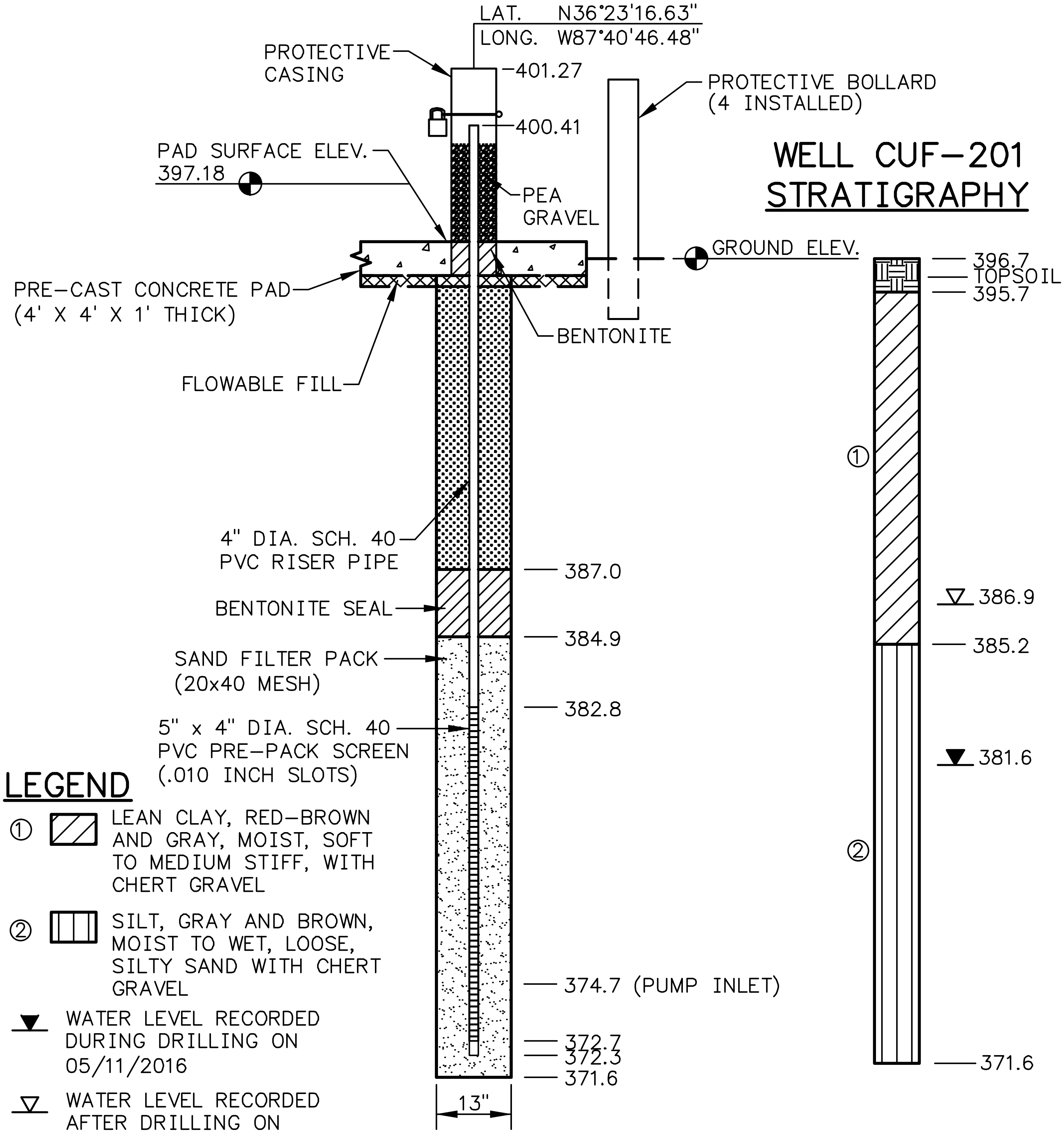
STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/3/17

Stantec

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'14.14", W87°39'09.66" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-120A** Total Depth 29.0 ft
County	Stewart, TN	Surface Elevation	388.0 ft (NGVD29)
Project Type	Piezometer Installation	Date Started	6/6/16 Completed 6/6/16
Supervisor	D. Pleiman Driller T. Taylor	Depth to Water	8.1 ft Date/Time 6/7/16
Logged By	B. Rosen	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
388.0	0.0	Top of Hole							
382.0	6.0	Lean Clay, brown, moist, stiff			0.0 - 10.0	10.0		--	6" Sonic to 29.0' Backfilled with bentonite grout; no water encountered within bedrock Becomes wet @ 8.1'
376.0	12.0	Lean Clay, brown, moist, stiff, with sand and gravel							
359.0	29.0	Limestone			10.0 - 20.0	10.0		--	
					20.0 - 29.0	9.0		--	
		No Refusal / Bottom of Hole							



LEGEND

① LEAN CLAY, RED-BROWN AND GRAY, MOIST, SOFT TO MEDIUM STIFF, WITH CHERT GRAVEL

② SILT, GRAY AND BROWN, MOIST TO WET, LOOSE, SILTY SAND WITH CHERT GRAVEL

▼ WATER LEVEL RECORDED DURING DRILLING ON 05/11/2016

▽ WATER LEVEL RECORDED AFTER DRILLING ON 05/11/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 05/11/2016 BTY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/2016).

PLOT DATE: 02/03/2017 USER: JENNINGS, MATTHEW
U:\1755\TVA GW MONITORING WELLS - CADD\CUF\175565299 - INSTALL\FROM_LEX\CUF_201.DWG

CUF-201 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

Stantec

Stantec Consulting Services Inc.
3052 Beaumont Centre Circle
Lexington, Kentucky
40513
859-422-3000
www.stantec.com

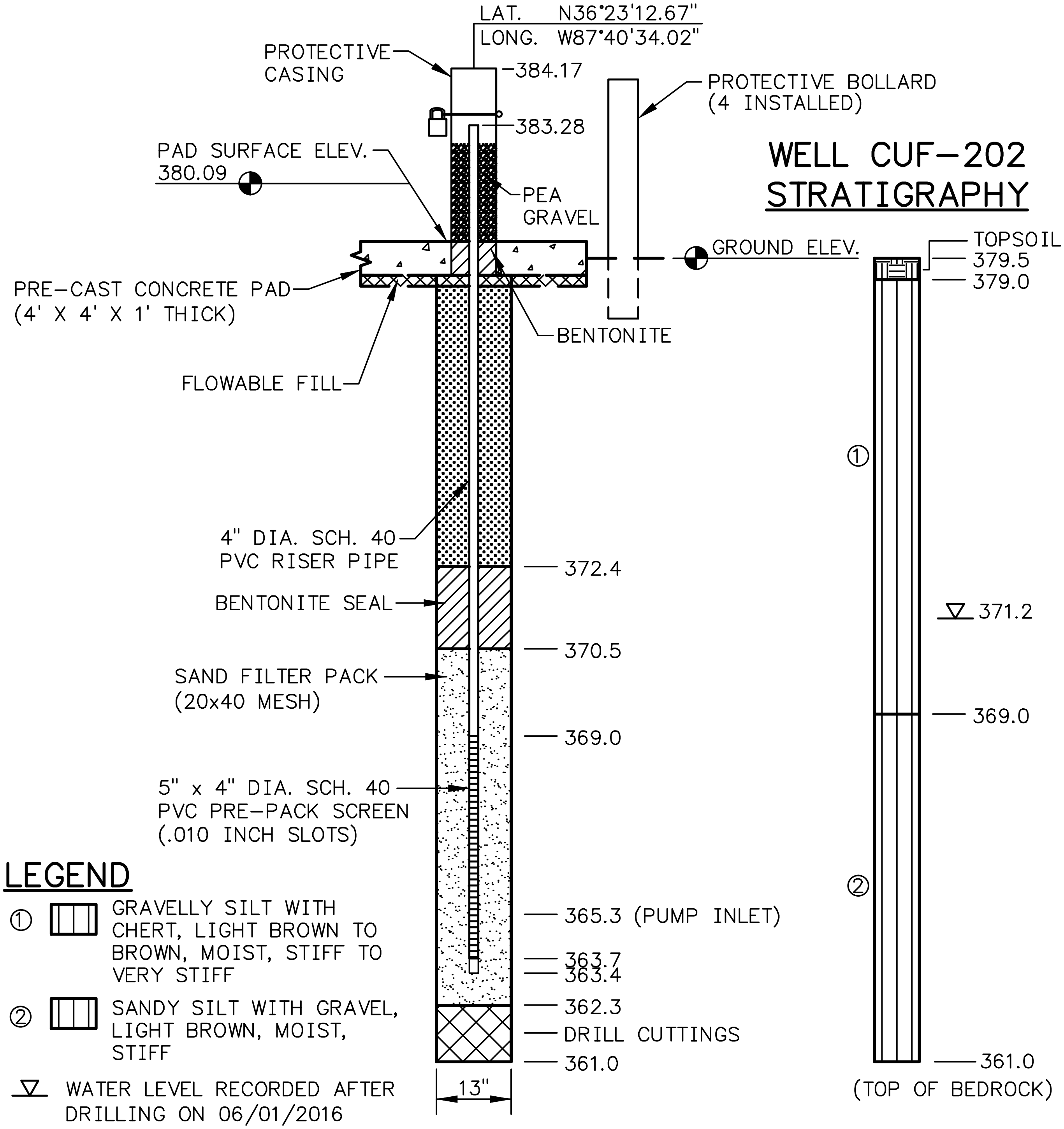
DRAWN BY	RWE	DATE	JAN., 2017	REVISED		SHEET
CHECKED BY	DRP	PROJ. NO.	175565299	1.	3.	1 of 1
CHECKED BY	BLB	SCALE	NTS	2.	4.	

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'16.63", W87°40'46.48" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-201** Total Depth 25.1 ft
County	Stewart, TN	Surface Elevation	396.7 ft (NGVD29)
Project Type	Well Installations	Date Started	5/11/16 Completed 5/11/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	15.1 ft Date/Time 5/11/16
Logged By	J. Andrew	Depth to Water	9.8 ft Date/Time 5/11/16

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
396.7	0.0	Top of Hole							
395.7	1.0	Topsoil							4" diameter well installed
		Lean Clay, reddish brown and gray, moist, soft to medium stiff, with chert gravel		SPT-1	2.5 - 4.0	0.4	3-3-5	--	
				SPT-2	5.0 - 6.5	1.0	2-3-4	--	
				SPT-3	7.5 - 9.0	1.0	3-5-8	--	
385.2	11.5			SPT-4	10.0 - 11.5	0.3	3-5-9	--	
		Silt, gray and brown, moist to wet, loose, silty sand with chert gravel		SPT-5	12.5 - 14.0	1.5	1-2-2	--	
				SPT-6	15.0 - 16.5	1.5	2-2-3	--	Water @ 15.1' during drilling
				SPT-7	17.5 - 19.0	1.5	2-5-5	--	
				SPT-8	20.0 - 21.5	1.0	13-10-16	--	
				SPT-9	22.5 - 24.0	0.6	3-5-8	--	
371.6	25.1								
		No Refusal / Bottom of Hole							

WELL CUF-202 STRATIGRAPHY



LEGEND

① GRAVELLY SILT WITH CHERT, LIGHT BROWN TO BROWN, MOIST, STIFF TO VERY STIFF

② SANDY SILT WITH GRAVEL, LIGHT BROWN, MOIST, STIFF

▽ WATER LEVEL RECORDED AFTER DRILLING ON 06/01/2016

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON SPT SAMPLES OBTAINED DURING THE DRILLING PROCESS.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 06/01/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 10/10/2016).

CUF-202 MONITORING WELL INSTALLATION DETAIL
TVA CUMBERLAND FOSSIL PLANT
CUMBERLAND CITY, STEWART COUNTY, TN

Stantec

Stantec Consulting Services Inc.
3052 Beaumont Centre Circle
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DRAWN BY	RWE	DATE JAN., 2017	REVISED			SHEET
CHECKED BY	DRP	PROJ. NO. 175565299	1.		3.	1 of 1
CHECKED BY	BLB	SCALE NTS	2.		4.	

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'12.67", W87°40'34.02" (NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-202** Total Depth 18.5 ft
County	Stewart, TN	Surface Elevation	379.5 ft (NGVD29)
Project Type	Well Installations	Date Started	6/1/16 Completed 6/1/16
Supervisor	D. Pleiman Driller D. Jessie	Depth to Water	8.3 ft Date/Time 6/1/16
Logged By	J. Matthews	Depth to Water	5.9 ft Date/Time 7/22/16

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
379.5	0.0	Top of Hole							
379.0	0.5	Topsoil		SPT-1	0.0 - 1.5	1.4	3-1-1	--	4" diameter well installed
		Gravelly Silt with chert, light brown to brown, moist, stiff to very stiff		SPT-2	2.5 - 4.0	0.8	WOH-1-13	--	
				SPT-3	5.0 - 6.5	1.5	10-9-12	--	
				SPT-4	7.5 - 9.0	1.4	13-9-17	--	Water @ 8.3' during drilling
369.0	10.5								
		Sandy Silt with Gravel, light brown, moist, stiff		SPT-5	10.0 - 11.5	1.5	9-10-10	--	
				SPT-6	12.5 - 14.0	1.0	7-13-10	--	
		Less gravel below 16.0'		SPT-7	15.0 - 16.5	1.4	6-6-4	--	
361.0	18.5			SPT-8	17.5 - 18.5	0.7	50+/.5	--	
		Auger Refusal / Bottom of Hole							

SUBSURFACE LOG

Project Number	175565299	Location	N36°23'07.61", W87°40'31.81"(NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-202A** Total Depth 9.0 ft
County	Stewart, TN	Surface Elevation	412.3 ft (NGVD29)
Project Type	Well Installations	Date Started	5/12/16 Completed 5/12/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	Dry Date/Time 5/12/16
Logged By	J. Andrew	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
412.3	0.0	Top of Hole							
403.3	9.0	Lean Clay, brown and red-brown with dark brown mottling, moist, soft to medium stiff, with chert gravel							Backfilled with Bentonite. Shallow bedrock encountered at 9'

Auger Refusal / Bottom of Hole

Top of Rock = 9.0 Elevation (403.3)

STANTEC/FMSM_LEGACY CUF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 2/9/17

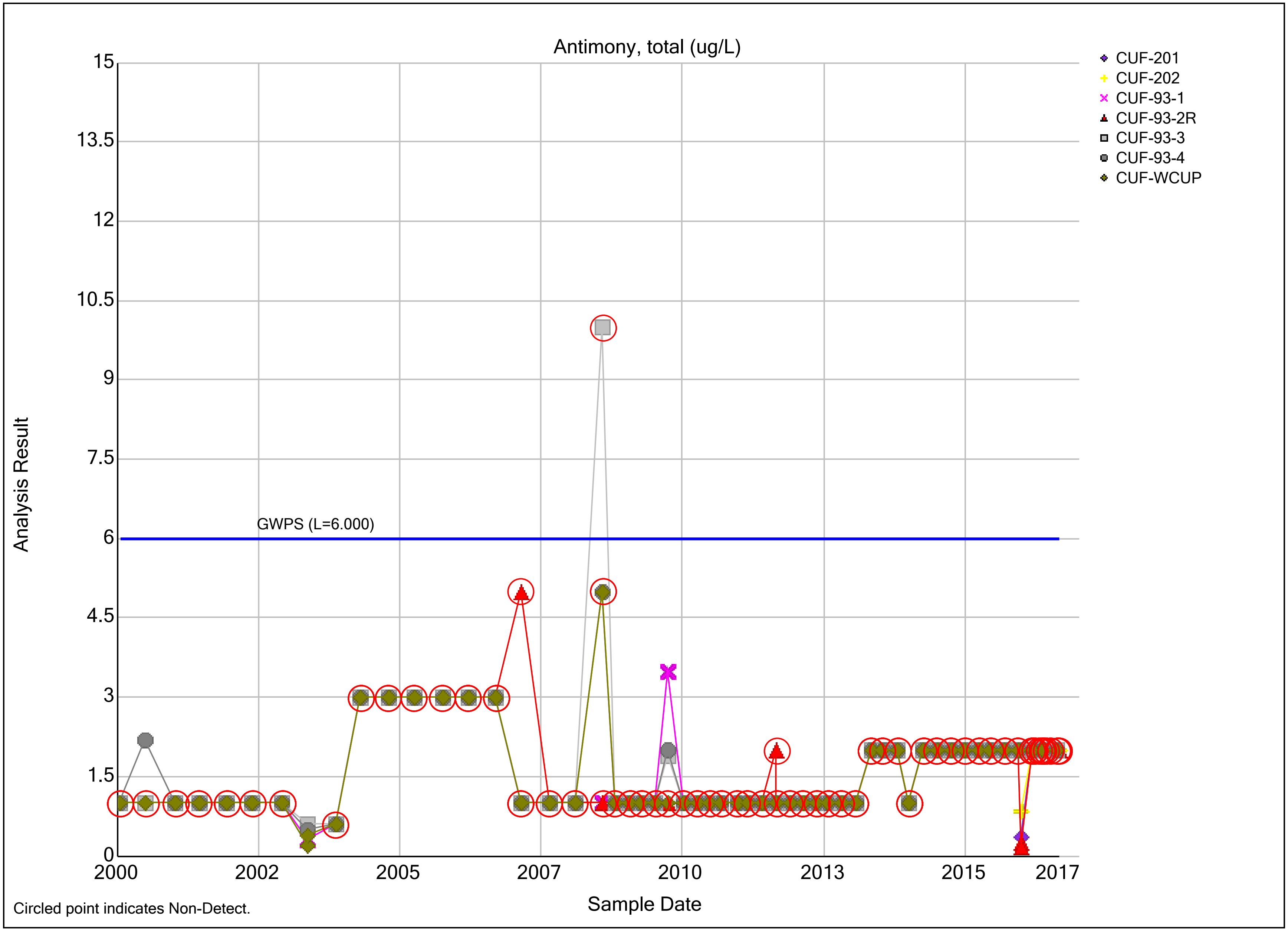
SUBSURFACE LOG

Project Number	175565299	Location	N36°23'12.24", W87°40'32.35"(NAD83)
Project Name	TVA - CUF Well Installations	Boring No.	**CUF-202B** Total Depth 31.0 ft
County	Stewart, TN	Surface Elevation	390.7 ft (NGVD29)
Project Type	Well Installations	Date Started	5/31/16 Completed 5/31/16
Supervisor	D. Pleiman Driller G. Thompson	Depth to Water	28.5 ft Date/Time 5/31/16
Logged By	J. Andrew	Depth to Water	26.8 ft Date/Time 5/31/16

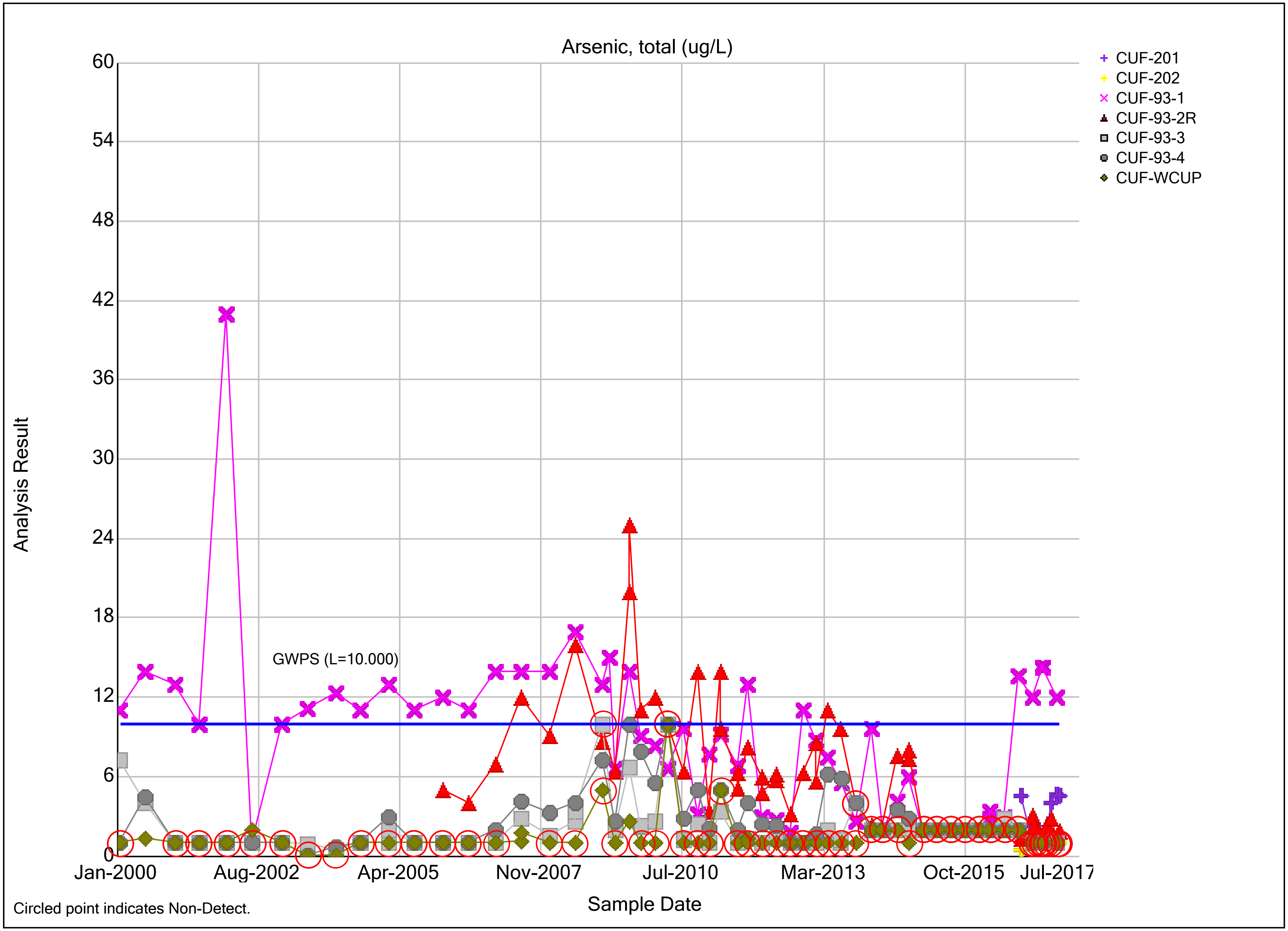
Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
390.7	0.0	Top of Hole						
390.5	0.2	Topsoil						Dry hole: backfilled with bentonite grout on 6/2/16
		Lean Clay, brown and red-brown with dark brown mottling, moist, soft to medium stiff, with chert gravel	SPT-1	2.5 - 4.0	0.8	8-11-14	--	Large chert gravel in SPT-1
			SPT-2	5.0 - 6.5	1.1	7-6-8	--	
			SPT-3	7.5 - 9.0	1.5	4-6-10	--	
			SPT-4	10.0 - 11.5	1.3	8-12-13	--	Large chert gravel in SPT-4
			SPT-5	12.5 - 14.0	0.9	10-18-13	--	
			SPT-6	15.0 - 16.5	1.5	8-7-8	--	
			SPT-7	17.5 - 19.0	0.8	2-5-6	--	
			SPT-8	20.0 - 21.5	1.3	3-7-8	--	
			SPT-9	22.5 - 24.0	1.3	4-11-8	--	
			SPT-10	25.0 - 26.5	1.3	3-5-6	--	
362.2	28.5		SPT-11	27.5 - 29.0	1.5	3-3-6	--	Water @ 28.5' during drilling
359.7	31.0	Sand and Gravel, brown, wet, loose, silty zones	SPT-12	30.0 - 30.6	0.2	WOH-50+/0.1	--	
		Auger Refusal / Bottom of Hole						

APPENDIX D

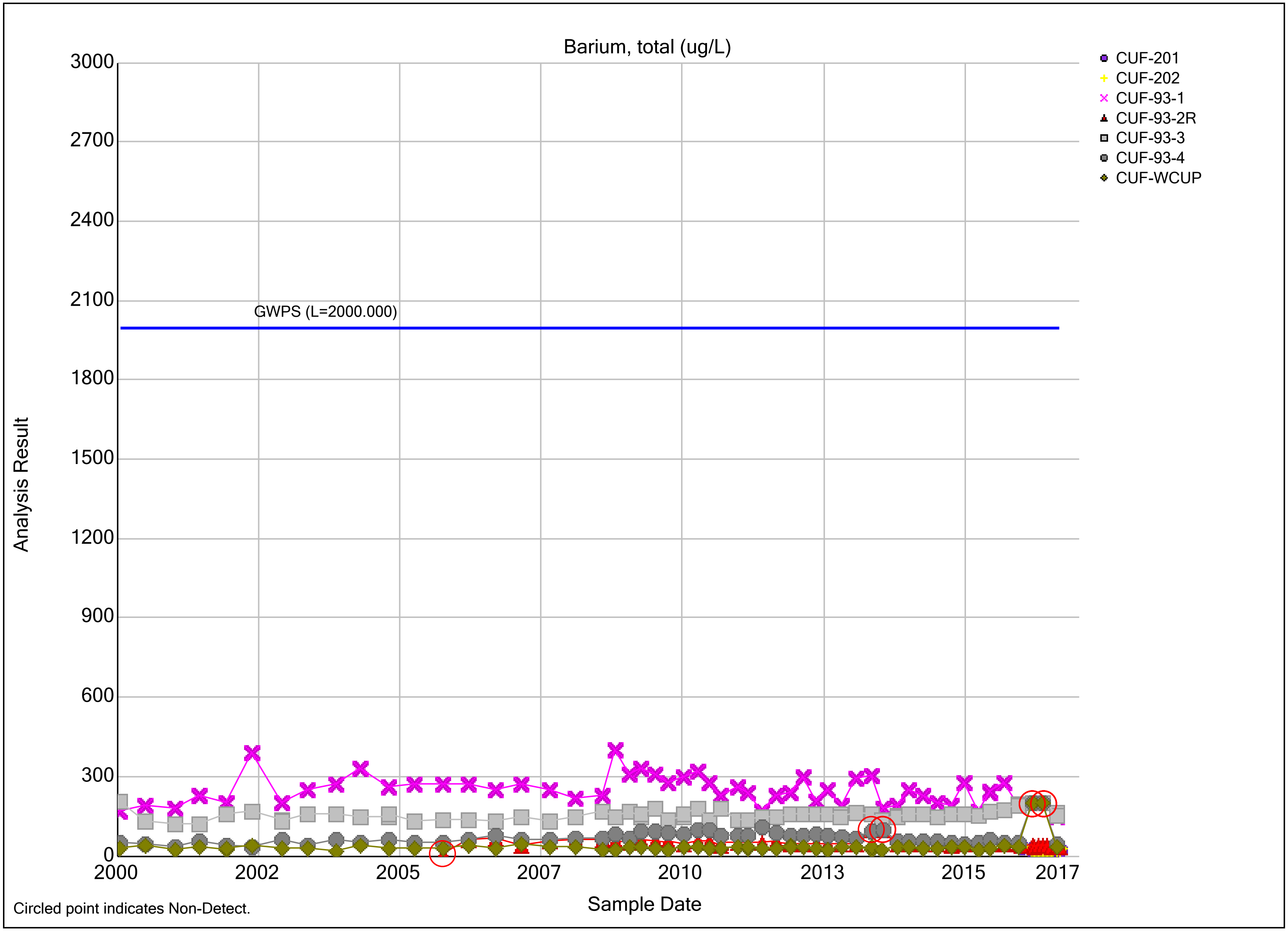
Time-Series Graphs of Sample Constituent Data



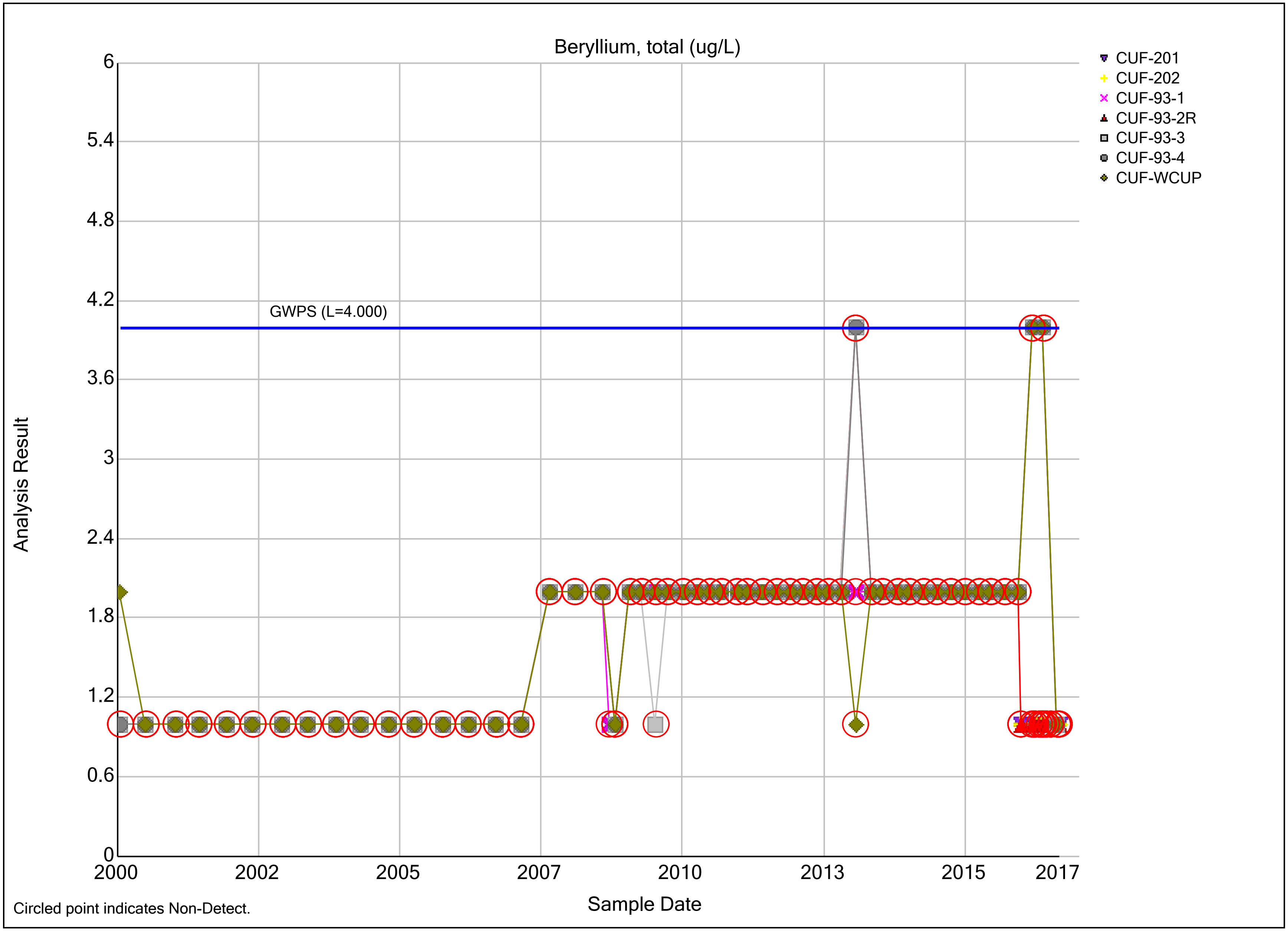
Antimony, total (ug/L)
Analysis Result
Sample Date
GWPS (L=6.000)
15
13.5
12
10.5
9
7.5
6
4.5
3
1.5
0
2000
2002
2005
2007
2010
2013
2015
2017
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Circled point indicates Non-Detect.

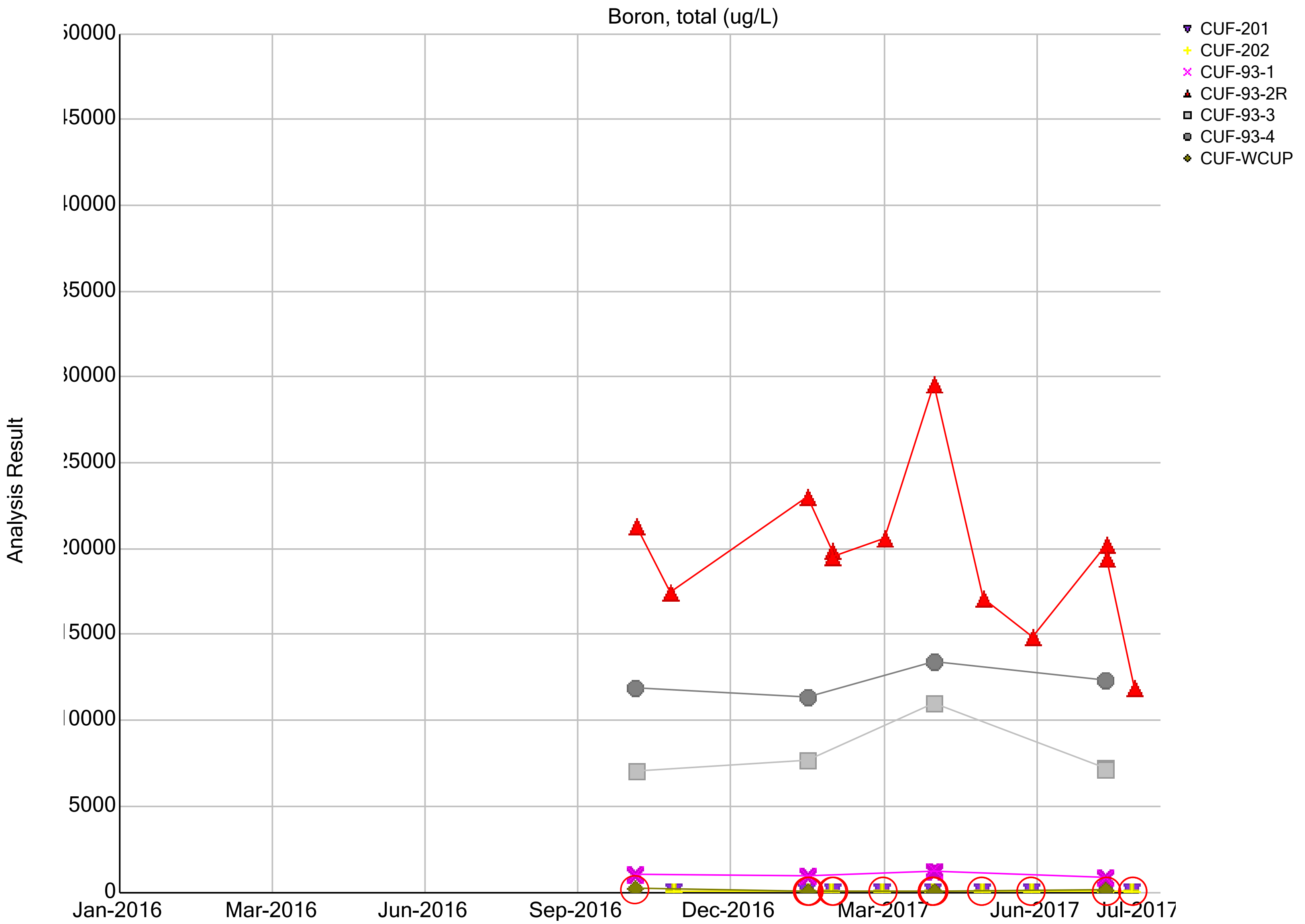


Arsenic, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=10.000)
Analysis Result
60
54
48
42
36
30
24
18
12
6
0
Jan-2000
Aug-2002
Apr-2005
Nov-2007
Jul-2010
Mar-2013
Oct-2015
Jul-2017
Sample Date
Circled point indicates Non-Detect.

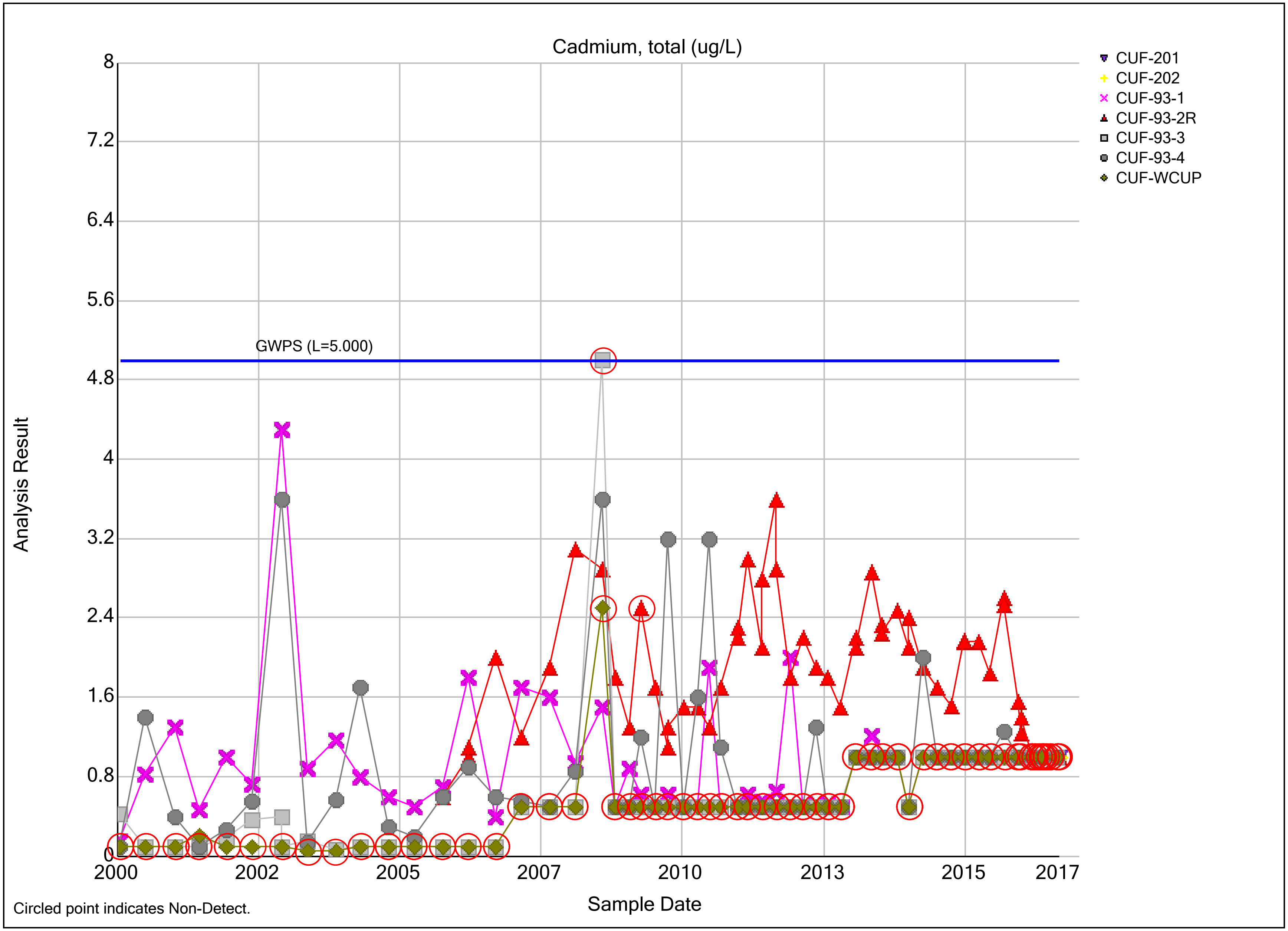


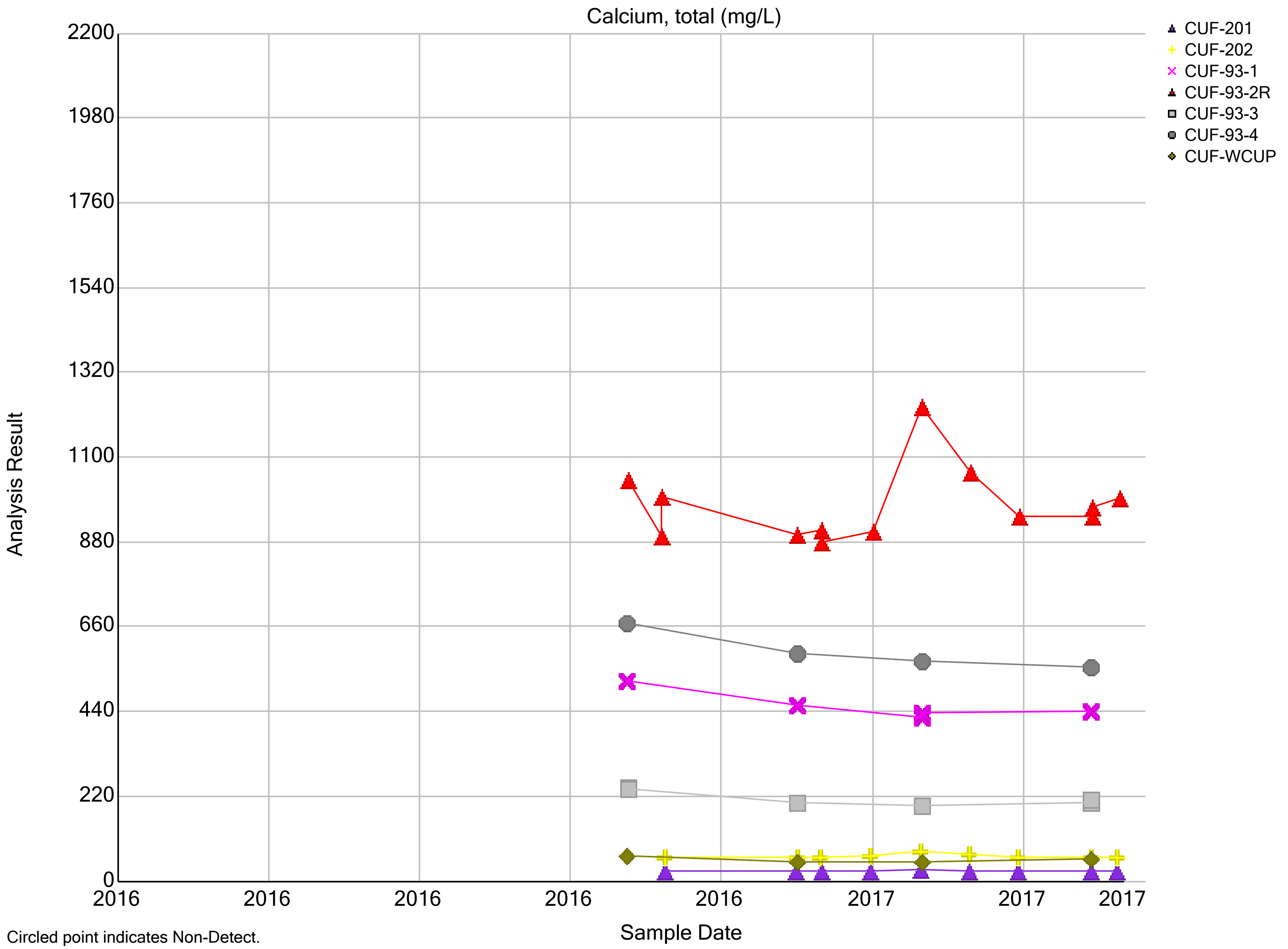
Barium, total (ug/L)
Analysis Result
3000
2700
2400
2100
1800
1500
1200
900
600
300
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
GWPS (L=2000.000)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Circled point indicates Non-Detect.


Beryllium, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=4.000)
Analysis Result
6
5.4
4.8
4.2
3.6
3
2.4
1.8
1.2
0.6
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.

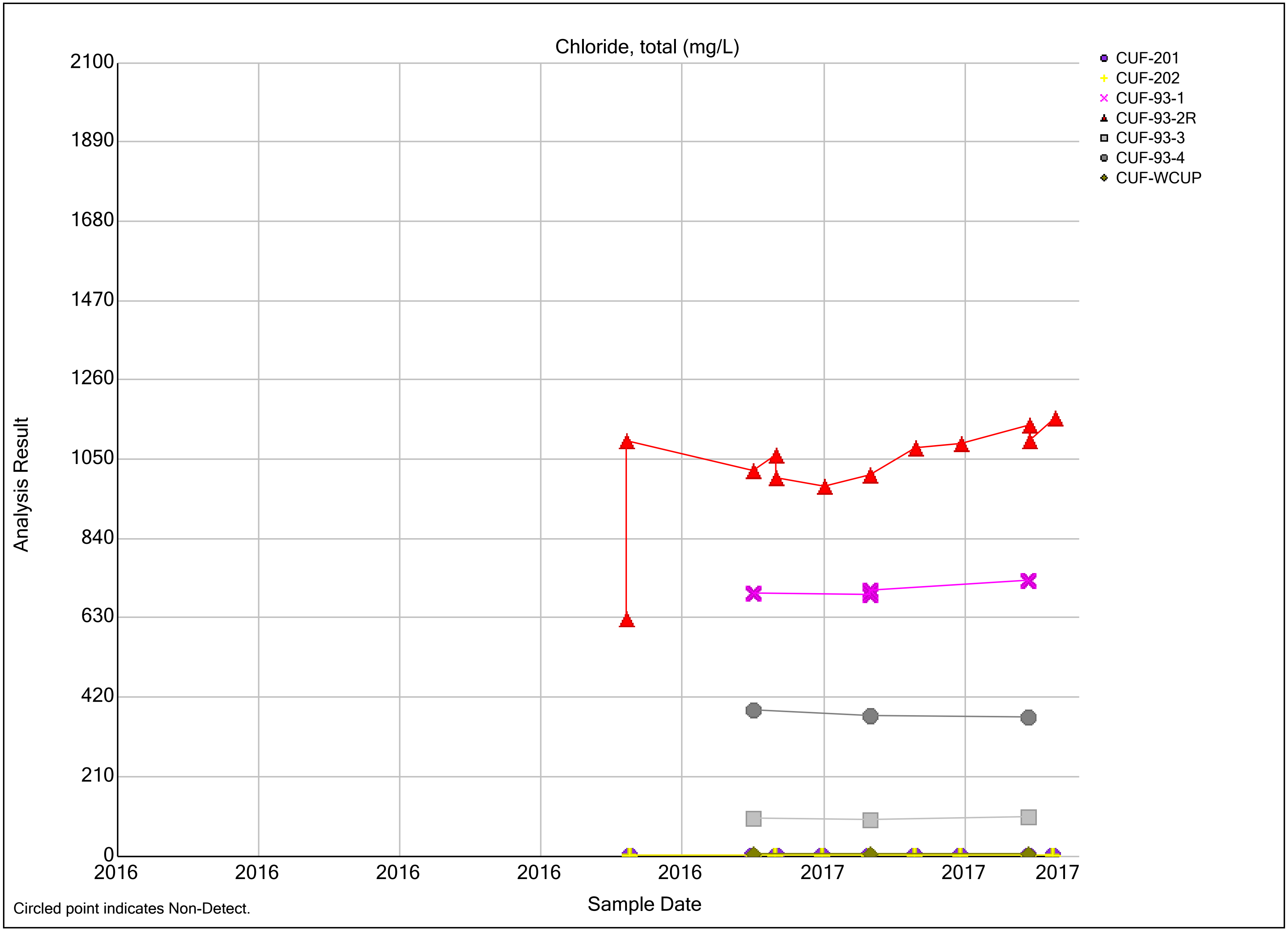


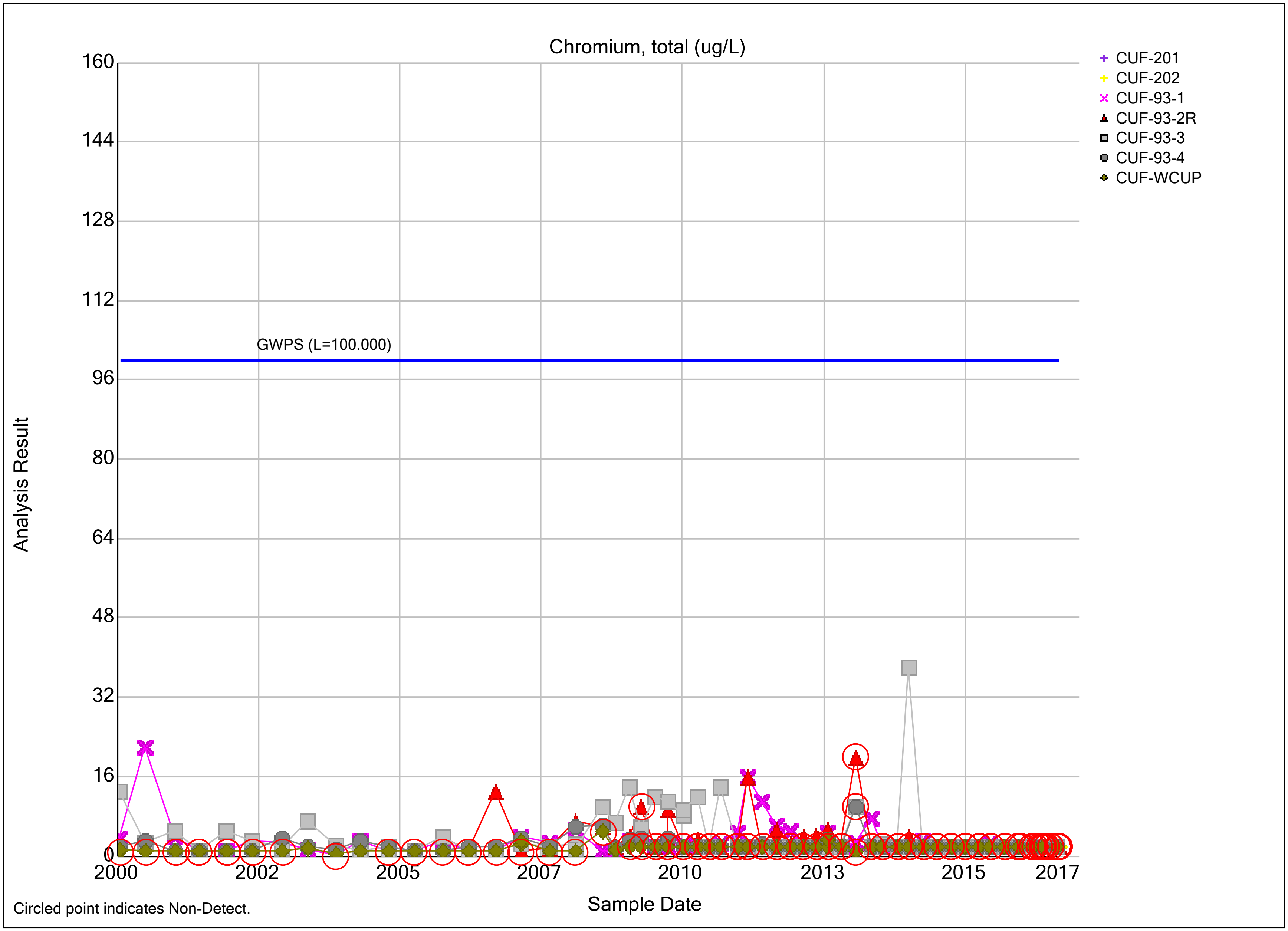
Circled point indicates Non-Detect.

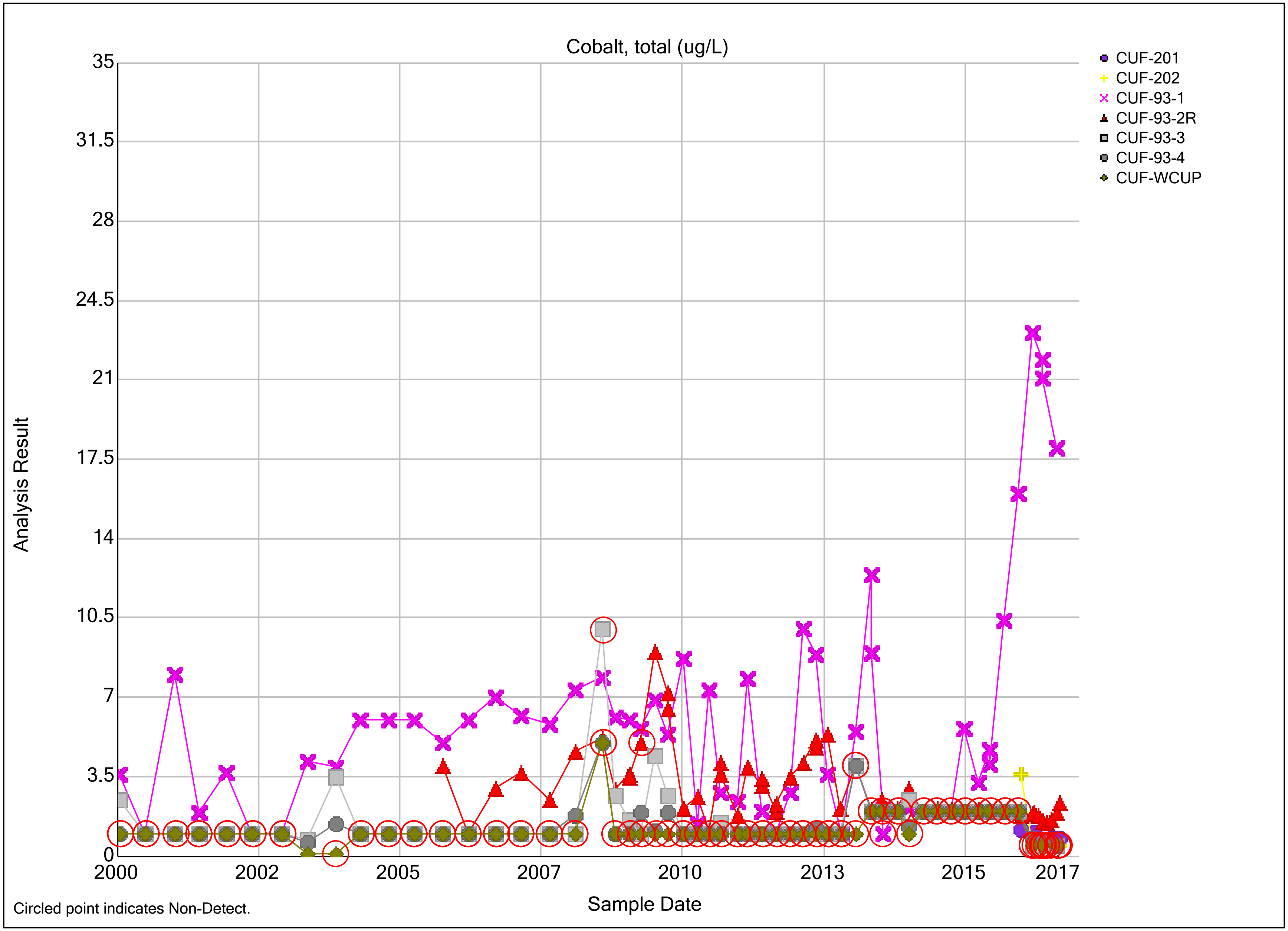

Cadmium, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=5.000)
Analysis Result
8
7.2
6.4
5.6
4.8
4
3.2
2.4
1.6
0.8
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.

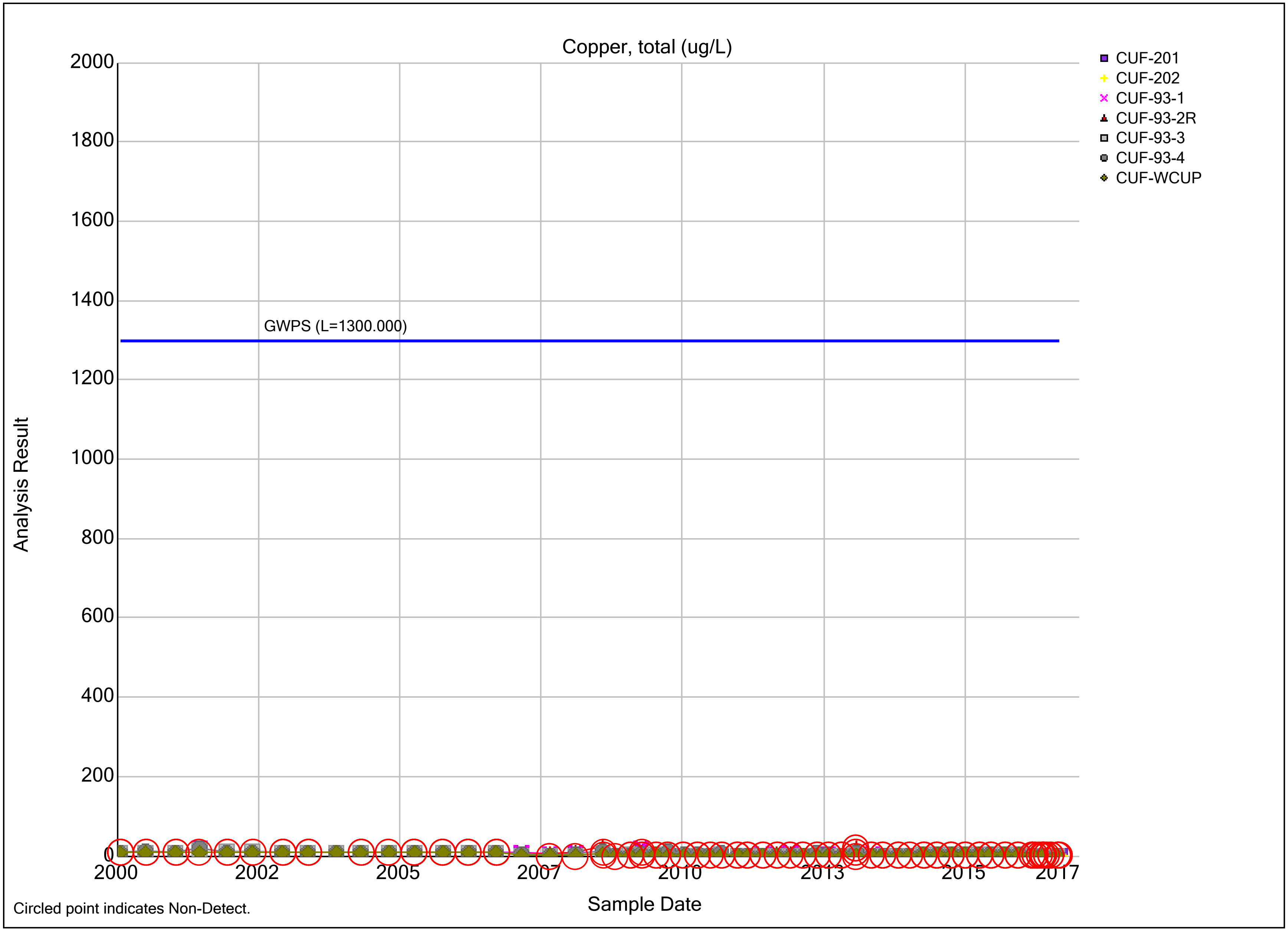


Circled point indicates Non-Detect.

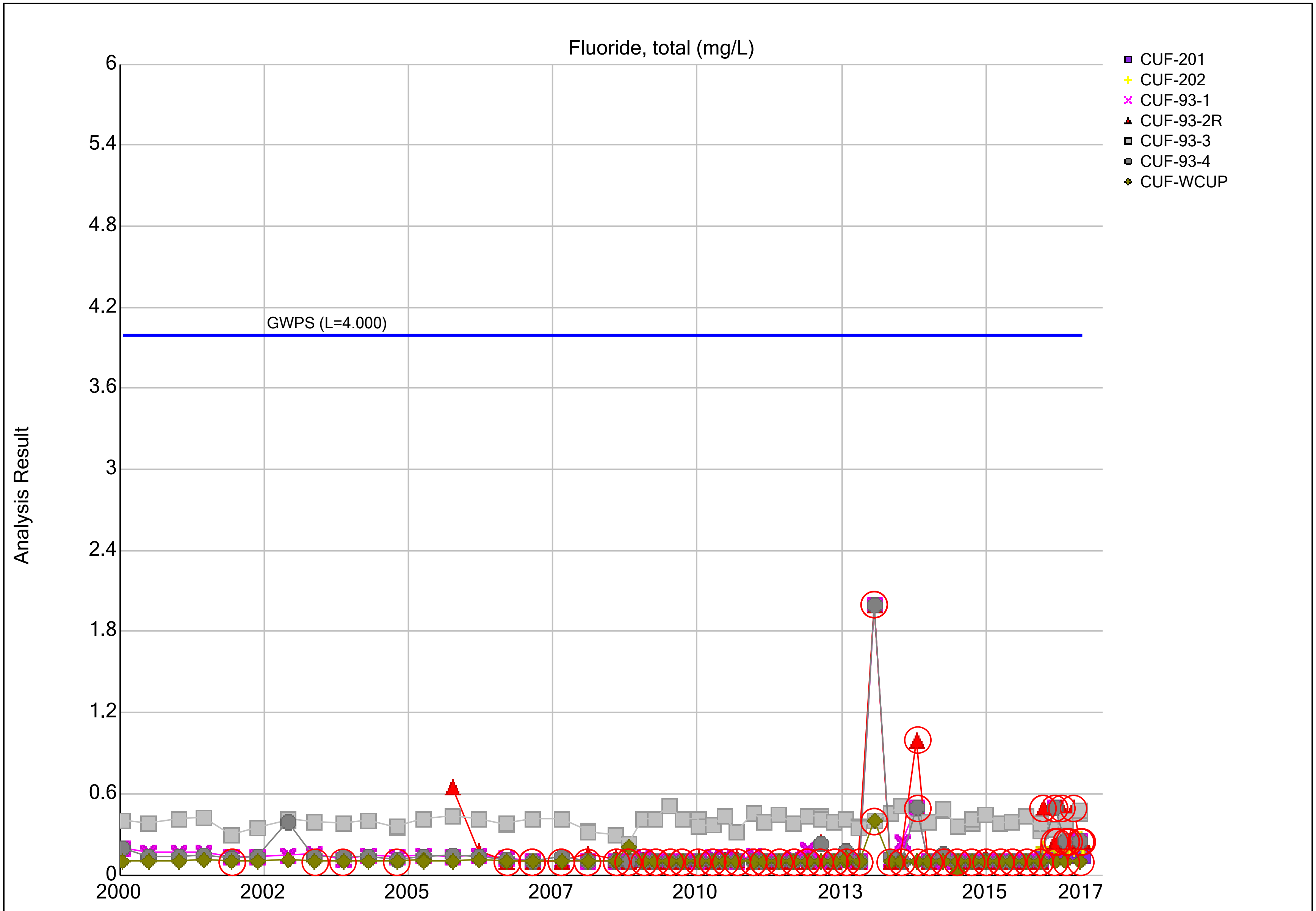

Chloride, total (mg/L)
Analysis Result
2100
1890
1680
1470
1260
1050
840
630
420
210
0
2016
2016
2016
2016
2016
2017
2017
2017
Sample Date
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Circled point indicates Non-Detect.


Chromium, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=100.000)
Analysis Result
160
144
128
112
96
80
64
48
32
16
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.

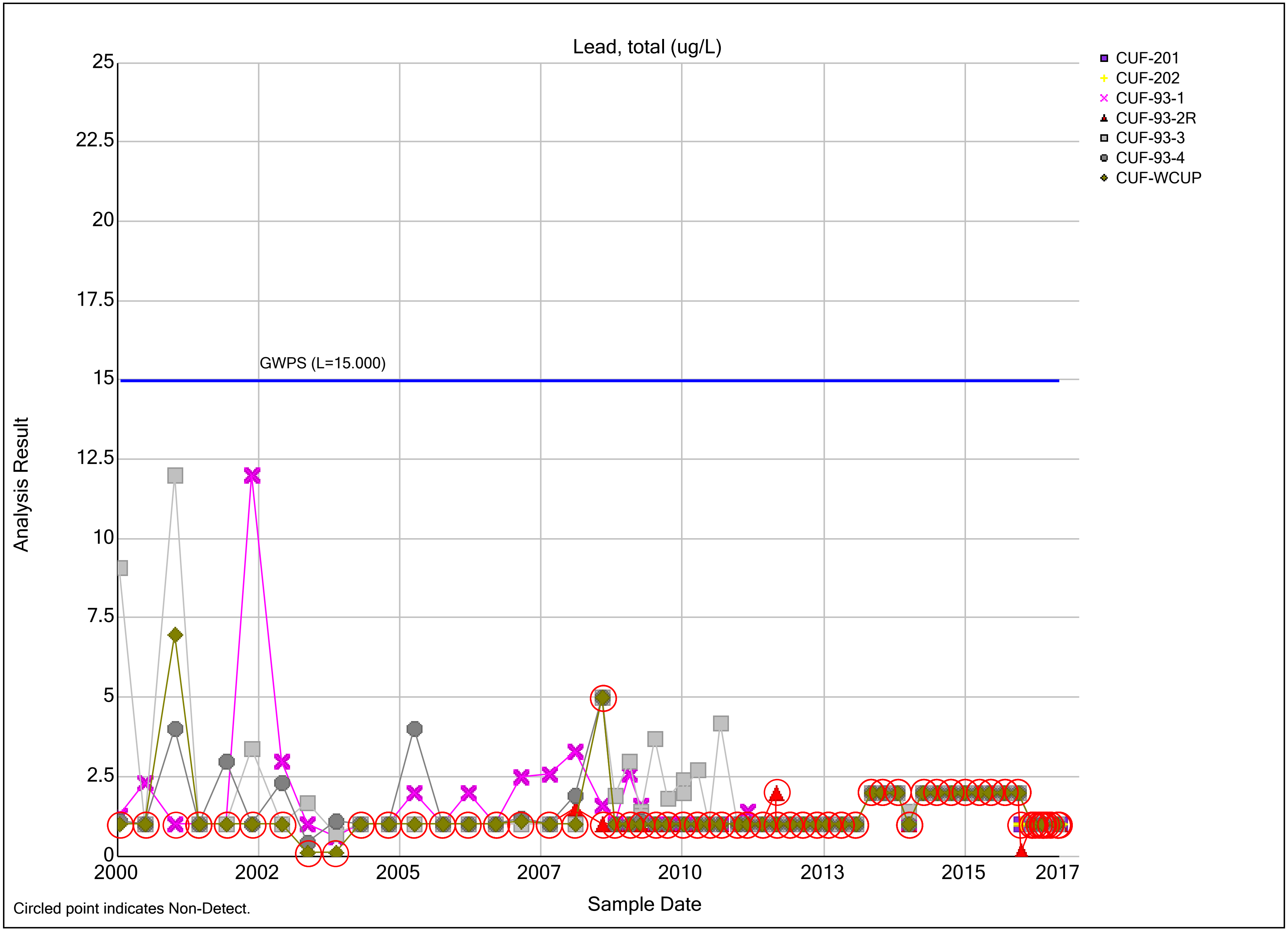

Cobalt, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Analysis Result
35
31.5
28
24.5
21
17.5
14
10.5
7
3.5
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.



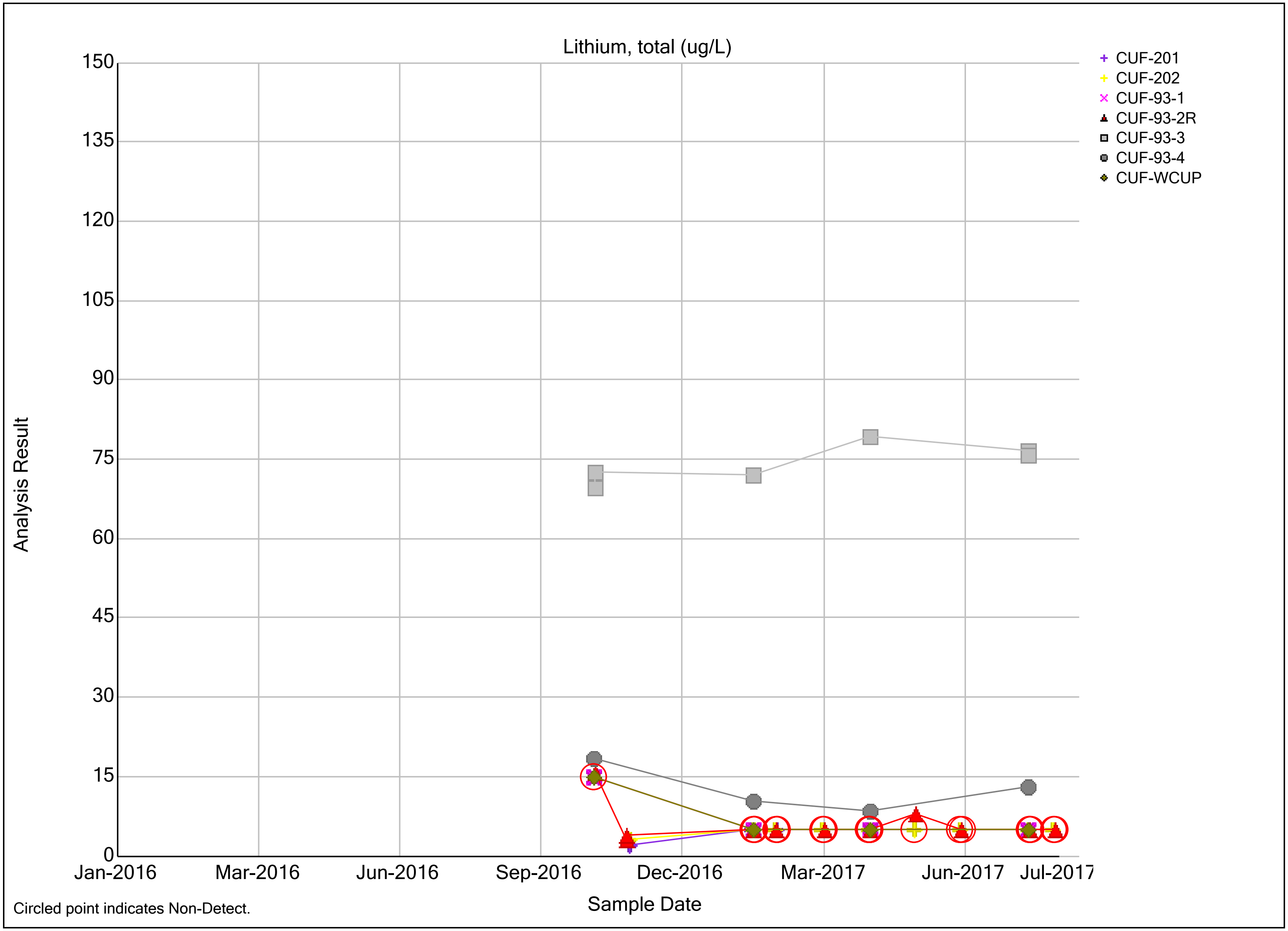
Copper, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=1300.000)
Analysis Result
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.



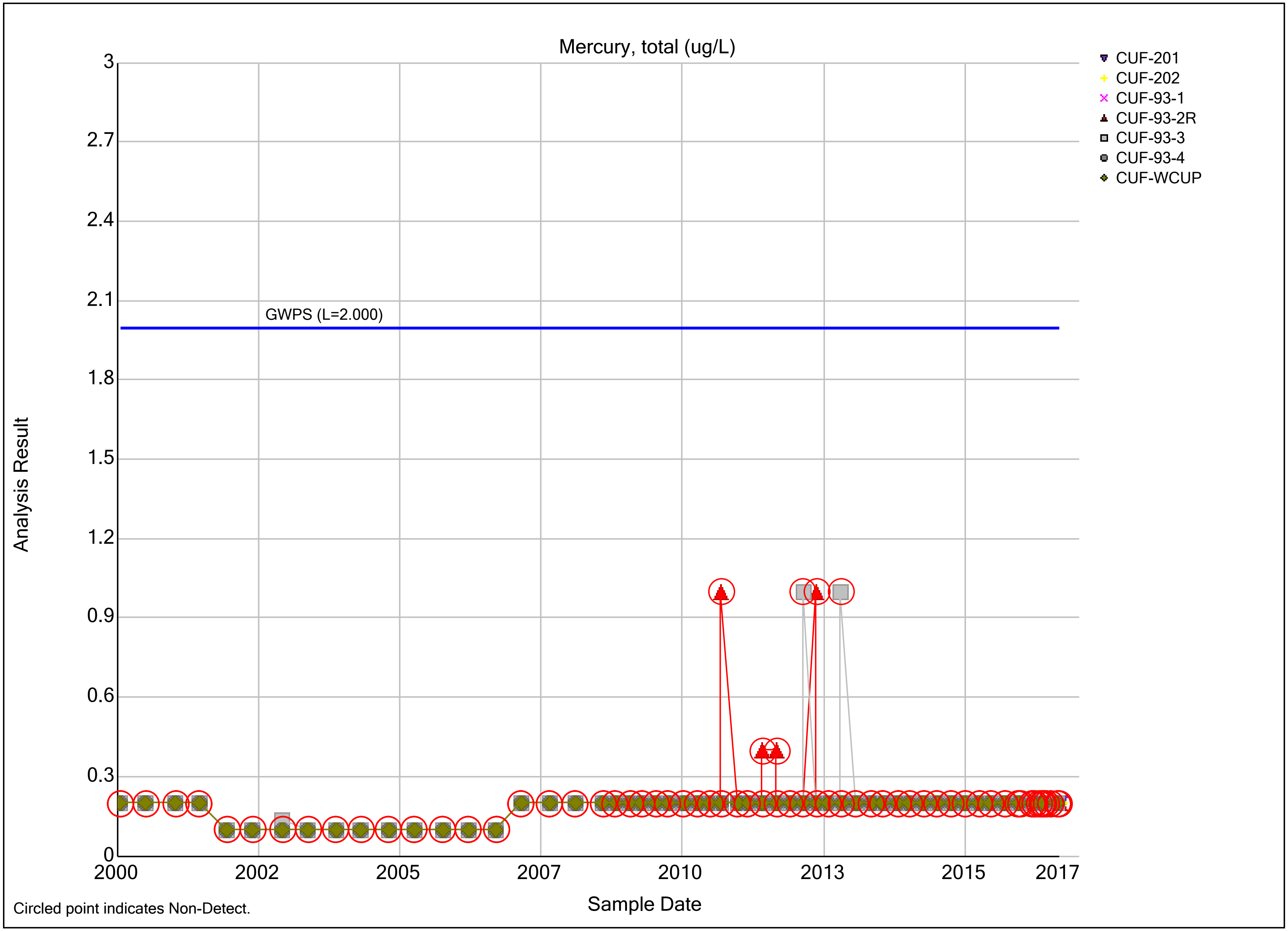
Circled point indicates Non-Detect.



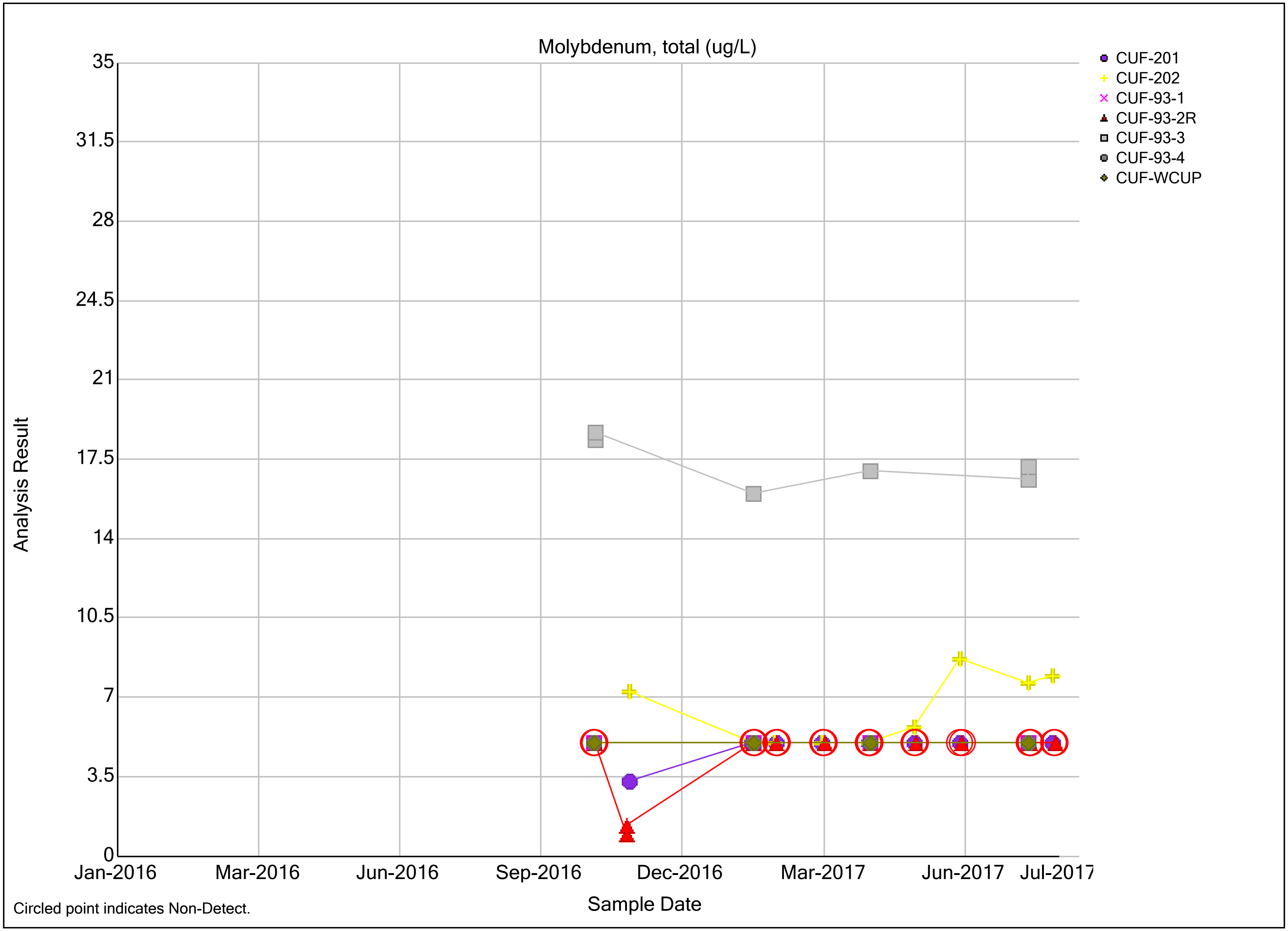
Lead, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=15.000)
Analysis Result
25
22.5
20
17.5
15
12.5
10
7.5
5
2.5
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.



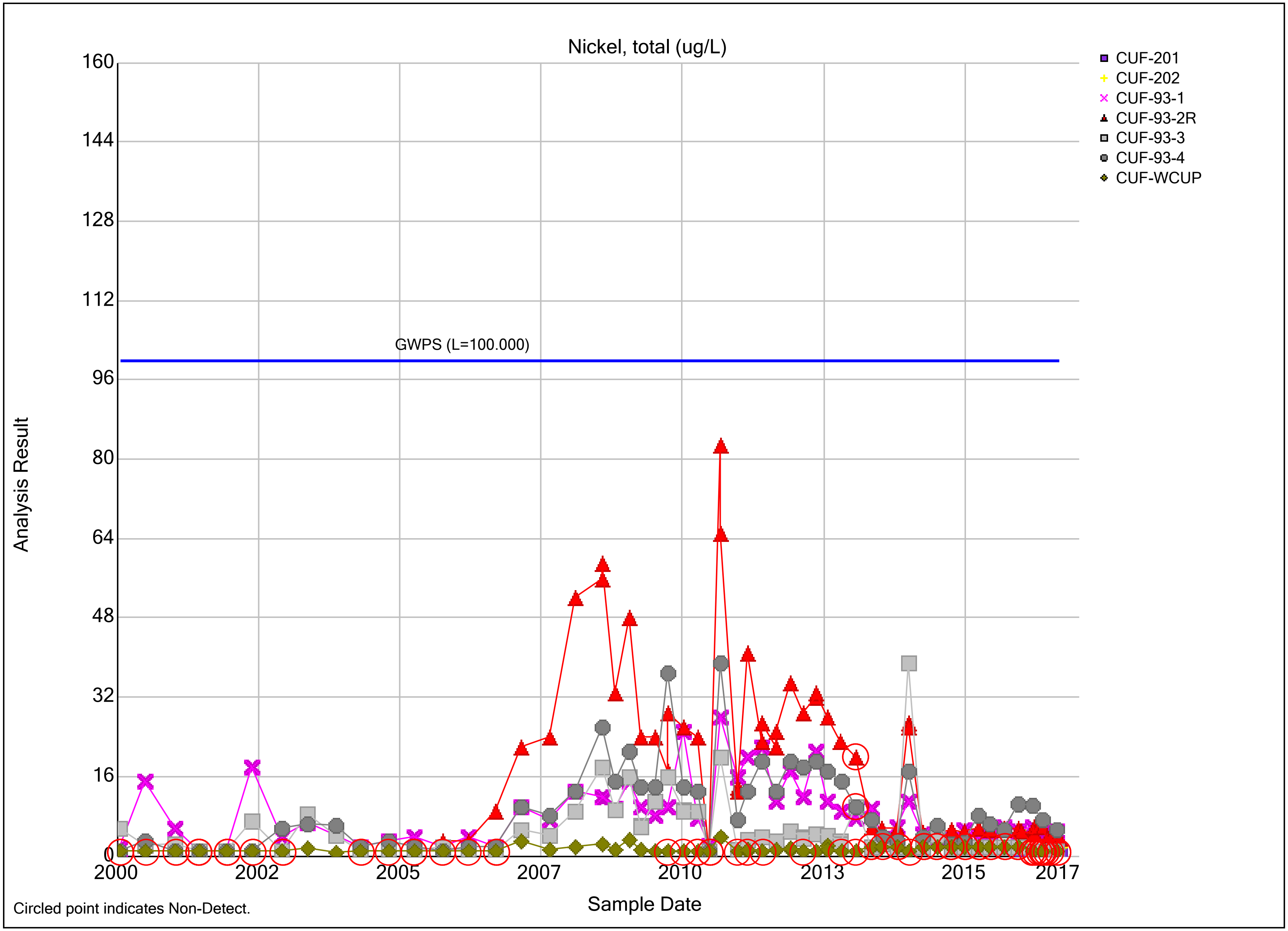
Lithium, total (ug/L)
150
135
120
105
90
75
60
45
30
15
0
Analysis Result
Jan-2016
Mar-2016
Jun-2016
Sep-2016
Dec-2016
Mar-2017
Jun-2017
Jul-2017
Sample Date
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Circled point indicates Non-Detect.



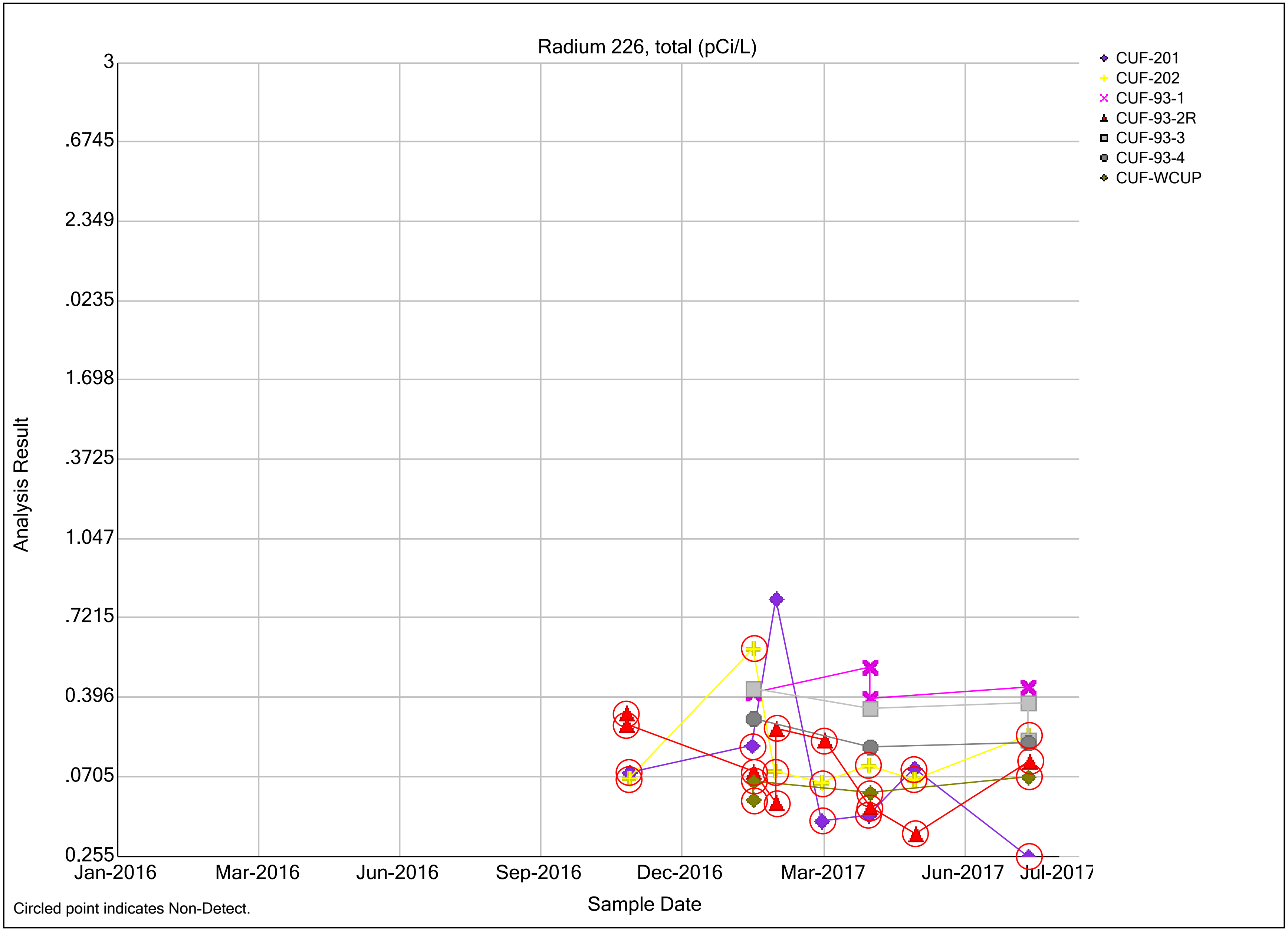
Mercury, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=2.000)
Analysis Result
3
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.



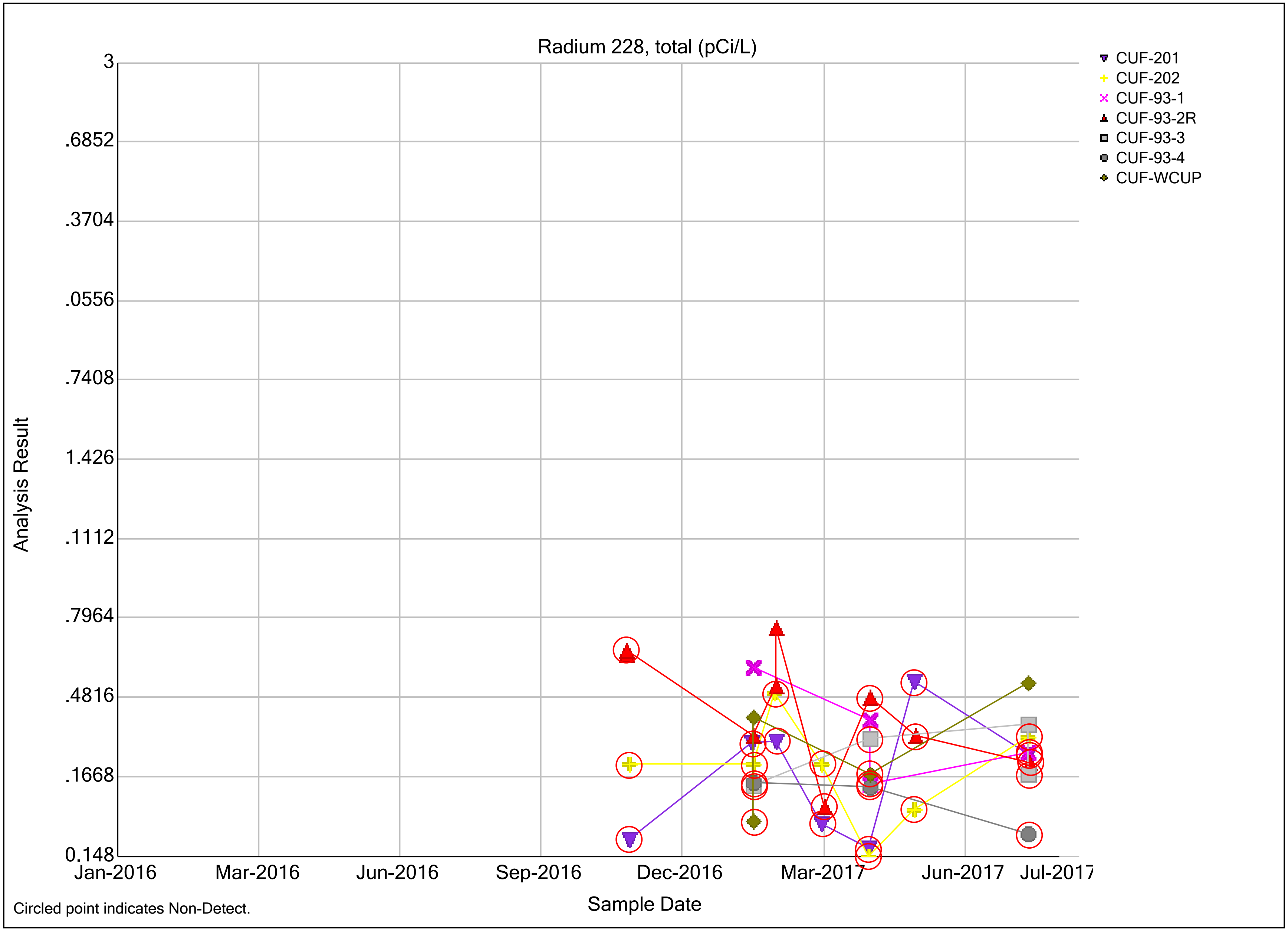
Molybdenum, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Analysis Result
35
31.5
28
24.5
21
17.5
14
10.5
7
3.5
0
Jan-2016
Mar-2016
Jun-2016
Sep-2016
Dec-2016
Mar-2017
Jun-2017
Jul-2017
Sample Date
Circled point indicates Non-Detect.



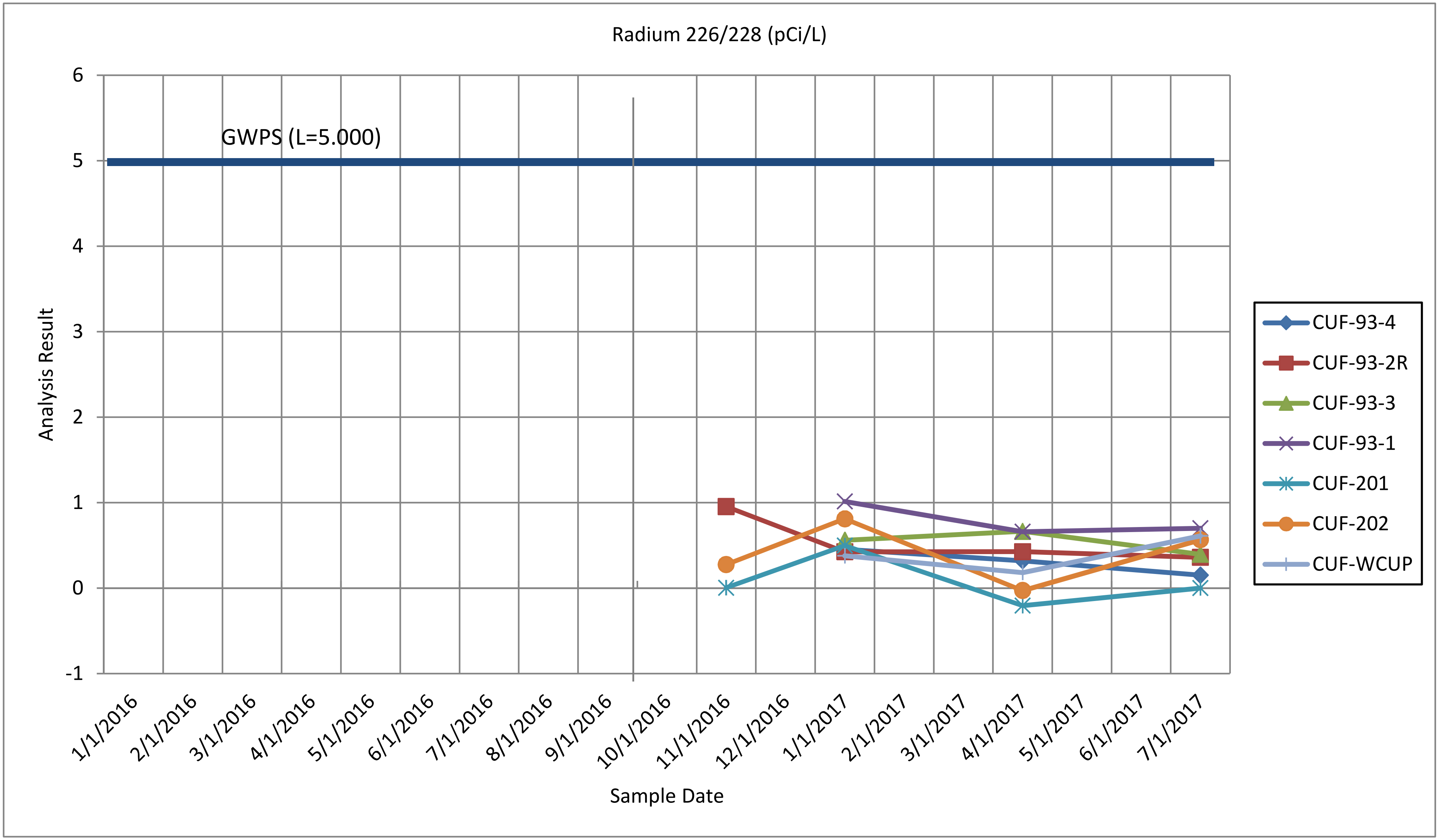
Nickel, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=100.000)
Analysis Result
160
144
128
112
96
80
64
48
32
16
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.



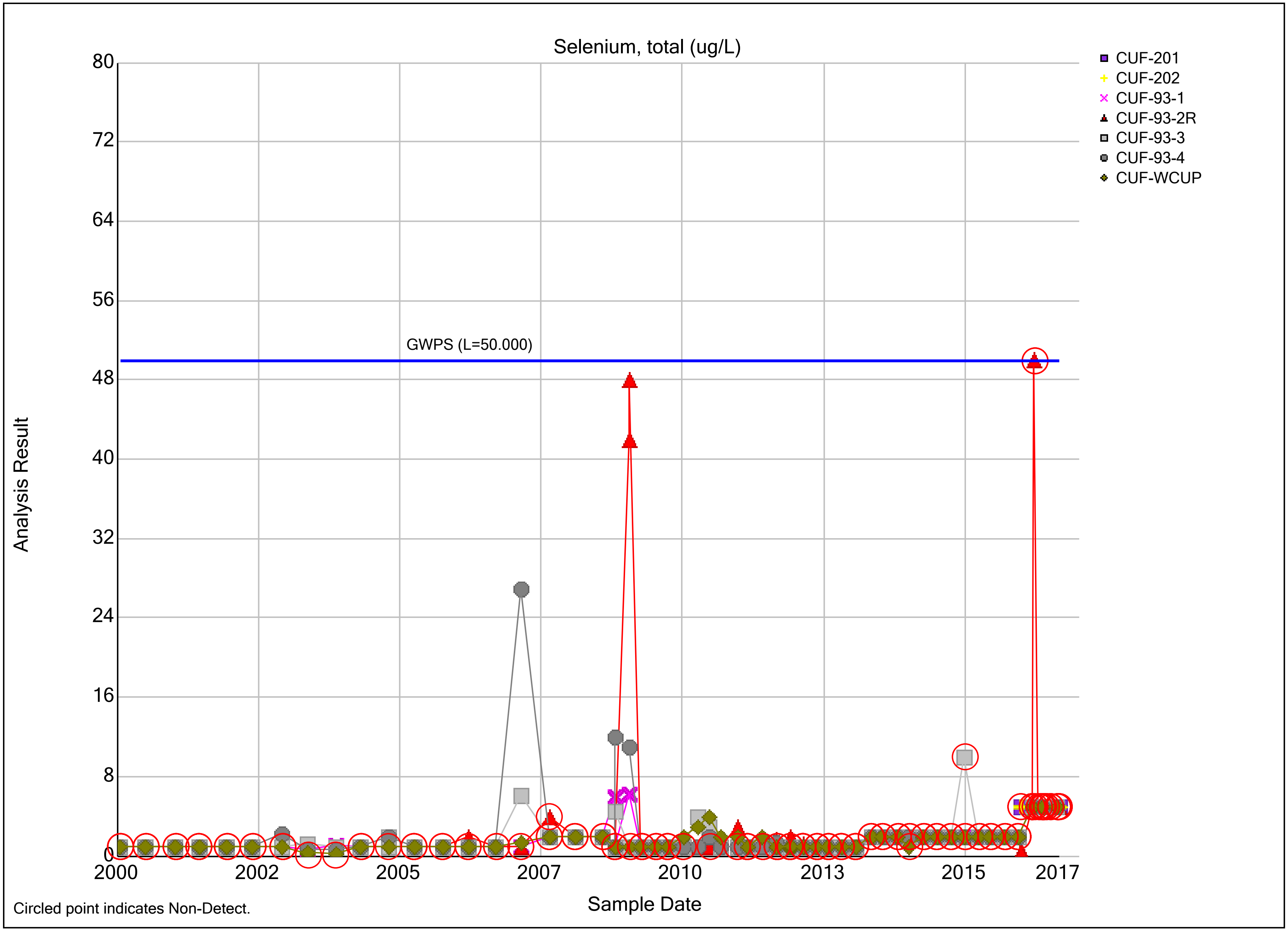
Radium 226, total (pCi/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
3
.6745
2.349
.0235
1.698
.3725
1.047
.7215
0.396
.0705
0.255
Analysis Result
Jan-2016
Mar-2016
Jun-2016
Sep-2016
Dec-2016
Mar-2017
Jun-2017
Jul-2017
Sample Date
Circled point indicates Non-Detect.



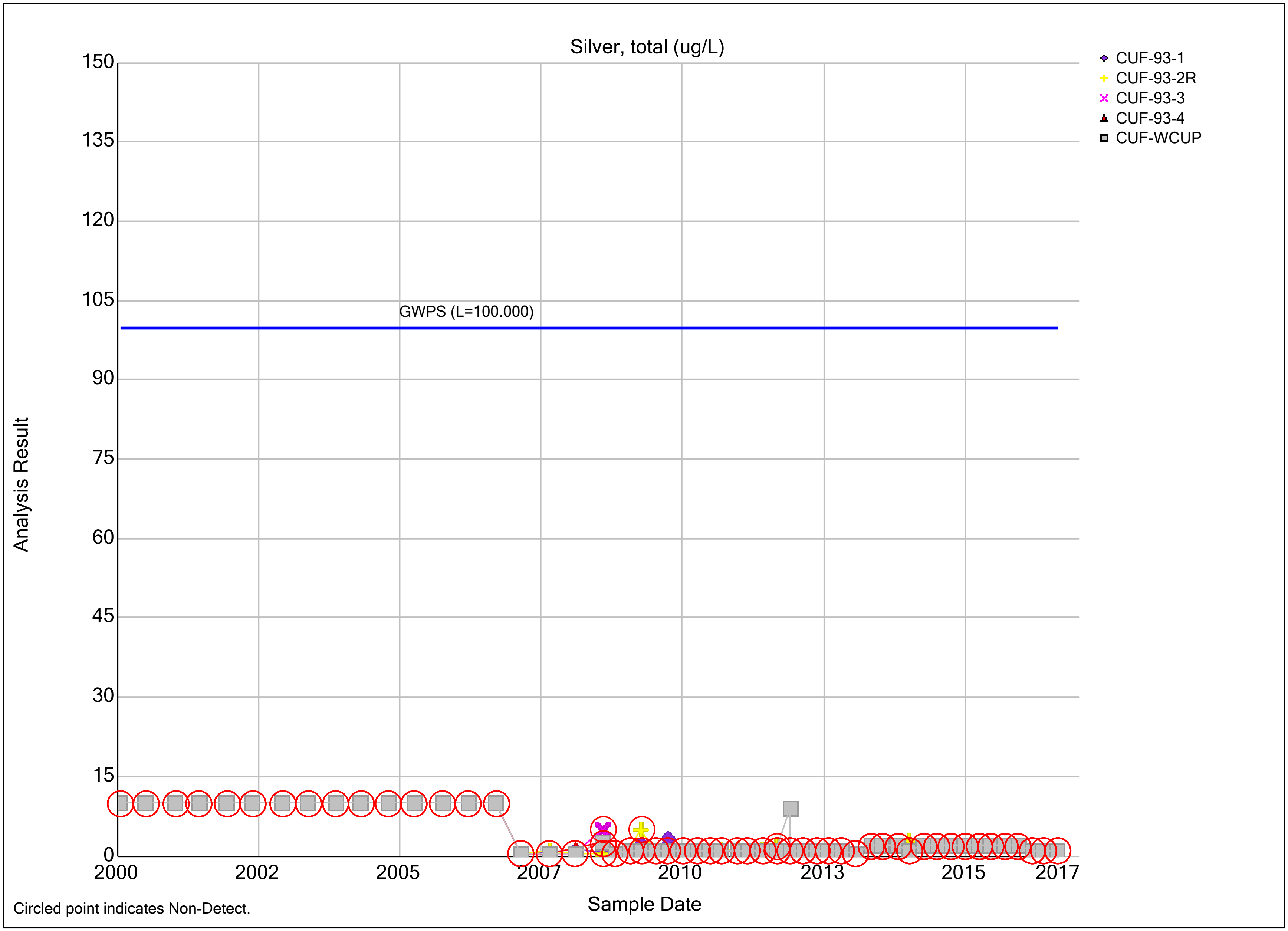
Radium 228, total (pCi/L)
Analysis Result
3
.6852
.3704
.0556
.7408
1.426
.1112
.7964
.4816
.1668
0.148
Jan-2016
Mar-2016
Jun-2016
Sep-2016
Dec-2016
Mar-2017
Jun-2017
Jul-2017
Sample Date
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Circled point indicates Non-Detect.



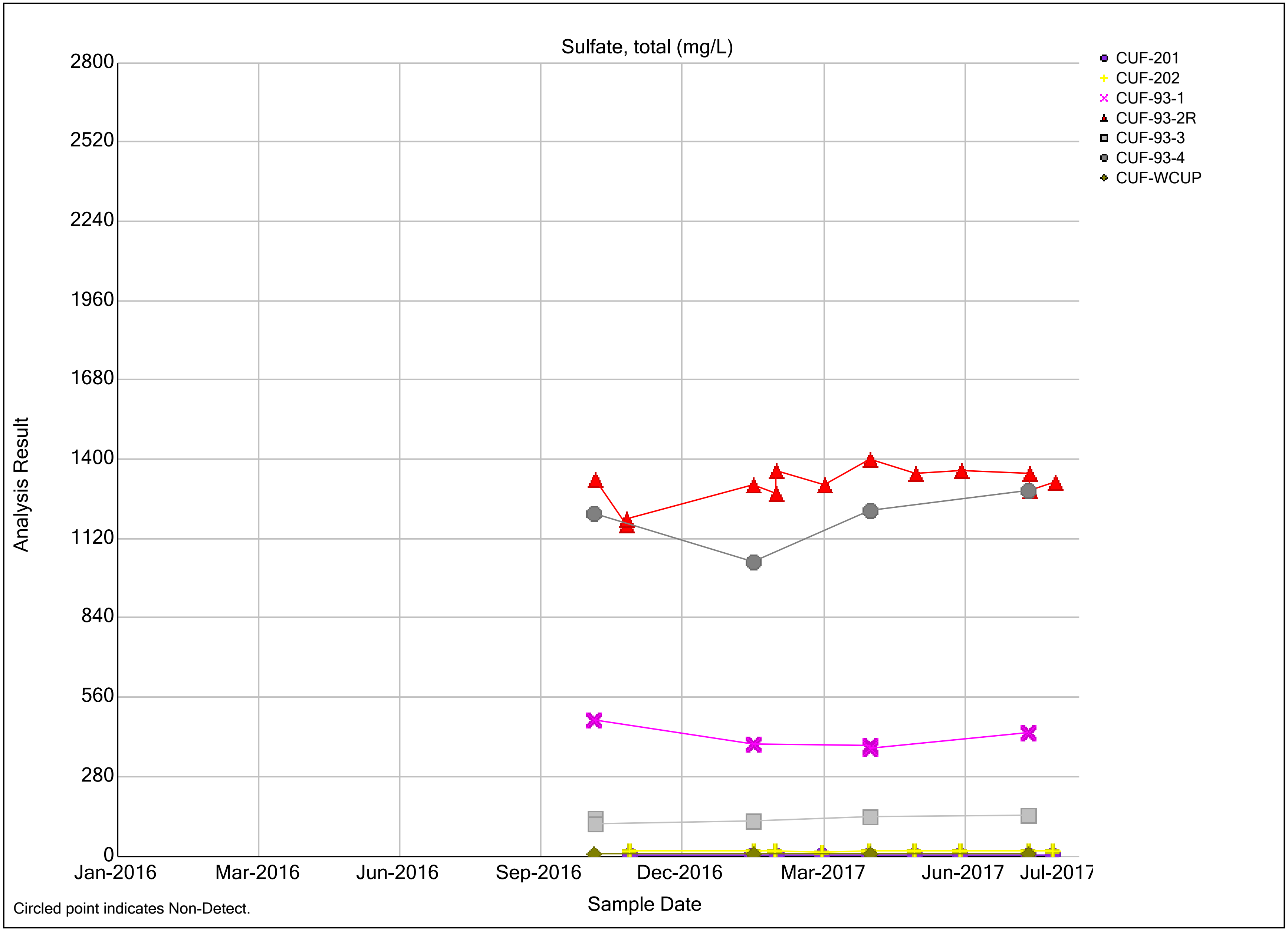
Radium 226/228 (pCi/L)
GWPS (L=5.000)
Analysis Result
6
5
4
3
2
1
0
-1
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
1/1/2017
2/1/2017
3/1/2017
4/1/2017
5/1/2017
6/1/2017
7/1/2017
Sample Date
CUF-93-4
CUF-93-2R
CUF-93-3
CUF-93-1
CUF-201
CUF-202
CUF-WCUP



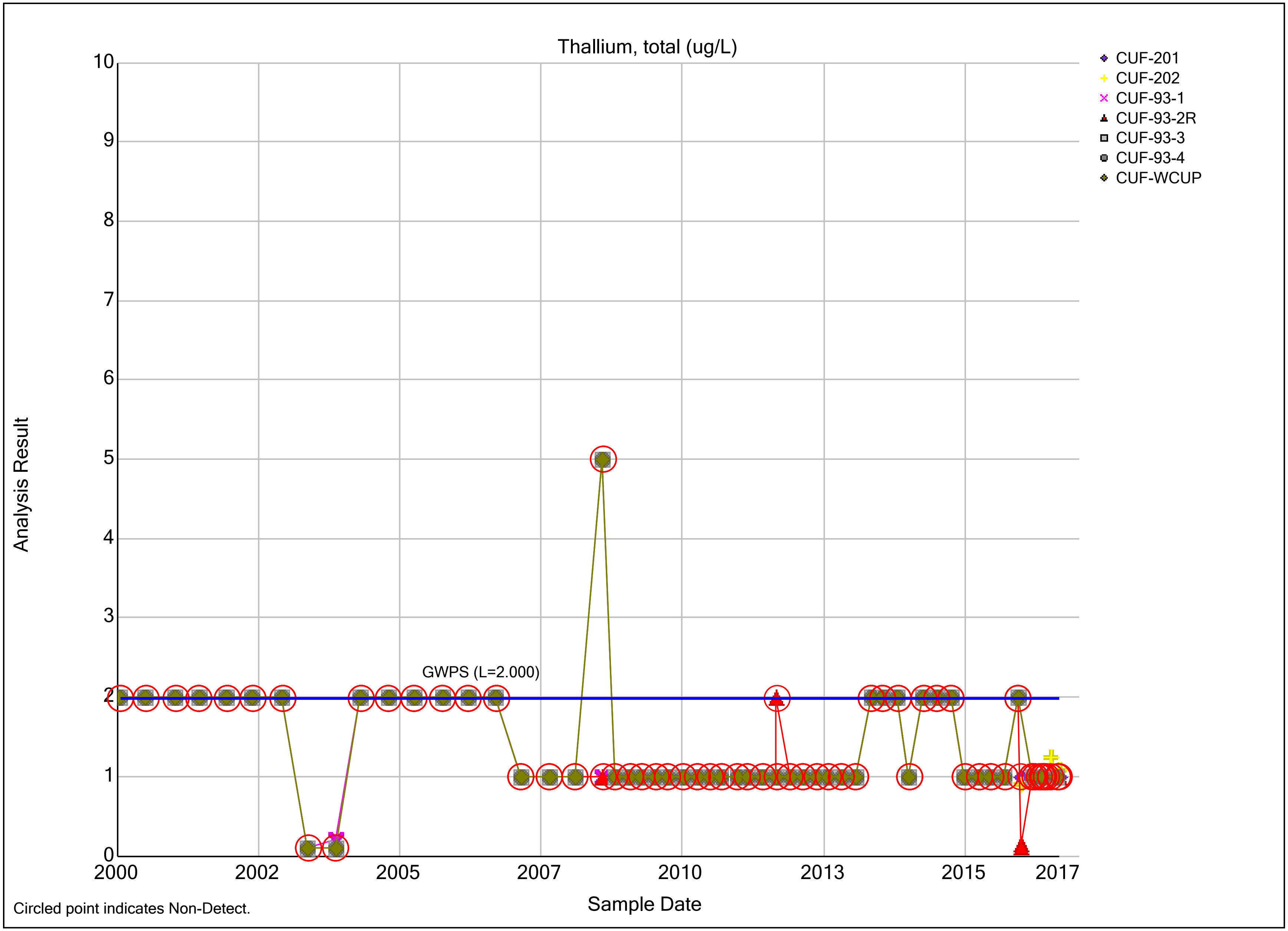
Selenium, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=50.000)
Analysis Result
80
72
64
56
48
40
32
24
16
8
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.

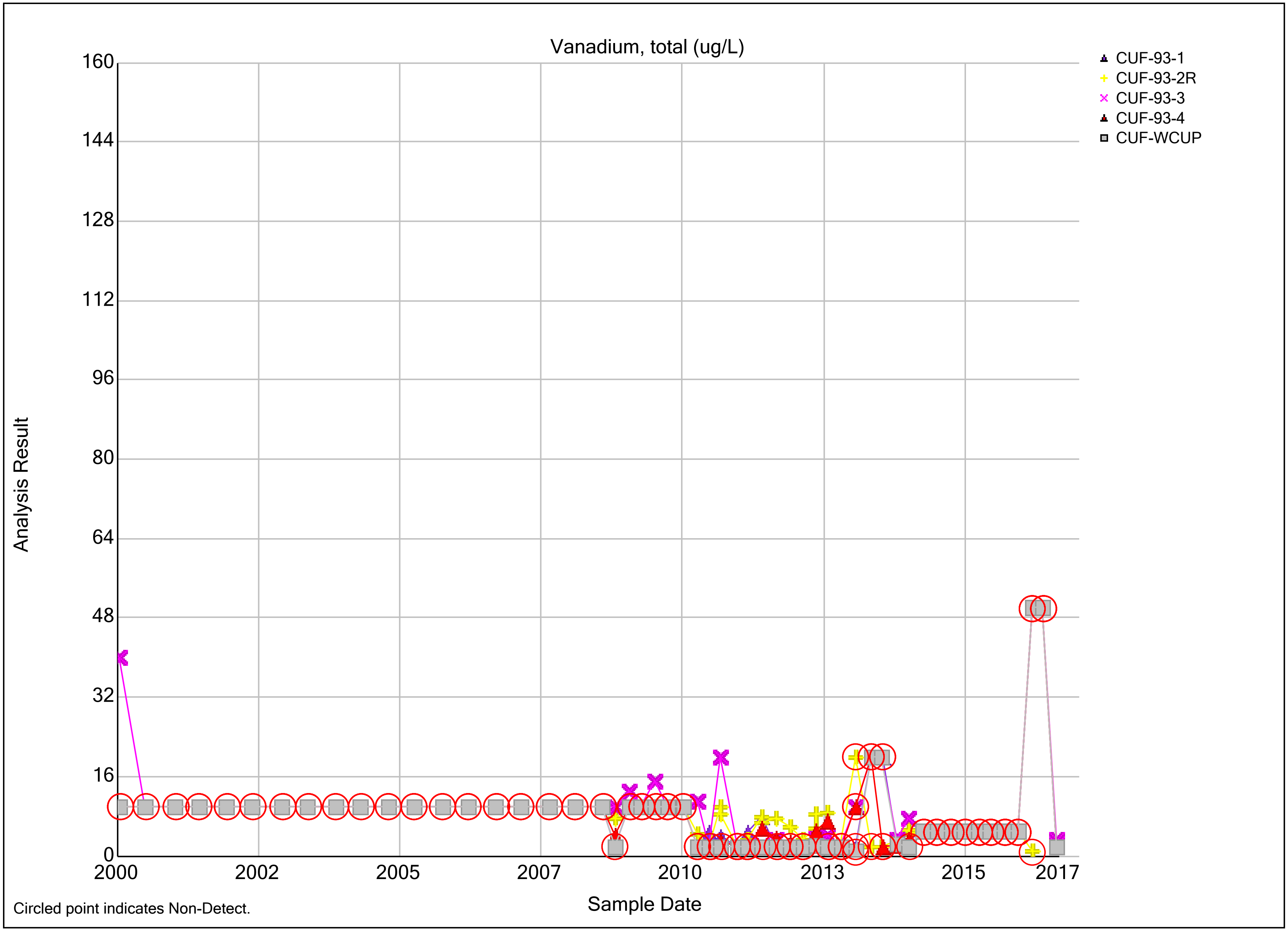


Silver, total (ug/L)
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
GWPS (L=100.000)
Analysis Result
150
135
120
105
90
75
60
45
30
15
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.

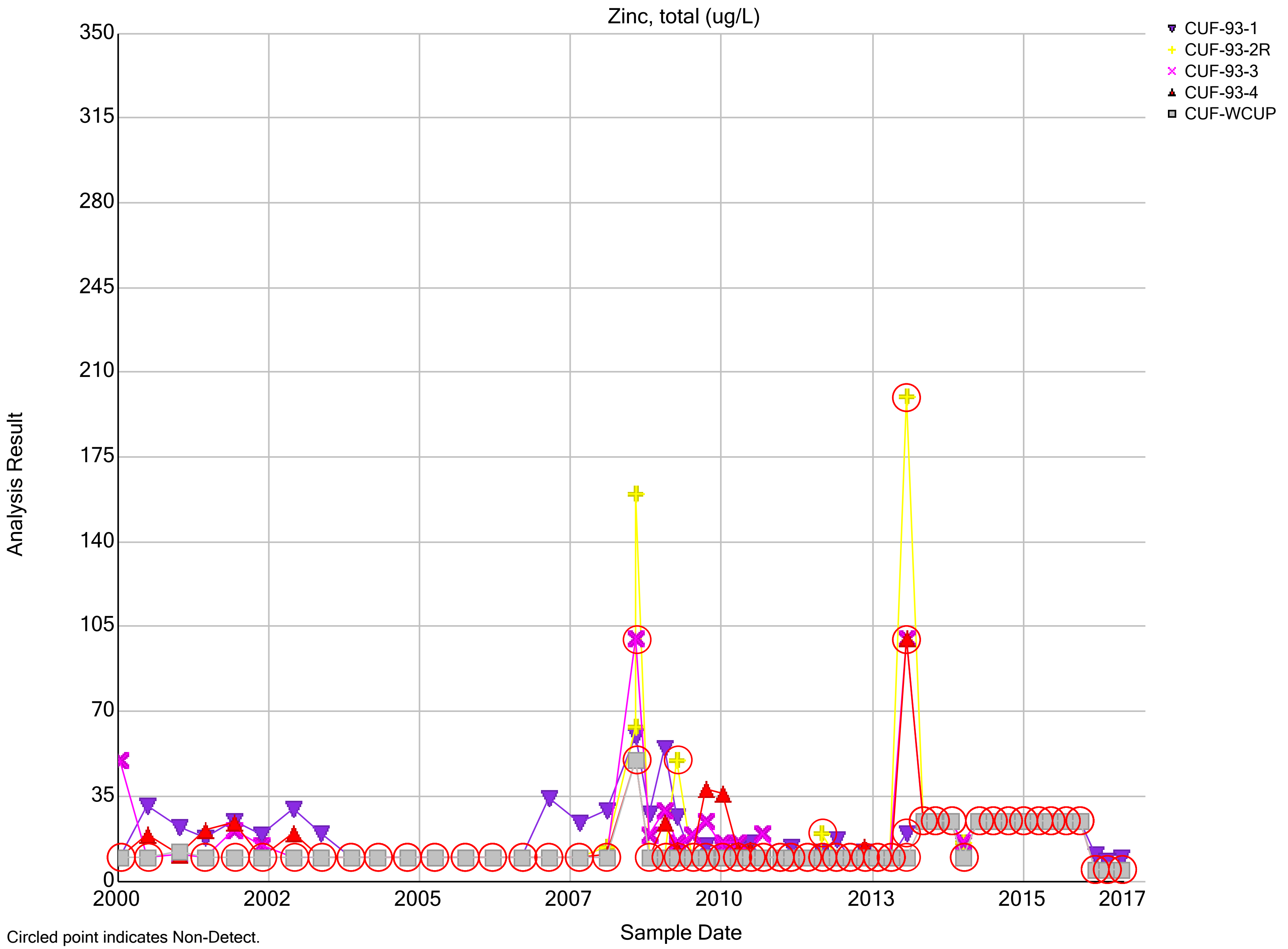


Sulfate, total (mg/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
2800
2520
2240
1960
1680
1400
1120
840
560
280
0
Analysis Result
Jan-2016
Mar-2016
Jun-2016
Sep-2016
Dec-2016
Mar-2017
Jun-2017
Jul-2017
Sample Date
Circled point indicates Non-Detect.

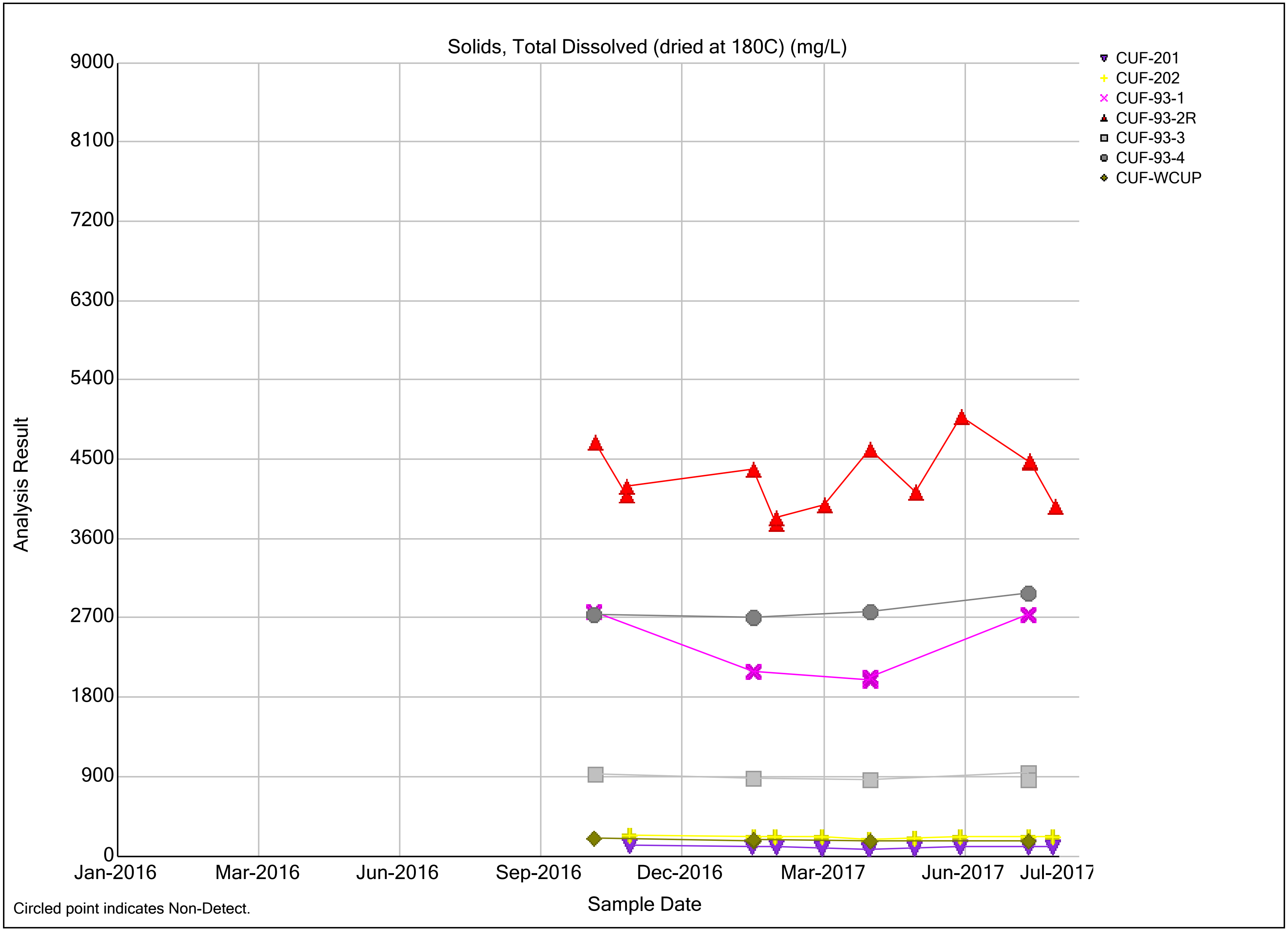

Thallium, total (ug/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Analysis Result
GWPS (L=2.000)
0
1
2
3
4
5
6
7
8
9
10
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.

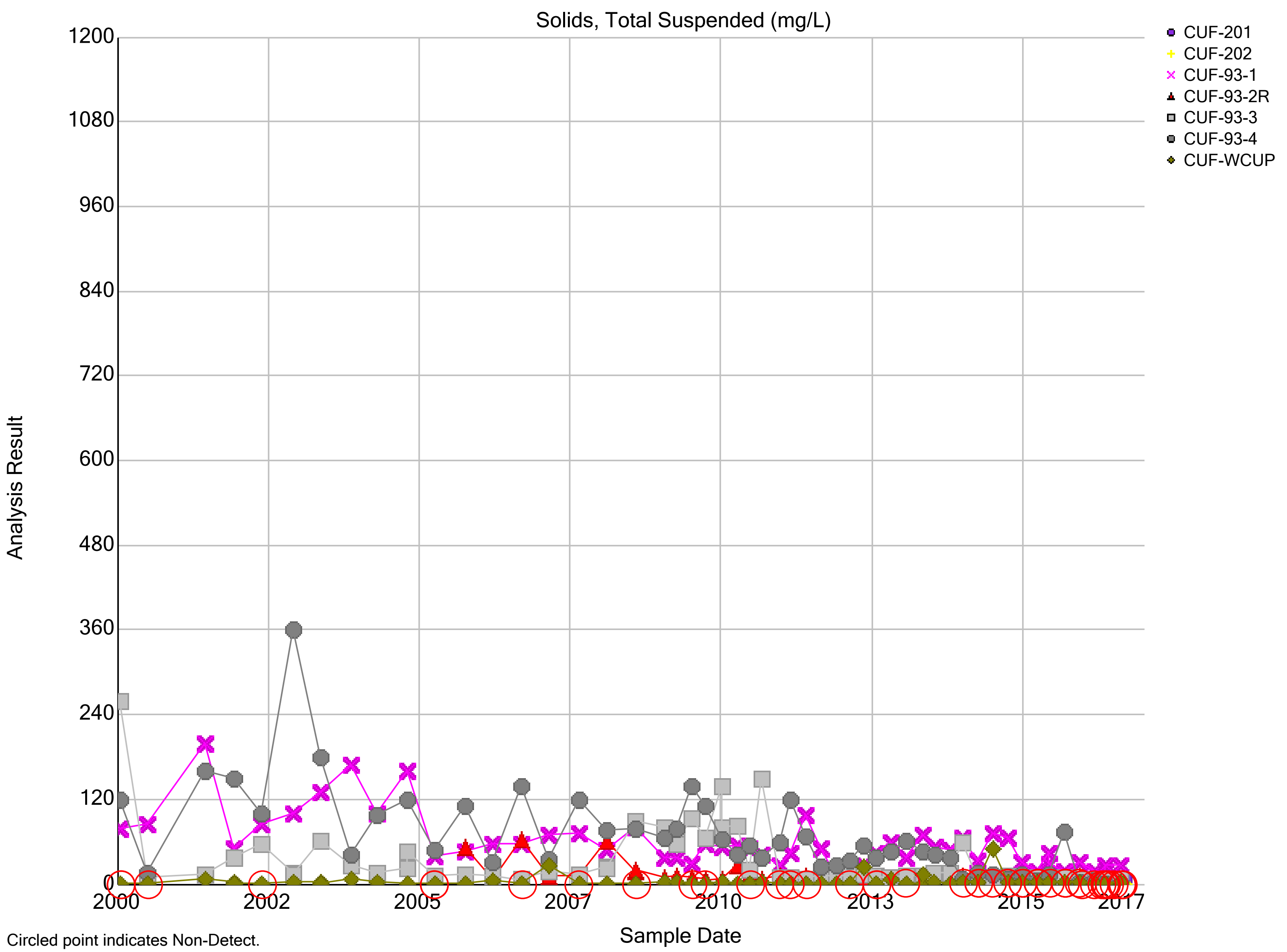


Vanadium, total (ug/L)
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Analysis Result
160
144
128
112
96
80
64
48
32
16
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.

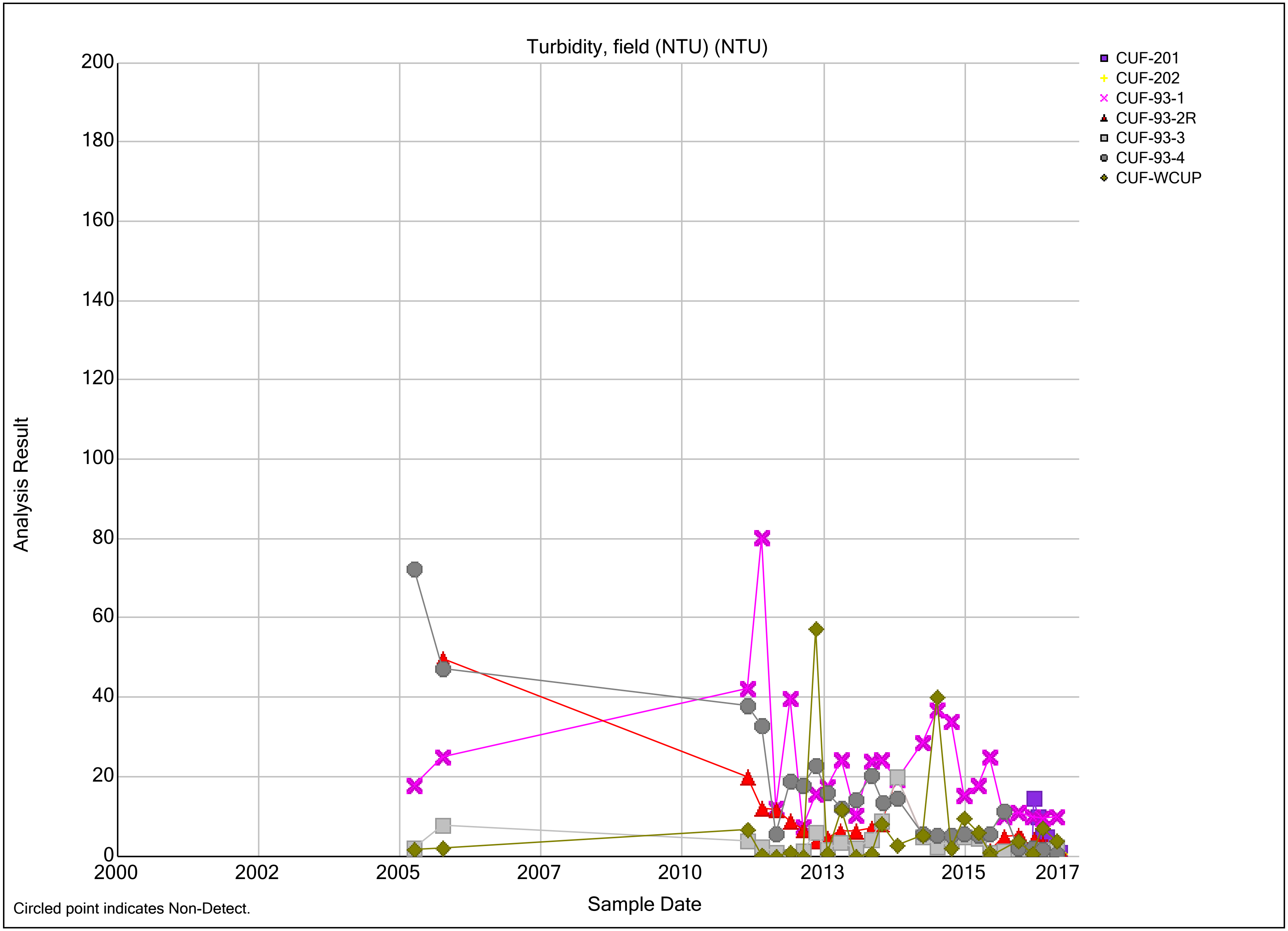


Circled point indicates Non-Detect.


Solids, Total Dissolved (dried at 180C) (mg/L)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Analysis Result
9000
8100
7200
6300
5400
4500
3600
2700
1800
900
0
Jan-2016
Mar-2016
Jun-2016
Sep-2016
Dec-2016
Mar-2017
Jun-2017
Jul-2017
Sample Date
Circled point indicates Non-Detect.



Circled point indicates Non-Detect.


Turbidity, field (NTU) (NTU)
CUF-201
CUF-202
CUF-93-1
CUF-93-2R
CUF-93-3
CUF-93-4
CUF-WCUP
Analysis Result
200
180
160
140
120
100
80
60
40
20
0
2000
2002
2005
2007
2010
2013
2015
2017
Sample Date
Circled point indicates Non-Detect.

APPENDIX R
BENTHIC SAP

Benthic
Sampling and Analysis Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

Benthic
Sampling and Analysis Plan
Cumberland Fossil Plant

TITLE AND REVIEW PAGE

Title of Plan: Benthic
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ____________ Revision: ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

Mark A. Hedgecoth 6/25/18
TVA Investigation Project Manager Date

Tyler Baker 6/25/18
TVA Investigation Field Lead Date

Paul K. Wilkins 6/25/18
Health, Safety, and Environmental Project Manager Date

DS Baker 6/25/18
Investigation Consultant Project Manager Date

Rock J. Vitale
QA Oversight Manager David A. Hay Date

WENDELL PENNINGTON Wendell Pennington 6/22/18
Ted Natterman
Laboratory Project Manager Date

Charles L. Head
TDEC Senior Advisor Date

Robert Wilkinson
TDEC CCR Technical Manager Date

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LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

TDEC's comments included requests for greater clarification in TVA's phased approach for evaluating whether CCR material has migrated from the CUF Plant (Plant) into surface streams. on or adjacent to the Plant. Based on these requests, a Benthic Sampling and Analysis Plan (SAP) and associated sediment sampling locations have been developed.

This Benthic SAP has been prepared to describe TVA's phased approach for evaluating whether CCR material has migrated from the Plant into surface streams. on or adjacent to the Plant. This Benthic SAP has also been prepared to assess potential impacts of CCR constituents on aquatic life as part of the biological studies at the Plant and to assist in providing a good overall view of conditions at the Plant. The results from implementation of this SAP will be evaluated and addressed in the Environmental Assessment Report (EAR).

2.0 OBJECTIVES

The objectives of this study are to characterize sediment chemistry, benthic macroinvertebrate (invertebrate) community composition, and benthic invertebrate bioaccumulation in surface streams on or adjacent to the Plant to determine if CCR material has migrated into those surface streams.

The initial approach is to collect sediment samples from identified transects in surface streams on or adjacent to the Plant. Samples will be analyzed for CCR parameters listed in 40 CFR Part 257, Appendices III and IV along with additional parameters required by the state groundwater monitoring program (copper, nickel, silver, vanadium, and zinc). These constituents will be hereafter referred to as "CCR parameters." Additionally, samples will be analyzed for percent ash, to determine the presence or absence of CCR.

This Benthic SAP will provide the procedures necessary to collect sediment samples from the proposed sediment sampling transects discussed in Section 4.0. The sediment sampling transects will coincide with surface stream sampling locations provided in the Surface Stream SAP. Bioaccumulation sampling locations will cover the same geographic areas as fish tissue sampling areas.

A phased approach to surface stream and sediment sampling has been proposed in the EIP. For Phase 1, all sediment samples collected will be analyzed by Polarized Light Microscopy (PLM) for percentage of ash and all sediment samples collected from 0 to 6 inches deep will be analyzed for the CCR parameters and strontium. All deeper sediment samples collected for the analysis of CCR parameters and strontium during Phase 1 will be held pending the results of the Phase 1 analyses. Should the percentage of ash in a Phase 1 sample exceed 20%, Phase 2 will consist of analysis of the held sediment sample(s) from the deeper strata collected from the location at which percentage of ash exceeded 20% for the CCR parameters and strontium. Depending on the location of the exceedance and collective results of the Phase 1 data, Phase 2 may include sediment sampling at additional locations in surface streams on or adjacent to the Plant. If Phase 2 is not required, no additional sediment samples will be taken or analyzed. Refer to Section 4.0 for additional Plant-specific details.

Quantitative benthic macroinvertebrate (invertebrate) samples will also be collected during Phase 1. The benthic invertebrate sediment samples will be collected along transects at the locations discussed in Section 4.0.

The benthic invertebrate samples will be submitted for processing during which the specimens will be identified and enumerated to the lowest practical taxonomic level. The results of the quantitative sampling will be used to assess benthic community diversity.

The benthic invertebrate evaluation will also include collecting composite samples of mayfly nymphs from random locations within the areas discussed in Section 4.0. Select mayfly nymph samples will have their digestive systems depurated in the laboratory prior to analysis. During mayfly nymph sampling activities, composite adult mayfly samples will be opportunistically collected by direct removal from vegetation or other structures along the shoreline or by use of sweep nets. Mayfly sampling locations will cover the same geographic areas as fish tissue sampling areas. The mayfly nymphs (collected for both depuration and non-depuration) and adult mayflies will be submitted for laboratory analysis of metals included in the CCR parameters list (excluding radium) and strontium. The mayfly analytical results will be used in conjunction with sediment and fish tissue data to evaluate contaminant bioaccumulation.

The field activities associated with Phase 1 will include the following tasks:

- Verify proposed sampling locations using the global positioning system (GPS)
- Collect sediment samples from proposed sampling locations
- Collect benthic invertebrate samples from proposed sampling locations
- Collect adult mayfly, non-depurated mayfly nymph, and depurated mayfly nymph composite samples from proposed sampling locations
- Package and deliver sediment samples to laboratory for analysis or for storage pending Phase 1 results
- Package and deliver benthic invertebrate samples to laboratory for community evaluation
- Package and deliver composite mayfly samples to laboratory for analysis

Should additional samples be needed as part of Phase 2 implementation, a new sampling location map will be developed. Data collected during this investigation will be reported to TDEC in the EAR.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

4.1 SEDIMENT SAMPLING LOCATIONS

Twenty-four sediment sample transects are planned for the Phase 1 investigation, with individual samples being collected perpendicular to flow from the right descending bank, the center of the channel, and the left descending bank at each transect. Background transects upstream of the Plant on Wells Creek and its tributaries and upstream of the Plant on the Cumberland River are proposed to provide a baseline of CCR parameter and strontium concentrations. Phase 1 sediment sampling transects adjacent to the Plant in Wells Creek and its tributaries were selected to evaluate areas where CCR could potentially have been released from the impoundment into the surface streams. Sampling is focused around known historic seep locations and an area of interest along the exterior dike adjacent to the creek. Samples are also proposed in the seasonally exposed areas along the southwestern bank of the plant adjacent to Wells Creek. These low-lying areas are often inundated by the Lake Barkley pool, which is a potential mechanism for ash deposition. Sampling in the low-lying areas is intended to capture potential effects from a breach of the exterior dike that occurred in 1997. Additional transects are proposed in the Cumberland River downstream of the ash pond discharge channel. See Table 1 below for a summary of transect locations and Figure 1 for proposed sediment sampling transects.

Sediment samples collected from 0 to 6 inches deep in the pond at the northeast corner of the Plant (transect SED-PO01 in Table 1) will only be analyzed for percentage ash using PLM during Phase 1. Sediment samples collected for analysis of the CCR parameters and strontium from 0 to 6 inches deep in the pond at the northeast corner of the Plant will be held along with the deeper samples for potential analysis of the CCR parameters and strontium during Phase 2 pending the Phase 1 PLM analytical results.

Water samples will also be taken at coincident sediment sampling locations as described in the Surface Stream Sampling and Analysis Plan. The number and/or location of the proposed sediment samples described above may have to be modified based on conditions encountered in the field.

Table 1. Proposed Sediment Sample Location

Transect Location ID	Description	Location
SED-WC01	Wells Creek Upstream of CUF (Background)	Transect location shown on Figure 1
SEC-WC02	Wells Creek Upstream of CUF (Background)	Transect location shown on Figure 1
SED-WC03	Wells Creek Upstream of CUF (Background)	Transect location shown on Figure 1
SED-WC04	Wells Creek and adjacent low-lying area at location of 1997 dike breach and seep	Transect location shown on Figure 1
SED-WC05	Wells Creek and adjacent low-lying area at location of 1997 dike breach and seep	Transect location shown on Figure 1
SED-WC06	Low-lying area adjacent to Wells Creek main channel – may have been affected by 1997 dike breach	Transect location shown on Figure 1
SED-WC07	Wells Creek at area of interest	Transect location shown on Figure 1
SED-WC08	Wells Creek at historic seep location	Transect location shown on Figure 1
SED-WC09	Wells Creek adjacent to location where dike crosses the pre-construction Wells Creek alignment	Transect location shown on Figure 1
SED-WC10	Wells Creek adjacent to ash pond	Transect location shown on Figure 1
SED-CuR01	Cumberland River Upstream of CUF (Background)	Transect location shown on Figure 1
SED-CuR02	Cumberland River Upstream of CUF (Background)	Transect location shown on Figure 1
SED-CuR03	Cumberland River Upstream of CUF (Background)	Transect location shown on Figure 1
SED-CuR02	Cumberland River downstream of the ash pond discharge channel	Transect location shown on Figure 1
SED-CuR03	Cumberland River downstream of the ash pond discharge channel	Transect location shown on Figure 1

Table 1. Proposed Sediment Sample Location

Transect Location ID	Description	Location
SED-CuR04	Cumberland River downstream of the ash pond discharge channel	Transect location shown on Figure 1
SED-CuR05	Cumberland River downstream of the ash pond discharge channel	Transect location shown on Figure 1
SED-UT01	Unnamed Tributary upstream of known historical seeps (Background)	Transect location shown on Figure 1
SED-UT02	Unnamed Tributary to Wells Creek at historic seep location	Transect location shown on Figure 1
SED-UT03	Unnamed Tributary to Wells Creek downstream of historic seep location	Transect location shown on Figure 1
SED-UT04	Unnamed Tributary to Wells Creek at historic seep location	Transect location shown on Figure 1
SED-UT05	Unnamed Tributary to Wells Creek downstream of historic seep location	Transect location shown on Figure 1
SED-DC01	Ash pond discharge channel	Transect location shown on Figure 1
SED-PO01 *	Embayment/pond at northeast corner of TVA property	Transect location shown on Figure 1

* 0 to 6- inch deep samples collected from this transect for analysis of the CCR parameters and strontium will be held pending the results of the Phase 1 PLM analyses.

4.2 BENTHIC INVERTEBRATE SAMPLING LOCATIONS

Quantitative benthic invertebrate sampling will also be conducted during Phase 1. The benthic invertebrate sediment samples will be collected along transects at the locations depicted on Figures 2 and 3. See Table 2 below for a summary of transect locations.

Benthic invertebrate sediment samples will be collected from five locations along each proposed transect. If it is not possible to collect samples due to conditions encountered in the field (e.g., large sediment grain size), locations may be adjusted based on the judgement of the field team.

Table 2. Proposed Benthic Invertebrate Transect Sample Locations

Transect ID	Description	Location
MAC-WC01	Wells Creek Upstream of CUF (Background)	Transect location shown on Figure 2
MAC-WC02	Wells Creek downstream from unnamed tributary	Transect location shown on Figure 2
MAC-WC03	Wells Creek upstream from 1997 dike breach and historic seep location	Transect location shown on Figure 2
MAC-WC04	Wells Creek downstream from 1997 dike breach and historic seep location	Transect location shown on Figure 2
MAC-WC05	Wells Creek upstream from area of interest and historic seep location	Transect location shown on Figure 2
MAC-WC06	Wells Creek downstream from area of interest and historic seep location	Transect location shown on Figure 2
MAC-CuR01	Cumberland River Upstream of CUF (Background)	Transect location shown on Figure 2
MAC-CuR02	Cumberland River downstream of the ash pond discharge channel	Transect location shown on Figure 2
MAC-CuR03	Cumberland River downstream of the confluence with Wells Creek	Transect location shown on Figure 2
MAC-CuR04	Cumberland River Mile 106.6	Transect location shown on Figure 3
MAC-CuR05	Cumberland River Mile 102.2	Transect location shown on Figure 3

4.3 MAYFLY SAMPLING LOCATIONS

Mayfly sampling will also be conducted during Phase 1. Both nymph and adult mayflies will be collected. Composite mayfly nymph samples will be collected from submerged sediments at multiple random locations within the areas depicted on Figure 4. See Table 3 below for a summary of these locations. During mayfly nymph sampling activities, adult mayflies will be opportunistically collected by direct removal from vegetation or other structures along the shoreline or by use of sweep nets. The timing of the sampling will need to be coordinated with local adult mayfly emergence.

Efforts will be made to collect mayfly adults/nymphs within the designated areas, however other species may need to be evaluated and/or other locations added if an insufficient number of mayfly adults/nymphs are encountered within the designated areas at the time the proposed sampling is conducted.

Table 3. Proposed Mayfly Sample Locations

Location ID	Description	Location
WCU	Wells Creek upstream	Area shown on Figure 4
WCD	Wells Creek downstream	Area shown on Figure 4
CuRU	Cumberland River upstream	Area shown on Figure 4
CuRA	Cumberland River adjacent	Area shown on Figure 4
CuRD	Cumberland River downstream	Area shown on Figure 4

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to collect samples, document field activities, and assist in providing scientifically defensible results.

Sample collection will adhere to TVA Technical Instruction (TI) documents. A project field book and/or field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Complete required health and safety paperwork and confirm Field Sampling Personnel have completed required training
- Coordinate activities with the Laboratory Coordinator, including ordering sample containers and preservatives (if required), obtaining coolers and analyte-free deionized (DI) water, and notifying the Laboratory Coordinator of sampling and sample arrival dates
- Coordinate activities with subcontractors
- Obtain required field equipment, including health and safety equipment and sediment sampling devices
- Complete sample paperwork to the extent possible, including chain-of-custody (COC) forms and sample labels
- Obtain ice prior to sample collection for sample preservation
- Complete utility locates and obtain excavation permit for VibeCore™ sample locations (An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the sampling locations with pertinent TVA staff. Prior to initiating subsurface activities, subsurface utility clearance will be sought via the plant engineering department and/or the TN 811 service. For locations within the Plant, engineering will provide primary utility clearance assurance in addition to TN 811 being notified. At sampling locations where underground obstructions or utilities are expected nearby, TVA or 3rd party underground locators will be engaged to clear sampling locations. For off-Plant sampling locations, utility avoidance assurance will be supplemented by the TN 811 service and the TVA or 3rd party underground locators.)

- Environmental Review (As required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate potential impact from the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC has a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, Plant staff will not issue an excavation permit ahead of the completed environmental review.)

5.2 SAMPLING METHODS AND PROTOCOL

Sampling and collection methods will be conducted in accordance with applicable TVA Technical Instructions, including:

- TI-05.80.02 *Sample Labeling and Custody*
- TI-05.80.03 *Field Record Keeping*
- TI-05.80.04 *Field Sampling Quality Control*
- TI-05.80.05 *Field Sampling Equipment Cleaning and Decontamination*
- TI-05.80.06 *Handling and Shipping of Samples*

5.2.1 Sampling Method

Samples should be located based on project work control documents using a survey grade GPS unit. Sample locations will be documented in the field logbook in accordance with TVA TI ENV-TI-05.80.03. Three-point anchoring may be required to stabilize the vessel during sampling.

5.2.1.1 Sediment sampling

Sediment sampling will be conducted at the transect locations discussed in Section 4.0, with individual samples being collected perpendicular to flow from the right descending bank, the center of the channel, and the left descending bank at each transect. Sediment samples at each location will be collected using a VibeCore™ vibration-driven sediment sampler. Refer to the TVA Gallatin *Standard Operating Procedure for Sediment Sampling* document (TVA-GAF-SOP-02) for additional information and guidelines regarding the use of VibeCore™ samplers. Sediment samples collected for analysis of PLM, the CCR parameters, and strontium are to be collected from downstream to upstream in surface streams on or adjacent to the Plant to prevent the disturbance of bottom sediments from impacting further downstream sample locations.

Upon arrival at a sample location where both sediment and surface water are being collected, the surface stream sample will be collected before the associated sediment sample. This sampling sequence will prevent sediment disturbance from affecting the surface stream sample.

At each location, the VibeCore™ sampler with a properly decontaminated acrylic core tube will be advanced the full six-foot length of the core tube or until refusal. Upon retrieval, the core will be photographed against a prepared board containing a graduated scale and location information. The core will be inspected and distinct horizons will be identified based on color, texture, etc. The core length and depth of horizon changes will be recorded in the field notes (logbooks and/or field forms). A sediment sample will be collected from the upper six inches of the collected sediment core at each location after thoroughly homogenizing the material. For each distinct horizon identified below six inches, the sediment will be portioned and homogenized to create a representative sample. Field Sampling Personnel wearing powder-free nitrile gloves will homogenize the samples using decontaminated high density polyethylene (HDPE) containers and new disposable HDPE scoops. Field Sampling Personnel will first remove twigs, roots, leaves, rocks, and miscellaneous debris from the sample, then mix the sediment until the physical appearance is consistent over the entire sample. Once homogenized, an appropriate volume of sediment will be transferred into certified clean laboratory-supplied pre-labeled containers required for each analysis using the disposable HDPE scoops. Samples will not be collected for deeper sediment-free native soil samples if recovered.

5.2.1.2 Benthic community sampling

Quantitative benthic invertebrate community sampling will be conducted using a properly decontaminated Wildco™ Ponar Dredge or similar self-closing mechanical benthic sampling device in accordance with TVA Kingston *Standard Operating Procedure for Reservoir Benthic Macroinvertebrate Sampling* document (TVA-KIF-SOP-35). Adult and nymph mayfly samples will also be collected in accordance with TVA Kingston *Standard Operating Procedure for Mayfly Sampling* (TVA-KIF-SOP-29). Self-closing mechanical benthic sampling devices use a spring-loaded system that releases when the sampler impacts the bottom and the lowering cable or line becomes slack, causing the scoops to close.

A transect will be established perpendicular to the direction of flow at the quantitative benthic invertebrate sampling locations as discussed in Section 4.0. Five grab samples will be collected along each transect from the upper approximate six inches of sediment at each location. Approximate water depth and proportions of substrate types recovered will be recorded for each sample. Three attempts will be made to collect an adequate sample volume based on the judgement of the Field Sampling Personnel at each location. In the event an insufficient volume of sediment is recovered after three attempts, the failed attempts will be documented and no sample for quantitative benthic invertebrate analysis will be collected at that location. Benthic invertebrate sediment samples will be washed on a 500-micrometer screen using river water to remove finer material.

The remaining substrate will be photographed then transferred into individual sample containers along with the benthic organisms. The contents of each sample container will then be fixed with a 10% buffered formalin solution.

5.2.1.3 Mayfly sampling

Adult and nymph mayfly samples will be collected in accordance with TVA Kingston *Standard Operating Procedure for Mayfly Sampling* (TVA-KIF-SOP-29). Mayfly nymphs will be collected from multiple random submerged locations within each area discussed in Section 4.0. The contents of the benthic sampling device from each mayfly nymph sampling location will be emptied onto a decontaminated stainless steel sieve fitted with 2 millimeter or less stainless steel, Nitex, or Teflon mesh/netting then rinsed with river water to remove fine sediment particles and expose the nymphs. The nymphs will then be removed from the sieve using decontaminated stainless steel, plastic, or Teflon-coated forceps and placed into a decontaminated or dedicated plastic container filled with surface water from the Plant to allow preliminary removal of substrate adhering to the organisms. Nymphs that appear damaged (i.e. severed head/abdomen) will be discarded. Undamaged nymphs collected from each area will be randomly sorted into composite samples, with a minimum of 50 to 75 nymphs from each area required for both puration and non-puration. Nymphs collected for analysis without depuration of their gut contents will then be transferred into individual sample containers and held on ice pending transport to the laboratory. Nymphs collected for depuration prior to laboratory analysis must be kept alive and handling stress to the nymphs must be minimized. Nymphs collected for depuration will be transferred into individual sample containers filled with water from the Plant and placed on ice in a cooler pending transport to the laboratory.

Adult mayflies will be opportunistically collected by direct removal from vegetation or other structures along the shoreline or by use of sweep nets. A minimum of 50 to 75 adult mayflies will be collected from each area discussed in Section 4.0. The adult mayflies from each area will be transferred to composite sample containers and stored on ice pending transport to the laboratory.

Issues that could affect the quality of samples will be recorded in the log book along with the action(s) taken to resolve the issue. These could include observations such as insufficient sediment recovery, partial sediment recovery, or defective materials or equipment. The sediment, quantitative benthic invertebrate and mayfly sampling methods described above may have to be modified based on conditions encountered in the field.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Consultant will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel, capped, and a signed and dated custody seal will be applied. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean. Each sample container will be individually wrapped with bubble wrap, secured using tape or rubber bands, and placed in a re-sealable plastic bag.

Sediment samples collected will be submitted for analysis of percentage of ash. Sediment samples collected from 0 to 6 inches deep will also be submitted for analysis of the CCR parameters and strontium. All deeper sediment samples collected for analysis of the CCR parameters and strontium will be held pending the results of the Phase 1 analyses.

Benthic invertebrate samples will be submitted for quantitative taxonomic analysis of community structure. Mayfly samples will be submitted for analysis of metals included in the CCR parameters list (excluding radium) and strontium. Mayfly nymph samples must be processed in the laboratory within 24 hours of sample collection, and mayfly nymphs collected for depuration must be kept alive and handling stress to the nymphs must be minimized. Refer to TVA-KIF-SOP-29 for further details.

Samples will be separated as described above and shipped to the following:

- Sediment samples collected for percentage of ash analysis will be submitted to the RJ Lee Group in Monroeville, Pennsylvania.
- Sediment samples collected for analysis of the CCR parameters and strontium (including samples being held pending the results of the Phase 1 analyses) will be submitted to TestAmerica in Pittsburgh, Pennsylvania.
- Benthic invertebrate samples collected for quantitative analysis will be submitted to Pennington and Associates, Inc. in Cookeville, Tennessee.
- Mayfly samples collected for analysis of metals included in the CCR parameters list (excluding radium) and strontium will be submitted to Pace Analytical in Minneapolis, Minnesota.
- Mayfly samples designated for depuration prior to laboratory analysis will be submitted to Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. Upon completion of the depuration process at ORNL the samples will be submitted to Pace Analytical in Minneapolis, Minnesota.

Coolers will be prepared for shipment in accordance with TVA TI ENV-TI-05.80.06 *Handling and Shipping of Samples* by taping the cooler drain shut, lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position.

Small uniformly sized containers (such as 4-ounce or 8-ounce soil jars) will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Gel ice or loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e. strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Consultant Project Manager.

5.2.5 Sample Analyses

All sediment samples will be submitted for analysis of percentage ash using PLM. The top six inches of each sediment sample will also be submitted for analysis of the CCR parameters and strontium. The CCR parameters are summarized in Tables 4 through 6. The quantitative benthic invertebrate samples will be submitted for processing during which the specimens will be identified and enumerated to the lowest practical taxonomic level. The total number of each taxa will be tallied and used to generate benthic invertebrate community metrics needed to quantify aspects of community structure. The mayfly samples will be submitted for analysis of metals included in the CCR parameters list (excluding radium) and strontium. Select mayfly nymph samples will have their digestive systems depurated before analysis.

Table 7 provides the analytical laboratory methods, preservation requirements, sample containers and holding times for the PLM analysis, CCR parameters and strontium, benthic invertebrates, and mayflies. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 4. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride *
Fluoride *
pH *
Sulfate *

*Not included in mayfly tissues analyses

Table 5. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride *
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined *

*Not included in mayfly tissues analyses

Table 6. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc
Strontium **

* Constituents not listed in CCR Appendices III and IV

** Constituent not included in TDEC regulations but included in sampling program

Table 7. Analytical Methods, Preservation, Container(s) and Holding Times

Constituent	Analytical Method	Preservative	Container(s)	Holding Time
Percent ash	PLM	NA	4 oz. glass jar	NA
Metals	SW-846 6020A	Cool to < 6° C	4 oz. glass jar	180 days
Mercury	SW-846 7471B	Cool to < 6° C	4 oz. glass jar	28 days
Radium 226	SW-846 901.1	Cool to < 6° C	8 oz. glass jar	180 days
Radium 228	SW-846 901.1	Cool to < 6° C	8 oz. glass jar	180 days
Chloride	SW-846 9056A Modified	Cool to < 6° C	4 oz. glass jar	28 days
Fluoride	SW-846 9056A Modified	Cool to < 6° C	4 oz. glass jar	28 days
Sulfate	SW-846 9056A Modified	Cool to < 6° C	4 oz. glass jar	28 days
pH	SW-846 9045D	Cool to < 6° C	4 oz. glass jar	NA*
Benthic Invertebrates	NA	10% buffered formalin solution	16 oz./32 oz. glass jars	NA
Non-depurated Mayfly Nymphs	SW-846 6020A	Cool to < 6° C	4 oz. glass jar	24 hours**
Depurated Mayfly Nymphs	SW-846 6020A	Surface water, cool to < 6° C	32 oz. glass jar	24 hours**
Adult Mayflies	SW-846 6020A	Cool to < 6° C	32 oz. glass jar	24 hours**

* Holding time for sediment pH samples is 15 minutes following creation of sediment paste. Sediment samples submitted for laboratory analysis of pH will have paste prepared in the laboratory so that analysis can be completed within the holding time.

**Additional laboratory preparation required upon receipt.

5.2.6 Equipment Decontamination Procedures

Decontamination procedures will be conducted in accordance with TVA TI ENV-TI-05.80.05. The following procedures will be used to maintain the overall objective of minimizing the potential for cross-contaminating samples and media during sampling activities. Sampling equipment will be cleaned before transport to the field. When appropriate or practical, disposable sampling equipment will be utilized in the field. However, non-dedicated and non-disposable equipment used for sampling is to be decontaminated prior to and after each use.

Equipment that comes into direct contact with sediment samples for laboratory analyses will undergo decontamination between each use that will include the following steps:

- Wash with non-phosphate detergent (i.e., LiquiNox™) and analyte-free DI water solution
- Rinse multiple times with analyte-free DI water
- Air drying

Equipment decontamination is not critical when sampling benthic invertebrates and mayflies. The Ponar Dredge and associated equipment will be rinsed with river water to ensure that all debris is removed from each between sampling locations.

Equipment will be placed in a clean trash bag or other separate container during transport to prevent cross-contamination. Equipment that is not fully decontaminated prior to leaving the Plant will be properly disposed or wrapped and stored to prevent contamination of other equipment until it can be properly decontaminated. Decontamination activities will be documented in the field book or on a field data sheet. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.7 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Sediment and debris
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to benthic sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Three types of field QA/QC samples will be collected during sampling activities: field duplicate samples, MS/MSD samples, and equipment blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One duplicate sediment sample will be collected for every twenty sediment samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected by splitting the homogenized sample volume into two sets of identical, laboratory-prepared sample bottles. One duplicate composite sample of mayflies per type (i.e. adult, depurated nymph, and non-depurated nymph) will be collected per sampling event. Duplicate samples will be prepared as blind duplicates and will be collected by dividing a composite sample into approximate equal numbers of whole individuals collected from one area.

For each duplicate sample collected of each type, one set of samples will be given the sample identifier indicative of the sample location, and the second set of sample bottles will be simply labeled as DUP1, DUP2, etc. followed by the collection date, as further defined below in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – Matrix spike samples will be collected to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sediment sample will be collected for every twenty sediment samples collected. MS/MSD samples will be collected by splitting the homogenized sample volume into three sets of identical, laboratory-prepared sample bottles. Samples designated in the field to be processed as the MS/MSD, for which extra sample volume will be collected, must be identified as such (i.e., "MS/MSD") in the comments field on the COC records and sample labels. The sample locations will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD (e.g., pH, radium-226, radium-228).

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected during each day of the sediment sampling activities. The sediment sampling equipment blank will be collected at a sediment sampling location by pouring laboratory-provided DI water into or over the decontaminated sampling equipment, then into the appropriate sample containers. One equipment (rinsate) blank will be collected during each day of the mayfly nymph sampling activities. The mayfly nymph sampling equipment blank will be collected at a mayfly sampling location by pouring laboratory-provided DI water through the decontaminated sieve and mesh/netting into the appropriate sample containers. The locations of collecting the equipment blanks will be noted in the log book.

Field quality control samples are not germane to quantitative benthic invertebrate sampling. Quality control will be assessed by the laboratory by recounting and re-keying a subset of samples and comparing the results to the primary analysis.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to ensure the label is not removed. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

PLM data will not be subjected to data validation due to the specialized training and equipment required to accurately visually quantitate ash. PLM data will be subjected to verification including a review of QC analyses and a reasonability assessment based on photomicrographs included in the data package.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP. The overall project schedule may be adjusted to reflect seasonal restrictions to when SAPs can be implemented for sampling of fish tissue (April through October), fish ovary (April through June) and benthic/mayfly (June through August). Approval of the final EIP will dictate the actual start and completion dates on the project timeline.

Table 8. Preliminary Schedule for Phase 1 Benthic SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Benthic SAP Submittal		Completed
Prepare for Field Activities	30 Days	Following EIP Approval
Conduct Field Activities	30 Days	Following Field Preparation
Laboratory Analysis	90 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

*Dependent upon seasonality.

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- The number and/or location of the proposed samples described in this SAP may have to be modified based on conditions encountered in the field. Any deviations from this SAP will be documented in the EAR.
- The sediment, quantitative benthic invertebrate, and mayfly sampling methods described in this SAP may have to be modified based on conditions encountered in the field. Any deviations from this SAP will be documented in the EAR.
- The anticipated schedule in Section 7.0 assumes that approval to proceed is provided such that sampling can be scheduled and conducted during the appropriate time of the year. If approval to proceed is received too late in the year, sampling will not proceed until the following year.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2013. "TVA Kingston Standard Operating Procedures – TVA-KIF-SOP-35 Standard Operating Procedure for Reservoir Benthic Macroinvertebrate Sampling, Rev 1." August.

Tennessee Valley Authority (TVA). 2015. "TVA Kingston Standard Operating Procedures – TVA-KIF-SOP-29 Standard Operating Procedure for Mayfly Sampling, Rev 2." March.

Tennessee Valley Authority (TVA). 2016. "TVA Gallatin Standard Operating Procedures – TVA-GAF-SOP-02 Standard Operating Procedure for Sediment Sampling, Rev 0." July.

Tennessee Valley Authority (TVA). 2017a. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001." March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

ATTACHMENT A
FIGURES

Figure No.
1

Title
Sediment Sampling

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by MB on 2018-01-22
Technical Review by JC on 2018-01-22

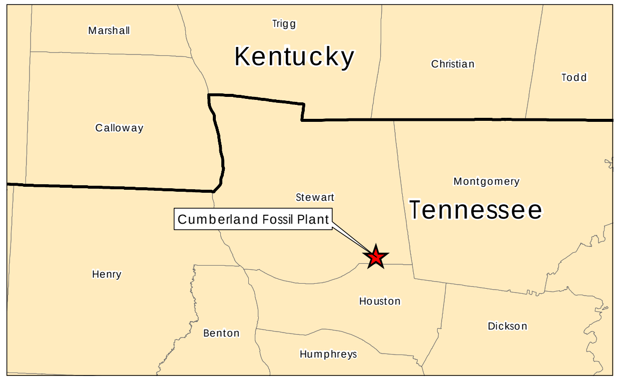
0 500 1,000 1,500 2,000 Feet
1:6,000 (At original document size of 22x34)

Legend

- Area of Interest
- Historic Seep (Approximate Location)
- Proposed Sediment Sampling Transect
- Stream
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

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Figure No.
2

Title

Benthic Macroinvertebrates Sampling

Client/Project

Tennessee Valley Authority
Cumberland Fossil Plant

Project Location

Stewart County, Tennessee

175566329
Prepared by MB on 2017-10-16
Technical Review by JC on 2017-10-16

0 400 800 1,200 1,600 Feet

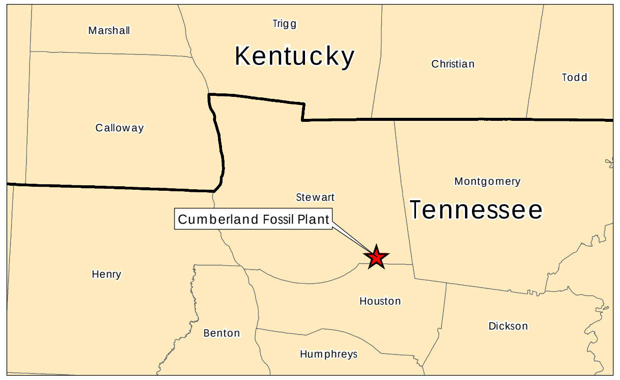
1:4,800 (At original document size of 22x34)

Legend

- Area of Interest
- Historic Seep (Approximate Location)
- Stream
- Transects
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec TVA

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Figure No.
3

Title
Off-Site Benthic Macroinvertebrates Sampling

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by MB on 2017-10-16
Technical Review by JC on 2017-10-16

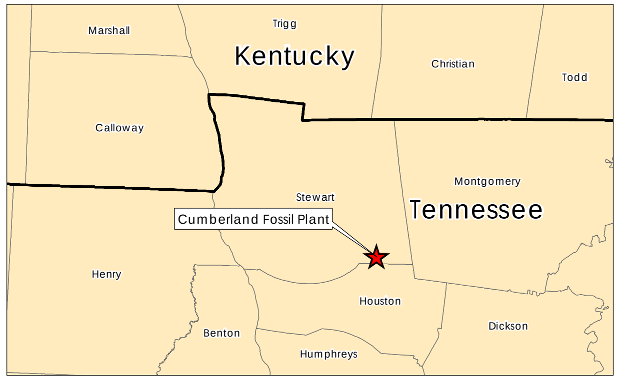
0 1,000 2,000 3,000 4,000 Feet
1:12,000 (At original document size of 22x34)

Legend

Transects

CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps (NAIP c. 2016)



U:\TVA-EIP\175566329\gis\mxds\REV2\17_CUF_Offsite_Benthic_Transects.mxd Revised: 2017-10-16 By: mbough

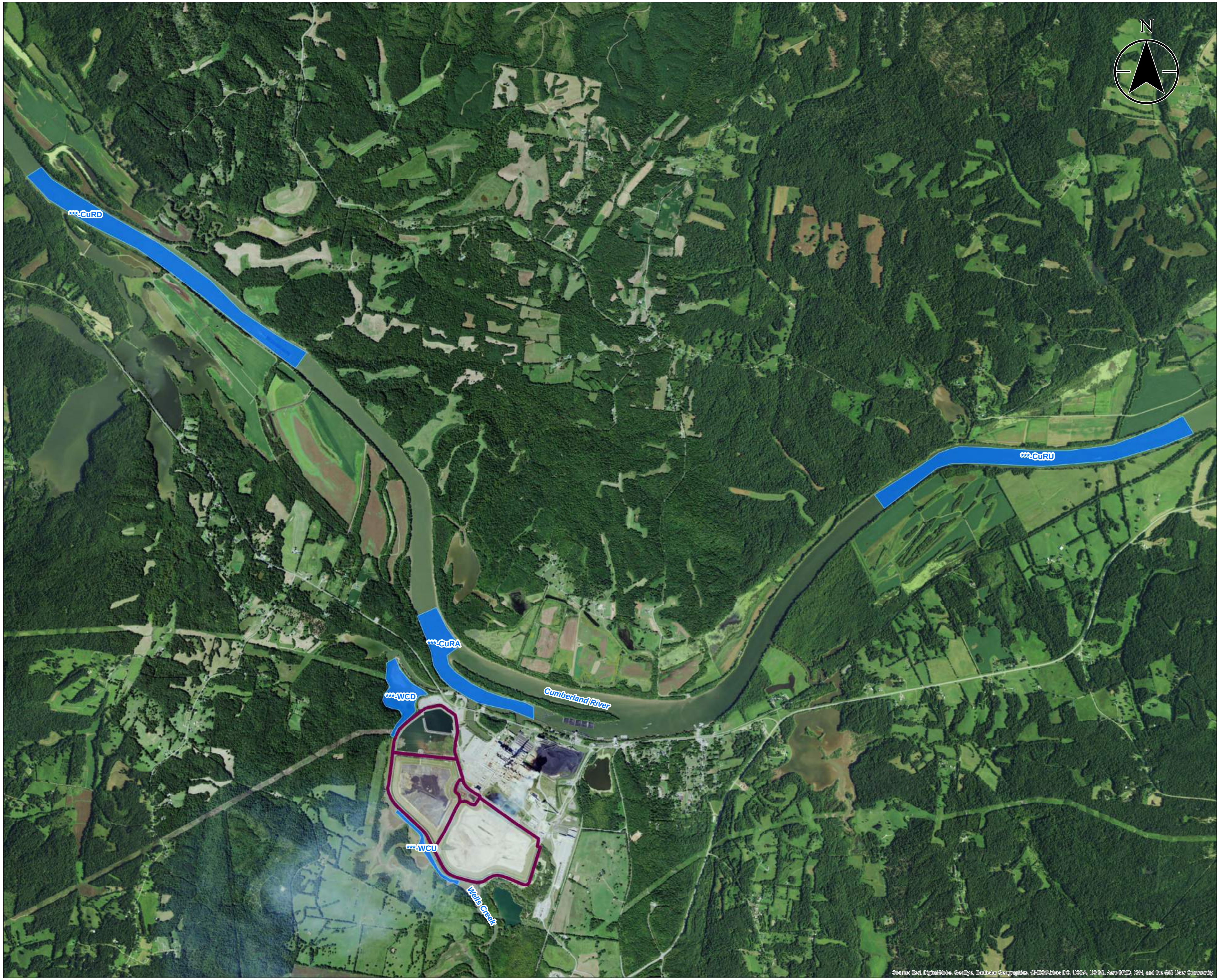


Figure No.
4

Title
Mayfly Sampling
Adult Mayflies, Purated Mayfly Nymphs, & Non-Purated Mayfly Nymphs

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

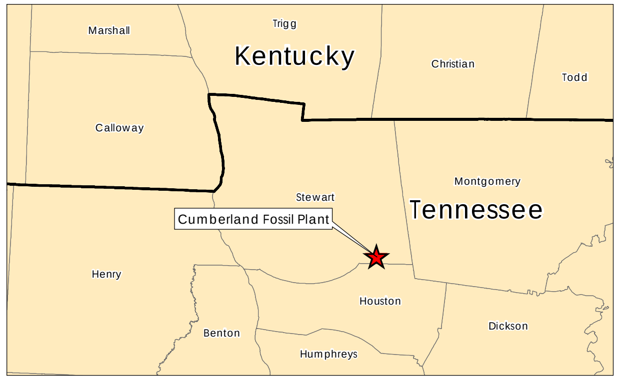
175566329
Prepared by TR on 2017-10-16
Technical Review by RD on 2017-10-16

0 1,500 3,000 4,500 6,000
Feet
1:18,000 (At original document size of 22x34)

Legend

- Mayfly Sample Location
- CCR Unit Area (Approximate)

Notes
1. *** Adult Mayflies, Purated Mayfly Numphs, and Non-Purated Mayfly Nymphs; sampled at each location, samples at each location will have a unique ID sample Biota Matrix Code (MFA, MFP, MFN respectively).
2. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
3. Imagery Provided by ESRI Basemaps (NAIP c. 2016)



Stantec
TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Benthic Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Submersible dissolved oxygen meter
500 micrometer screen
Decontaminated HDPE containers and new lab-certified HDPE scoops
Stainless steel sieve fitted with 2 millimeter or less stainless steel, Nitex, or Teflon mesh/netting
Stainless steel, plastic, or Teflon-coated forceps
Sweep nets
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX S
HISTORIC SEEP SUMMARY

CUF Seepage History Summary

TVA has conducted annual dike inspections at CUF since 1972. These inspections have primarily focused on stability issues pertaining to seeps. NPDES Permit No. TN0005789 was issued by TDEC to the TVA Cumberland Fossil Plant on November 30, 2005, and expired on May 31, 2010. However, because TVA submitted an application for renewal in 2009 and 2016, the permit is administratively continued in accordance with 40 CFR 122.6. Under the NPDES permit, TVA visually inspects the dikes and toe areas at least quarterly for seepage and submits an annual report to the TDEC Nashville Environmental Field Office documenting the findings of the inspections and remedial activities implemented.

A Seepage Action Plan was developed for CUF in 2010. It described inspection protocols, seepage action levels, a list of possible problems and recommendations, and initiated the use of a facility seepage log. When the site was evaluated for the CUF Dry Fly Ash Stack and Gypsum Disposal Complex Seepage Improvements Project, the seepage log listed 17 seepage areas. Of the 17 seepage areas, 10 were identified above the perimeter dike, subject to capture by the perimeter drainage ditch and subsequent routing to the Ash Pond and exiting through the NPDES outfall. The seepage areas are addressed below in their respective units.

Remedial activities include the construction of a clay seal in the Retention Pond where seepage was observed under the northernmost dike crossing of the abandoned Wells Creek channel in 1974. The clay seal, 30-40 feet in width, was placed on the inside of the dike to mitigate the flow of seepage through the dike. Riprap was also placed on the slope for wave protection. Seepage was not observed at this location during subsequent inspections.

A map depicting historic seepage areas is shown on Figure 1. A summary of the seep history for CUF is provided in Table 1.

Table 1. Seepage History Summary

Figure No.	Seep No.	CCR Unit	Description
1	A	Ash Disposal Area 1 (old designation, aka Active Ash Pond)	Historic seep identified in 1974 at the northern dike crossing of the pre-construction Wells Creek alignment. A clay seal, 30-40 feet wide, was placed on inside of dike as a repair measure, and the slope was riprapped for wave protection. Seepage was not identified at this location during subsequent inspections.
1	Seep Log No. 1	Gypsum Disposal Complex	This seep was identified at the southwest corner of the complex in August 2009 and classified as Action Level 2 (Flowing – No Erosion). A graded filter was installed to address this seep with respect to structural stability in 2015.
1	Seep Log No. 2	Gypsum Disposal Complex	This seep was identified in 2005 and classified as Action Level 1 (Non-Flowing). A graded filter was installed to address this seep with respect to structural stability in 2011.
1	Seep Log No. 3	Gypsum Disposal Complex	This seep was identified on the southeast toe of dike between subdrain-14 and subdrain-15 in 2010 and classified as Action Level 2 (Flowing – No Erosion). This seep is located above the perimeter ditch; therefore, drainage from this seep is routed to an NPDES-permitted outfall. The Dry Ash Stack and Gypsum Disposal Complex Partial Closure Project (TVA Project No. 607600). IFC Plans issued to TDEC for review include the installation of a graded filter and riprap to address this seep with respect to structural stability. TVA will continue to monitor this seep until it receives approval from TDEC to proceed with construction of the project.

Table 1. Seepage History Summary

Figure No.	Seep No.	CCR Unit	Description
1	Seep Log Nos. 4, 5, & 6	Gypsum Disposal Complex	These seeps were identified on the east perimeter dike at the toe of dike 2 / crest of dike 1 in 2010 and classified as Action Level 1 (Non-Flowing). A graded filter was installed in March 2015 to address these seeps with respect to structural stability.
1	Seep Log No. 7	Gypsum Disposal Complex	This seep was identified on the south portion of dike 3 in 2010 and classified as Action Level 2 (Flowing-No Erosion). This seep is located above the perimeter ditch; therefore, drainage from this seep is routed to an NPDES-permitted outfall. The Dry Ash Stack and Gypsum Disposal Complex Partial Closure Project (TVA Project No. 607600) IFC Plans issued to TDEC for review include the installation of a graded filter and riprap to address this seep with respect to structural stability. TVA will continue to monitor this seep until it receives approval from TDEC to proceed with construction of the project.
1	Seep Log Nos. 8 & 9	Gypsum Disposal Complex	These seeps were identified on the south portion of dike 3 in 2010 and classified as Action Level 1 (Non-Flowing). These seeps are located above the perimeter ditch; therefore, drainage from these seeps is routed to an NPDES-permitted outfall. The Dry Ash Stack and Gypsum Disposal Complex Partial Closure Project (TVA Project No. 607600) IFC Plans issued to TDEC for review include the installation of a graded filter and riprap to address these seeps with respect to structural stability. TVA will continue to monitor these seeps until it receives approval from TDEC to proceed with construction of the project.
1	Seep Log No. 10	Gypsum Disposal Complex	This seep was identified on the south portion of dike 3 just above the perimeter ditch in 2010 and classified as Action Level 2 (Flowing-No Erosion). This seep is located above the perimeter ditch; therefore, drainage from this seep is routed to an NPDES-permitted outfall. The Dry Ash Stack and Gypsum Disposal Complex Partial Closure Project (TVA Project No. 607600) IFC Plans issued to TDEC for review include the installation of a graded filter and riprap to address this seep with respect

Table 1. Seepage History Summary

Figure No.	Seep No.	CCR Unit	Description
			to structural stability. TVA will continue to monitor this seep until it receives approval from TDEC to proceed with construction of the project.
1	Seep Log No. 11	Gypsum Disposal Complex	This seep was identified on the south portion of dike 3 in 2010 and classified as Action Level 1 (Non-Flowing). This seep is located above the perimeter ditch; therefore, drainage from this seep is routed to an NPDES-permitted outfall. The Dry Ash Stack and Gypsum Disposal Complex Partial Closure Project (TVA Project No. 607600) IFC Plans issued to TDEC for review include the installation of a graded filter and riprap to address this seep with respect to structural stability. TVA will continue to monitor this seep until it receives approval from TDEC to proceed with construction of the project.
1	Seep Log Nos. 12 & 13	Gypsum Disposal Complex	These seeps were identified on the southwest portion of dike 3 in 2010 and classified as Action Level 1 (Non-Flowing). These seeps are located above the perimeter ditch; therefore, drainage from these seeps is routed to an NPDES-permitted outfall. The Dry Ash Stack and Gypsum Disposal Complex Partial Closure Project (TVA Project No. 607600) IFC Plans issued to TDEC for review include the installation of a graded filter and riprap to address these seeps with respect to structural stability. TVA will continue to monitor these seeps until it receives approval from TDEC to proceed with construction of the project.
1	Seep Log No. 14	Dry Fly Ash Stack	This seep was identified in 1975 and classified as Action Level 1 (Non-Flowing). A graded filter was installed in March 2015 to address this seep with respect to structural stability.
1	Seep Log No. 15	Gypsum Disposal Complex	This seep was identified in 2016 and classified as Action Level 1 (Non-Flowing).

Table 1. Seepage History Summary

Figure No.	Seep No.	CCR Unit	Description
			A graded filter was installed in 2016 to address this seep with respect to structural stability.
1	Seep Log No. 16	Dry Fly Ash Stack	This historic seep was located on east slope of Dry Ash Stack. A graded filter was installed in 2013 to address this seep with respect to structural stability.
1	Seep Log No. 17	Dry Fly Ash Stack	This historic seep was located on the north slope of Dry Ash Stack adjacent to detention area. A graded filter was installed in 2013 to address this seep with respect to structural stability.

References

Stantec Consulting Services Inc. (Stantec). 2010. "2010 Annual Inspection of Waste Disposal Areas, Cumberland Fossil Plant." June 28.

Stantec Consulting Services Inc. (Stantec). 2011. "2011 Annual Inspection of CCP Facilities and Ponds, Cumberland Fossil Plant." July 19.

URS. 2012. "2012 Annual Dam Safety Inspection, Cumberland Fossil Plant." October 18.

Stantec Consulting Services Inc. (Stantec). 2013. "Construction Certification Report – Dry Fly Ash Stack and Gypsum Disposal Complex Seepage Improvements Project." Prepared for Tennessee Valley Authority. October 15.

Stantec Consulting Services Inc. (Stantec). 2014. "2014 Intermediate (Annual) Inspection of CCP Facilities and Ponds, Cumberland Fossil Plant." January 10.

Stantec Consulting Services Inc. (Stantec). 2015. "2015 Formal (5 Year) Inspection of CCP Facilities and Ponds, Cumberland Fossil Plant." April 29.

Tennessee Valley Authority (TVA). 1973-2009. "Cumberland Fossil Plant – Annual Report on Waste Disposal Areas."

APPENDIX T
SEEP SAP

Seep
Sampling and Analysis Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

SEEP
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Seep
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ____________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	6/25/18 Date
TVA Investigation Field Lead	6/25/18 Date
Health, Safety, and Environmental (HSE) Manager	6/25/18 Date
Investigation Consultant Project Manager	06/25/18 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.06.21 16:01:18 -04'00' QA Oversight Manager	Date
Laboratory Project Manager	06/22/18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

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1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, this Seep Sampling and Analysis Plan (SAP) has been developed to evaluate whether dissolved CCR material is present in the surface streams of Wells Creek and the Cumberland River. This Seep SAP presents a phased approach and plan to sample water from seeps along surface impoundments and landfills at the CUF Plant (Plant).

2.0 OBJECTIVES

The objectives of this Seep SAP are to identify and characterize active seeps at the Plant for CCR constituents, and identify information that may explain and/or assess the potential movement of groundwater/pore water with dissolved CCR constituents into surface water streams on or adjacent to the Plant, through seepage.

This Seep SAP will provide the procedures necessary to identify and conduct the sampling and analysis of water from active seeps, along with soil samples from the same active seep area.

Proposed sampling locations are discussed in Section 4.0. Field activities will include the following tasks:

- Conduct a seep investigation to identify active seeps, if any, that could potentially discharge to adjacent surface water bodies
- Document the location of identified active seeps using a sub-meter global positioning system (GPS)
- Use the GPS data to identify seeps on the seep sampling location map
- Collect surface water samples from active seeps
- Collect soil samples from active seeps
- Package and deliver samples to the laboratory for analyses of CCR Parameters

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

Figure 1 (Attachment A) illustrates the locations of historic seeps at the Plant. Sampling locations will be based on the identification of active seeps at the impoundments and landfills below the perimeter ditch, with locations verified in the field using Global Positioning System (GPS). Water and soil samples will be taken at each active seep location. A list of the identified active seep(s) will be included in a Table 1, Proposed Seep Sampling Locations, and the completed Table 1 will be included in the EAR.

Table 1. Proposed Seep Sampling Locations

Sample Location ID	Description
e.g., SeS01	(To be determined)
e.g., SeS02	(To be determined)
e.g., SeW01	(To be determined)
e.g., SeW02	(To be determined)

SeS – Seep Soil; SeW – Seep Water

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, collect samples, and assist in providing scientifically defensible results.

Seep water sample collection will adhere to TVA Environmental Technical Instruction (TI) documents. The seep water sampling will be conducted in accordance with TVA TI EMA-TI-05.80.40, *Surface Water Sampling*, which references other TIs that are applicable to various aspects of surface water sampling.

A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

Both soil and water samples (provided flow is available), will be collected at each active seep location. Soil samples will be collected provided the seep occurs from soils and not rock. Soil samples will be collected as a five-point composite from within the saturated soil area. If required for access to seeps, any removal of aggregate and riprap filters at repaired seep locations will be coordinated through TVA prior to sampling. Seep surface water samples will be collected provided flow is adequate to obtain sufficient sample volume. Due to anticipated high turbidity conditions of seep surface water samples, both field-filtered samples and unfiltered surface water samples will be taken from active seeps. The purpose of field filtering is to obtain a sample that is representative of dissolved constituents in the seepage fluid; unfiltered seep surface water samples will be taken for comparative purposes.

Seep soil and seep water samples will be analyzed for the CCR Parameters listed in Section 5.3.5.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer
- Complete required health and safety paperwork and confirm field team members have completed required training.
- Coordinate activities with the Laboratory Coordinator, including ordering sample bottles with contained preservatives (as required), obtaining coolers and analyte-free deionized water, if needed, and notifying the laboratory of sampling and sample arrival dates.
- Obtain required calibrated field instruments, including health and safety equipment

- Perform environmental review prior to sampling – as required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC has a number of signatories from TVA.

- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping.*

- Obtain decontamination materials, including scrub brushes, soap, solvents, buckets, and DI water, as indicated in TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*.

- Obtain ice prior to sample collection for sample preservation

5.2 SEEP INVESTIGATION

As outlined in the EIP, a one-time seep investigation will be conducted to identify active seeps that do not flow through a permitted National Pollutant Discharge Elimination System (NPDES) outfall, are not permitted as an NPDES outfall, and have the potential to discharge into the adjacent surface streams. Known locations of historic seeps, inspection reports, and any other related information will be utilized in the identification of active seeps. If active seeps in this area are discovered, their locations will be staked in the field and shown on a Seep Sampling Location(s) map.

In order to evaluate seeps not visible due to structural mitigation activities (e.g., rip rap), the following investigative protocol will be used:

1. Field testing shall be conducted at the point where water from a seep(s) most likely enters a stream. TVA shall use a boat to monitor the stream channel and surface water at the water's edge.

2. Field testing will be conducted for pH, temperature, dissolved oxygen and conductivity using a multiparameter Sonde.

3. If field testing indicates a significant difference between stream channel samples and samples adjacent to the stream bank, then TVA shall determine if there is a flow from the seep.

4. If the seep is covered with rock or other material, the material shall be removed to determine if there is flow from the seep. [Note: an additional work order will be required to remove the rip rap.]

5. If there is flow from the seep, then the seep shall be sampled and analyzed for the CCR parameters.

Should active seeps be discovered during the investigation, a seep sampling location map will be finalized, and seep sampling will be implemented in accordance with Section 5.3.

5.3 SAMPLING METHODS AND PROTOCOL

Samples will be analyzed for CCR constituents listed in 40 CFR Part 257, Appendices III and IV. However, five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the federal CCR Appendices III and IV, have been added to the list of CCR constituents for analyses to maintain continuity with other TDEC environmental programs. Those additional constituents include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as "CCR Parameters."

Seep soil and surface water samples will be collected once and then submitted to the laboratory for the chemical analysis of the CCR Parameters. Various means and methods for collecting seepage water will be used based on the location and flow of the seep. Sampling and collection methods will be conducted in accordance with applicable TVA TIs, including:

- ENV-TI-05.80.02, Sample Labeling and Custody
- ENV-TI-05.80.03, Field Record Keeping
- ENV-TI-05.80.04, Field Sampling Quality Control
- ENV-TI-05.80.05, Field Sampling Equipment Cleaning and Decontamination
- ENV-TI-05.80.06, Handling and Shipping of Samples
- EMA-TI-05.80.40, Surface Water Sampling
- ENV-TI-05.80.46, Field Measurement Using a Multiparameter Sonde

5.3.1 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use.

Additional information regarding field equipment inspection and testing is included in the Quality Assurance Project Plan (QAPP).

5.3.2 Field Documentation

Field documentation will be maintained in accordance with TVA TI *ENV-05.80.03, Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.3.2.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.3.2.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.3.2.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Consultant will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.3.2.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.3.3 Collection of Samples

5.3.3.1 Seep Soil Sample Collection

Seep soil samples will be collected from surface soils as a five-point composite from within the saturated soil area. Five surface soils will be collected from discolored areas in the seep areas using a dedicated or decontaminated trowel (or similar tool) or disposal sampling scoop, and placed in a re-sealable dedicated plastic bag or decontaminated glass or plastic bowl for compositing. The collected sample will be homogenized until the physical appearance is consistent over the entire sample. After homogenization, a sample will be collected from the mixed soil and placed in the appropriate laboratory-supplied sampling container. Seep soil samples will be submitted to the laboratory for the chemical analysis of the CCR Parameters. Any free water issues will be addressed by the laboratory.

5.3.3.2 Seep Water Sample Collection

Seep water samples will be collected from active seep locations at impoundments and landfills provided flow is adequate to obtain sufficient sample volume, as defined and required by the laboratory. A seep water sample will be collected by directly filling a properly decontaminated sampling device or clean, non-preserved laboratory container from the seep area, and transferring the seep surface water to an appropriate laboratory-supplied and preserved, sampling container for analysis of CCR Parameters listed in Section 5.3.5. Due to the expected high turbidity of seep surface water samples, a second sample of water from each location will be field filtered using a peristaltic pump and a new, certified clean 0.45-micron filter and placed in an appropriate laboratory-supplied and preserved, sampling container for analysis of dissolved constituents. The purpose of field filtering is to obtain a sample that is representative of the dissolved constituents in the seepage itself. In instances where a non-preserved laboratory supplied bottle is used as the transfer container, the transfer container will only be used at that seep location, properly disposed and will not be used for sampling at other seeps, unless properly decontaminated. A handheld calibrated pH meter will be used to collect pH data at each seep water sample location.

At locations where the surface water stream is not deep enough to directly fill the sampling device or transfer bottle, but a small area of "pooling" is occurring, a peristaltic pump with new, certified clean tubing or a pipette with a bulb may be viable collection options, if recharge is adequate. Collection options are dependent upon field conditions and every effort will be made to collect viable water samples from the seep locations. Filtered and unfiltered seep surface water samples will be submitted to the laboratory for the chemical analysis of CCR Parameters listed in Section 5.3.5.

5.3.4 Preservation and Handling

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody*. Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-TI-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Consultant Project Manager.

5.3.5 Sample Analyses

Samples will be submitted to the TVA-approved laboratory for analysis per the QAPP. Both soil and water samples will be analyzed for the CCR Parameters, while filtered and unfiltered water samples will also be evaluated for dissolved and total constituents, respectively. Tables 2, 3, and 4 summarize the listed constituents. Analytical methods, preservation, containers(s) and holding times are presented in Table 5. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 2. 40 CFR Part 257, Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)

* Add TSS for aqueous unfiltered sampling

Table 3. 40 CFR Part 257, Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead

Appendix IV Constituents
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 4. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Radium 226	SW-846 903.0	HNO3 to pH < 2 Cool to <6°C	1 L glass or Plastic; 8-oz glass (soil)	180 days
Radium 228	SW-846 904.0	HNO3 to pH < 2 Cool to <6°C	2 L glass or plastic; 8-oz glass (soil)	180 days
Chloride	SW-846 9056A	Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days
Fluoride	SW-846 9056A	Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days
Sulfate	SW-846 9056A	Cool to <6°C	125-mL HDPE; 4-oz glass (soil)	28 days
Total Dissolved Solids (TDS)	SM2540C	Cool to <6°C	250-mL HDPE	7 days
Total Suspended Solids (TSS)	SM2540C	Cool to <6°C	1 L HDPE	7 days
pH	SW-846 9040C (field measurement)	NA	NA (liquids); 4-oz glass (soil)	NA*

*The pH of groundwater samples will be measured in the field. Holding time for soil pH samples is 15 minutes following creation of soil paste. Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time.

5.3.6 Equipment Decontamination Procedures

Documented decontamination will be performed for sampling equipment and instruments in contact with water or subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination.

Following decontamination, fluids will be placed into a drum for storage, transportation, and ultimately disposal in accordance with Section 5.3.7. Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instruments (e.g., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is in the QAPP.

5.3.7 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to pore water sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. MS/MSD samples will be collected by filling bottles alternately by thirds in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control* into three sets of identical, laboratory-prepared sample bottles.

Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD. For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of blank per lot.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals, (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to ensure the label is not removed. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 6. Preliminary Schedule for Seep SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Seep SAP Submittal		Completed
Prepare for Field Activities	25 Days	Following NTP
Conduct Field Activities – Seep Investigation	20 Days	Following Field Preparation
Conduct Field Activities – Implement Seep SAP (if required)	20 Days	Following Seep Investigation
Laboratory Analysis (if required)	50 Days	Following Field Activities
Data Validation (if required)	30 Days	Following Lab Analysis

8.0 ASSUMPTION AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Approved sampling methods and protocols may have to be substituted in the EIP based on changing field conditions.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017a. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2013. "Surface Water Sampling." Technical Instruction EMA-TI-05.80.40, Revision 0000. January 1.

Tennessee Valley Authority (TVA). 2017f. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

ATTACHMENT A
FIGURE

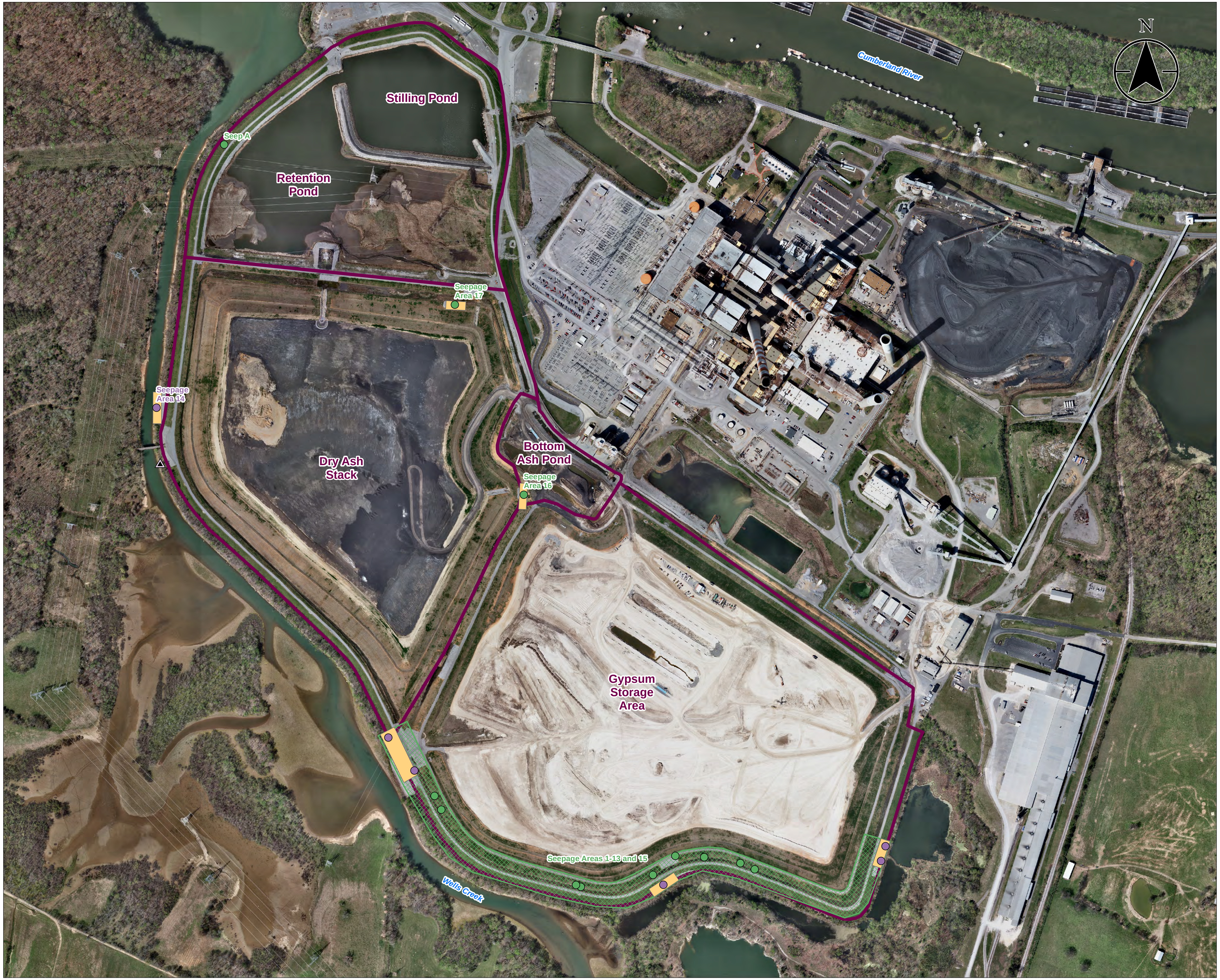


Figure No.
1

Title
Historic Seepage Areas (Approximate Location)

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2018-01-22
Technical Review by CA on 2018-01-22

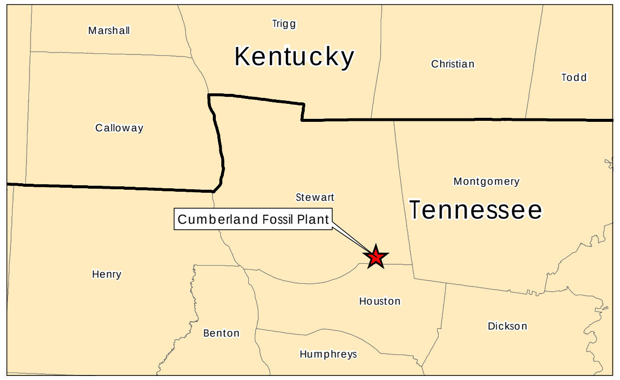
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Seepage Area Above Perimeter Ditch
- Seepage Area Below Perimeter Ditch
- Area of Interest
- Graded Filter Approximate Location *(Not to Scale)*
- Seep Area
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (c. 2017)



Stantec
TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Seep Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Boat and paddles
Anchor
Two outboard gas tanks
Rope
Waders, muck boots, knee boots, etc.
pH and conductivity meters
Thermometer
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Drilling rig equipment will be selected based on site conditions, selected by the Drilling Contractor, and approved by TVA.

APPENDIX U
SURFACE STREAM SAP

Surface Stream
Sampling and Analysis Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

SURFACE STREAM
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

SURFACE STREAM
SAMPLING AND ANALYSIS PLAN
CUMBERLAND FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Surface Stream
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ____________________ Revision __

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	6/25/18 Date
TVA Investigation Field Lead	6/25/18 Date
Health, Safety, and Environmental (HSE) Manager	6/25/18 Date
Investigation Consultant Project Manager	6/25/18 Date
Rock J. Vitale QA Oversight Manager	Date
Laboratory Project Manager	6/22/18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

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LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

TDEC's comments included a request for greater clarification on TVA's phased approach for evaluating whether dissolved CCR material has migrated to surface streams on or adjacent to the CUF Plant (Plant). TDEC also requested the submittal of a Surface Stream Sampling and Analysis Plan (SAP) and a map of surface stream sampling locations.

2.0 OBJECTIVES

The objective of this Surface Stream SAP is to characterize surface stream water quality on or adjacent to the Plant for CCR constituents, and identify information that may explain the potential transport of CCR constituents into those surface streams.

This Surface Stream SAP will provide the procedures necessary to conduct investigation activities associated with the sampling and analysis of water bodies bordering and in the vicinity of the Plant. Surface stream sampling is anticipated to be conducted concurrently with sediment sampling, as described in the Sediment SAP. Most sample locations will require both sediment and water sampling, but some locations will require one or the other. At locations that require both surface water and sediment sampling, the surface water sample will be collected first. To account for seasonal variations, two surface stream sampling events are proposed.

Surface stream samples will be collected from designated transects in the subject streams and analyzed for total and dissolved CCR constituents, as listed in Appendices III and IV of the CCR Rule, as well as TN Rule 0400-11-01-.04 Appendix 1. Five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the federal CCR Appendices III and IV, have been added to the list of CCR constituents for analyses to maintain continuity with other TDEC environmental programs. Those additional constituents include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as "CCR Parameters."

Proposed surface stream sampling transects to be evaluated are discussed in Section 4.0. Field activities will include the following tasks:

- Verify proposed sampling locations using the global positioning system (GPS)
- Collect water quality parameters and surface water samples from proposed sampling transects
- Package and deliver surface stream samples to laboratory

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

A phased approach to surface stream sampling will be utilized. Phase 1 surface stream sampling locations in Wells Creek and its tributary, the Cumberland River, and the Discharge Channel illustrated on Figure 1 (Attachment A) were selected to evaluate whether ash processing at CUF has had or is having any adverse effects on water quality.

Twenty-four surface stream sample locations are planned for the Phase 1 of this investigation (see Figure 1). Table 1 provides a summary of the proposed sampling locations. Seven sampling locations are proposed in the Cumberland River to capture water quality upstream of the CCR Units, near the CUF Impoundment permitted discharge location, and downstream of the CCR Units. Eleven sampling locations are proposed along Wells Creek, three of which will serve as background samples upstream of the CCR Units on Wells Creek to provide a baseline of CCR Parameters concentrations. An additional five sample locations will be from an unnamed tributary to Wells Creek that flows at the base of the exterior dike of the current gypsum stack. One sample location will be in the CUF Discharge Channel. Samples will be analyzed for total and dissolved CCR Parameters. The Surface Stream SAP for Phase 1 is written such that sediment and surface stream sampling would be conducted during the same sampling event. Sampling and laboratory specific information is covered in more detail in the QAPP.

Phase 2 of surface stream sampling will be conducted if there is an exceedance of 20% ash content (based on PLM analysis) in one or more of the sediment samples collected in accordance with the Benthic SAP. Phase 2 will consist of collecting additional surface stream samples from the location(s) where greater than 20% ash occurs. Several surface stream sample transects at the location(s) with greater than 20% ash content may be necessary to delineate the extent of potential contamination. Should this second phase be implemented, a new sampling location map will be developed. Phase 2 sampling procedures will remain the same as those described in this SAP. Only the sampling locations will differ.

Table 1. Proposed Surface Stream Sample Locations

Sample Location ID	Description
STR-WC01	Wells Creek Upstream of CUF – Background
STR-WC02	Wells Creek Upstream of CUF - Background
STR-WC03	Wells Creek Upstream of CUF - Background
STR-WC04	Wells Creek located downstream of Unnamed Tributary, Upstream of historic graded filter slope stabilization
STR-WC05	Wells Creek located at graded filter slope stabilization
STR-WC06	Wells Creek located upstream of an Area of Concern
STR-WC07	Wells Creek at location of an Area of Concern
STR-WC08	Wells Creek located at graded filter slope stabilization
STR-WC09	Wells Creek adjacent to location where dike crosses the pre-construction Wells Creek alignment
STR-WC10	Wells Creek in depositional area corresponding to sediment sample
STR-WC11	Wells Creek at the Cumberland City Rd. bridge
STR-UT01	Unnamed Tributary to Wells Creek upstream of graded filter slope stabilization
STR-UT02	Unnamed Tributary to Wells Creek at graded filter slope stabilization
STR-UT03	Unnamed Tributary to Wells Creek downstream of graded filter slope stabilization
STR-UT04	Unnamed Tributary to Wells Creek at graded filter slope stabilization
STR-UT05	Unnamed Tributary to Wells Creek downstream of graded filter slope stabilization
STR-CuR01	Cumberland River upstream of CUF (corresponds to fish tissue sampling location)

Table 1. Proposed Surface Stream Sample Locations

Sample Location ID	Description
STR-CuR02	Cumberland River upstream of CUF
STR-CuR03	Cumberland River just upstream of the storm water pond discharge
STR-CuR04	Cumberland River downstream of discharge channel
STR-CuR05	Cumberland River downstream of confluence of Wells Creek
STR-CuR06	Cumberland River downstream of CUF
STR-CuR07	Cumberland River downstream of CUF (corresponds to fish tissue sampling location)
STR-DC-01	CUF Discharge Channel at the Cumberland City Rd. bridge

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to collect samples, document field activities, and assist in providing scientifically defensible results.

Surface stream sample collection will adhere to TVA Environmental Technical Instruction (TI) documents. The surface stream sampling will be conducted in accordance with TVA TI EMA-TI-05.80.40 *Surface Water Sampling*, which references other TIs that are applicable to various aspects of surface stream sampling. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

Preparation for field activities will be conducted in accordance with TVA TI ENV-TI-05.80.01, *Planning Sampling Events.* As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer
- Complete required health and safety paperwork and confirm field team members have completed required training
- Coordinate activities with the Laboratory Coordinator, including ordering sample bottles containing preservatives (if required), obtaining coolers and analyte-free, deionized water (DI), if needed, and notifying the Laboratory Coordinator of sampling and sample arrival dates
- Obtain required field instruments, including health and safety equipment, Hydrolab® DS5X (or similar) multiparameter sonde, handheld sonic water depth meter (if needed), and sampling equipment and accessories (i.e. peristaltic pump or Kemmerer depth sampler, as per EMA-TI-05.80.40 *Surface Water Sampling*).
- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*
- Determine current flow conditions of subject streams to assess whether conditions are appropriate to conduct sampling. Sampling will need to occur during seasonal mean flows as described in Section 5.2.4
- Coordinate arrangements for obtaining a boat or vessel for accessing sample locations.

- Obtain ice prior to sample collection for sample preservation
- Obtain decontamination materials, including scrub brushes, soap, solvents, buckets, and DI water, as indicated in TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*.

5.2 SAMPLING METHODS AND PROTOCOL

Sampling and collection methods will be conducted in accordance with applicable TVA TIs, including:

- ENV-TI-05.80.01, *Planning Sample Events*
- ENV-TI-05.80.02, *Sample Labeling and Custody*
- ENV-TI-05.80.03, *Field Record Keeping*
- ENV-TI-05.80.04, *Field Sampling Quality Control*
- ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*
- ENV-TI-05.80.06, *Handling and Shipping of Samples*
- EMA-TI-05.80.40, *Surface Water Sampling*
- ENV-TI-05.80.46, *Field Measurement Using A Multi-Parameter Sonde*

5.2.1 Field Analyses

A Hydrolab® DS5X (or similar) multiparameter sonde will be used to record a depth profile of conventional water quality parameters at each sample location. If water depth is less than two meters, water quality parameters will be monitored at the surface and mid-depth of the water column. For depths greater than two meters, water quality parameters will be monitored within 1 meter of the stream bottom and in increments of one meter to the surface. If a thermocline is observed, the depth interval will be adjusted to better define the thermocline. The instrument will undergo documented calibration daily. Instrument use and calibration will follow TVA TI ENV-TI-05.80.46, *Field Measurement Using A Multi-Parameter Sonde*. Conventional field parameters to be measured include:

- Temperature (°C)
- Dissolved Oxygen (mg/L)
- Specific Conductivity (mS/cm)

- Oxidation Reduction Potential (mV)
- pH (Standard Units)
- Turbidity (NTU)

Water depth and velocity will be measured at each water sample location. Data will be recorded as described in TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Project-specific field forms will be used to record field measurements and observations for specific tasks.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field QC samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COCs will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a QC check of samples in each cooler compared to sample IDs on the corresponding COC. The Investigation Consultant will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

A Hydrolab® DS5X (or similar) will be used to collect water quality parameters along sample location transects. If thermal stratification is identified based on the Hydrolab® data, four water column samples will be collected at the stream thalweg (deepest point), right bank, and left bank along the sample transect for a total of 12 samples. If no thermal stratification is identified, surface, mid-depth, and epibenthic samples will be collected at the thalweg, right bank, and left bank locations for the transect for a total of nine samples. Sampling procedures may be adjusted as described below to accommodate willow and narrow sample locations. Water depth and velocity will be measured with respective meters and recorded.

Collection of surface stream samples will follow TVA's Technical Instruction EMA-TI-05.80.40 *Surface Water Sampling*. Sample collection will follow the procedures detailed below. Note that sampling methods may have to be substituted in some locations based on changing field conditions (obstructions, water depth, etc.). To account for seasonal variations, two sampling events are proposed. Sampling should be conducted during seasonal mean flows. Flow during sampling events should be in less than the 75th percentile based on analysis of the mean daily flows of the nearest United States Geological Survey (USGS) gage.

- Surface stream samples are to be collected from downstream to upstream to prevent the disturbance of bottom sediments from impacting further downstream sample locations.

- A sub-meter GPS unit will be used to navigate to sample locations. The depth and velocity of water will be determined and water quality parameters will be measured in-situ with the Hydrolab® DS5X (or similar) multiparameter sonde.

- Determine presence of thermal stratification along sample transects. This will determine sampling procedure outlined below. Where applicable, surface water samples will be collected prior to collection of sediment samples. A peristaltic pump sampler or Kemmerer depth sampler (or approved other sampler) will be used to obtain samples. Samples will be collected at the thalweg, right bank, and left bank locations along each transect. Sampling will be conducted as follows:

  If thermally stratified, collect near-bottom (epibenthic) sample 0.5 m above streambed, mid-hypolimnion sample (midway between bottom of thermocline and streambed), mid-epilimnion sample (midway between top of thermocline and water surface, and near-surface (0.5 m depth) sample. This sampling approach will yield 12 total samples per transect.

  If not thermally stratified, collect surface, mid-depth, and epibenthic samples. This sampling approach will yield nine total samples per transect.

  For waterbodies that may not have adequate depth to collect multiple samples from the water column, the field sampling team may adjust the number of samples to accommodate. Similarly, if the width of the waterbody along a sampling transect is not sufficient to support the collection of multiple samples along the transect, the field sampling team may adjust the procedure accordingly.

  Specific sample collection procedures are included in EMA-TI-05.80.40 Surface Water Sampling. Samples will be collected for both total and dissolved inorganic analysis. The field team will filter dissolved fractions immediately following sample collection using a new, certified clean high-capacity inline 0.45-micron filter and following the quality assurance procedures for filter blanks.

- When filling sample bottles, care will be taken to minimize sample aeration (i.e., water will be directed down the inner walls of the sample bottle) and avoid overfilling and diluting preservatives. Each sample bottle will be capped before filling the next bottle.

- The sampling team should take care not to contaminate the samples. Nitrile gloves will be worn when collecting samples. A new pair of gloves will be used at each sample location.

5.2.5 Preservation and Handling

Samples will be collected in a transfer bottle that will then be poured into laboratory-provided sample containers.

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody*. Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright single layer. Small uniformly sized containers will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Loose ice will be placed around and among the sample containers to ensure that the samples remain at <six degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to ensure containers are secure.

The original COC will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC. If multiple coolers are required to ship samples contained on a single COC the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed/dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been broken previously and that the seal number corresponds with the number on the COC. The laboratory will note the condition and temperature of the samples upon receipt and will identify any discrepancies between the contents of the cooler and COC. If there are any discrepancies the laboratory project manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC to the QA Oversight Manager and Investigation Consultant Project Manager.

5.2.6 Sample Analyses

Surface stream samples will be submitted to the TVA-approved laboratory for analysis. Surface stream samples will be analyzed by a lab for concentrations of the CCR Parameters summarized in Tables 2, 3, and 4.

Table 2. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)*

*Total Suspended Solids (TSS) for aqueous unfiltered sampling will be added.

Table 3. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 4. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

*Constituents not listed in CCR Rule Appendices III and IV

Surface stream data collected during this investigation will be reported to TDEC in an Environmental Assessment Report (EAR).

Table 5. Analytical Methods, Preservation, Container(s) and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Radium 226	SW-846 903.0	HNO3 to pH < 2 Cool to <6°C	1 L glass or Plastic	180 days
Radium 228	SW-846 904.0	HNO3 to pH < 2 Cool to <6°C	2 L glass or plastic	180 days
Chloride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Fluoride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Sulfate	SW-846 9056A	Cool to <6°C	125-mL HDPE	28 days

5.2.7 Equipment Decontamination Procedures

The following procedures will be used to maintain the overall objective of minimizing the potential for cross-contaminating samples and media during sampling activities. Sampling equipment will be cleaned before transport to the field. When appropriate or practical, disposable sampling equipment will be utilized in the field. However, non-dedicated and non-disposable equipment used for sampling is to be decontaminated prior to and after each use in accordance with TVA TI ENV-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*.

Equipment that comes into direct contact with surface stream samples for laboratory analyses will undergo decontamination between each use that will include the following steps:

- Wash with non-phosphate detergent (i.e., LiquiNox™) and DI water solution
- Rinse multiple times with analyte-free, DI water
- Air drying

Decontamination of water quality meters will be performed upon arriving to a new sampling location. Equipment will be placed in a clean trash bag or other separate container during transport to prevent cross-contamination. Equipment that is not fully decontaminated prior to leaving the Plant will be properly disposed or wrapped and stored to prevent contamination of other equipment until it can be properly decontaminated. Decontamination activities will be documented in the field book or on a field data sheet. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but will not be limited to:

- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to surface stream sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below.

Field Duplicate Samples – One duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. MS/MSD samples will be collected filling bottles alternately by thirds in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control* into three sets of identical, laboratory-prepared sample bottles. Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book.

The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD. For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of blank per lot.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals, (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, Sample Labeling and Custody and ENV-TI-05.80.03, Field Record Keeping. Each sample container will have a sample label affixed and secured with clear package tape as necessary to ensure the label is not removed. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP. The overall project schedule may be adjusted to reflect seasonal restrictions to when SAPs can be implemented for sampling of fish tissue (April through October), fish ovary (April through June) and benthic/mayfly (June through August). Approval of the final EIP will dictate the actual start and completion dates on the project timeline.

Table 6. Preliminary Schedule for Surface Stream SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Surface Stream SAP Submittal		Completed
Prepare for Field Activities	30 Days	Following EIP Approval
Conduct Field Activities	15 Days	Following Field Preparation
Laboratory Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Sampling methods and field locations may be adjusted based on actual field conditions. Any adjustments will be reported in the EAR.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2013. *Surface Water Sampling*. Technical Instruction EMA-TI-05.80.40, Revision 0000. January 1.

Tennessee Valley Authority (TVA). 2016. *Planning Sampling Events*. Technical Instruction ENV-TI-05.80.01, Revision 0000 May 5.

Tennessee Valley Authority (TVA). 2017a. *Sample Labeling and Custody*. Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017b. *Field Record Keeping*. Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. *Field Sampling Quality Control*. Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. *Field Sampling Equipment Cleaning and Decontamination*. Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. *Handling and Shipping of Samples*. Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017f. *Field Measurement Using a Multi-Parameter Sonde*. Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

United States Geological Survey (USGS). 2006. *Techniques of Water-Resources Investigations Book 9, National Field Manual for the Collection of Water Quality Data*, Chapter A4. Collection of Water Samples.

ATTACHMENT A
FIGURE

Figure No.
1

Title
Surface Stream Sampling

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

175566329
Prepared by TR on 2018-01-22
Technical Review by RD on 2018-01-22

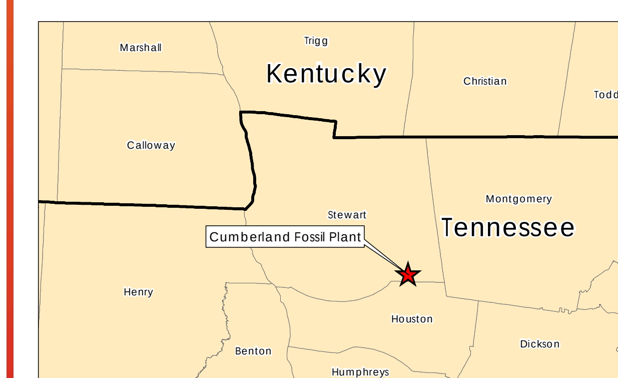
0 1,250 2,500 3,750 5,000 Feet
1:15,000 (At original document size of 22x34)

Legend

- Area of Interest
- Historic Seep (Approximate Location)
- Surface Stream Sample Location
- Stream
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemap (NAIP c. 2016)
3. Samples will be collected at the left bank, right bank, and deepest channel location



Stantec

TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Surface Stream Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Waders, muck boots, knee boots, etc.
Peristaltic pump
Tubing
Hydrolab DS5X
Sonic depth meter
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX V
FISH TISSUE SAP

Fish Tissue
Sampling and Analysis Plan
Cumberland Fossil Plant

Revision 3 Final

TDEC Commissioner's Order:
Environmental Investigation Plan
Cumberland Fossil Plant
Cumberland City, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

June 25, 2018

REVISION LOG

Revision	Description	Date
1	Addresses January 13, 2017 TDEC Review Comments and Issued for TDEC Review	May 12, 2017
2	Addresses August 31, 2017 TDEC Review Comments and Issued for TDEC Review	November 9, 2017
3	Addresses December 11, 2017 TDEC Review Comments and Issued for TDEC Review	January 26, 2018
3 Final	Addresses Public Comments and Issued as Final	June 25, 2018

Fish Tissue
Sampling and Analysis Plan
Cumberland Fossil Plant

TITLE AND REVIEW PAGE

Title of Plan: Fish Tissue
Sampling and Analysis Plan
Cumberland Fossil Plant
Tennessee Valley Authority
Cumberland City, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ______________________

Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

______________________ 6/25/18
TVA Investigation Project Manager — Date

______________________ 6/25/18
TVA Investigation Field Lead — Date

______________________ 6/25/18
Health, Safety, and Environmental (HSE) Manager — Date

______________________ 6/25/18
Investigation Consultant Project Manager — Date

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@cmvltd.com, c=US Date: 2018.06.21 15:57:23 -04'00'
QA Oversight Manager — Date

Tod Noltemeyer
Laboratory Project Manager — Date

____
Charles L. Head
TDEC Senior Advisor — Date

____
Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Cumberland Fossil Plant (CUF) on March 9-10, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at CUF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On April 11, 2016, TDEC issued a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 11, 2016, TVA submitted CUF EIP Revision 0 to TDEC. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, this Fish Tissue Sampling and Analysis Plan (SAP) has been developed to evaluate whether fish in the immediate vicinity and downstream of CUF have higher concentrations of CCR-related constituents than fish from reference locations not adjacent to or downstream from the CUF Plant (Plant).

2.0 OBJECTIVES

The objective of this Fish Tissue SAP is to set forth the procedures to be followed to capture fish, remove tissue samples, and store and ship samples to a laboratory. Laboratory-generated results from the samples will be used to assess whether fish in the immediate vicinity and downstream of the Plant have higher tissue concentrations of CCR-related constituents than the same species of fish from reference locations not adjacent to or downstream of the Plant.

The fish tissue analytical results will be used in conjunction with sediment and mayfly data to evaluate contaminant bioaccumulation. Methods for collecting and analyzing sediment and mayfly tissues are described in other SAPs. This Fish Tissue SAP:

- Provides guidance on the use of boat-mounted electro-shocker and/or gill nets to capture target fish species
- Describes protocols for obtaining and processing fish tissue samples, and completing quality control activities, to ensure that data quality objectives are achieved
- Documents the analytical method/parameter list for sample analysis to be performed by TVA's contracted laboratory
- Describes the data validation and management activities that will be performed on the fish tissue samples and resulting data

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Investigation Consultant will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks. The designated Safety Officer will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

Five reaches have been selected for the collection of fish and associated fish tissue as shown in Figure 1 (Attachment A) and Table 1. These five reaches are strategically located based on access, current hydrogeologic knowledge, and the greatest expectation of successfully capturing target fish species. Two reaches are located along Wells Creek and are associated with the CCR Units. The downstream Wells Creek reach (WCD) starts at river mile 0.5 (WeCM-0.5) and extends upstream for about 0.5 miles to river mile 1.0 (WeCM-1.0), which is located between two overhead utility line corridors. The upstream Wells Creek reach (WCU) is located between river mile 1.5 and 2.0 (WeCM-1.5 and 2.0). The remaining three reaches are located along the Cumberland River. One of these reaches is located adjacent to CUF (CuRA) in the Cumberland River between CuRM-102.3 and CuRM-103.3. This reach starts just downstream of Wells Creek confluence and extends for approximately 1.0 mile upstream with the upstream portion only including the south side of the island. The downstream reach (CuRD) on the Cumberland River is located between CuRM-100.5 and CuRM-98.5. The third reach and the most upstream sampling location (CuRU) on the Cumberland River starts at CuRM-106 and extends for two miles up to CuRM-108. This reach will be a reference reach. The sampling locations may be modified based on conditions in the field at the time of the sampling activities. Table 1 lists each of the approximate fish collection sampling locations proposed for the fish tissue sampling. Proposed sampling locations are shown on Figure 1.

Table 1. Fish Collection Sampling Reaches Used for the Fish Tissue Sampling at CUF, Stewart County, Tennessee.

Sampling Reach Name	Drainage	Approximate River/Creek Mile	Latitude	Longitude
WCD	Wells Creek	0.5 – 1.0	36.399582	-87.667311
			36.393273	-87.666959
WCU	Wells Creek	1.5 – 2.0	36.386656	-87.666284
			36.380897	-87.660828
CuRA	Cumberland River	102.3 – 103.3	36.404709	-87.663758
			36.395527	-87.651931
CuRD	Cumberland River	98.5 - 100.5	36.442574	-87.707251
			36.426126	-87.677823
CuRU	Cumberland River	106 - 108	36.414996	-87.614013
			36.421908	-87.580305

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to collect fish tissue samples and document field activities.

Fish tissue sample collection will be consistent with applicable United States Environmental Protection Agency (EPA) and TVA Technical Instruction (TI) and Standard Operating Procedure (SOP) documents. Quality Assurance/Quality Control (QA/QC) procedures and data quality objectives are included in Section 6.0 and the Plant-specific Quality Assurance Project Plan (QAPP). Related TVA methods used for sampling and/or any deviations from standard techniques listed in this SAP, the SOPs, or TI's will be documented in the field logbook. A project field logbook and field forms will be maintained by the Investigation Consultant Field Team Leader to record field data and observations including water quality data, electro-shocking and gill netting efforts, number and species of fish captured, and specific data for fish processed for laboratory testing. Field activities will be documented in accordance with Section 5.2.3.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer
- Complete required health and safety paperwork and confirm field team members have completed required training
- Coordinate activities with the Laboratory Coordinator, including ordering sample bottles, obtaining re-sealable sample bags, coolers, and high-purity deionized (DI) water, if needed, and notifying the Laboratory Coordinator of sampling and sample arrival dates
- Coordinate activities with Tennessee Wildlife Resources Agency (TWRA) as required by the Scientific Collection Permit
- Obtain the required field instruments and perform calibrations each day of sampling
- Obtain field equipment
- Discuss project objectives and potential hazards with project personnel
- Complete sample paperwork to the extent possible prior to deploying into the field, including chain-of-custody forms and sample labels

- Locate Sampling Reaches – Prior to starting sampling efforts each day, locate the sampling reaches using the Global Positioning System (GPS) and collect new coordinates if sampling reaches are modified due to field conditions
- Complete a field reconnaissance of proposed sampling locations to identify access locations

5.2 SAMPLING METHODS AND PROTOCOL

Fish collection and associated fish tissue sampling will be completed following TVA TI's/SOPs to the extent practicable. Methods used for sampling and any deviations from the TVA TI's/SOPs will be documented in the field logbook. The TVA TI's/SOPs to be used during fish tissue sampling include but are not limited to the following:

- ENV-TI-05.80.02, *Sample Labeling and Custody*
- ENV-TI-05.80.03, *Field Record Keeping*
- ENV-TI-05.80.04, *Field Sampling Quality Control*
- ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*
- ENV-TI-05.80.06, *Handling and Shipping of Samples*
- KIF-SOP-31, *Fish Sampling with Gill Nets*
- KIF-SOP-33, *Fish Sampling Using Boat-Mounted Electroshocker*

The following sections describe fish collection and tissue sampling procedures.

5.2.1 Fish Collection

The fish sampling team will consist of personnel with expertise in fish sampling techniques and experience with the quality control requirements of the sampling protocols listed in Section 6.0. Prior to conducting fish sampling for tissue collection, appropriate Scientific Collection Permits will be obtained from TWRA. In addition, the survey will be coordinated with TWRA's Regional Office in accordance with TWRA's Scientific Collection Permits. Fish sampling will be completed on sampling reaches discussed in Section 4.0. Fish sampling will be conducted using a combination of boat-mounted electro-shocking (electro-fishing) and gill netting. The primary collection method will be electro-shocking; however, in the event that any species proves difficult to collect, gill nets will be used.

Electro-fishing will be performed beginning at the upstream end of each sampling reach and moving with the current to the downstream end of each sampling reach. As fish are shocked and begin to surface, Field Sampling Personnel will use dip nets to retrieve individuals with priority given to females of the target species. Up to five electro-shocking passes of a stream sampling reach will be performed, if necessary, to collect the appropriate number of fish for analysis.

Collected fish will be stored in a livewell or bucket until the sampling reach is completed. Once completed, the appropriate numbers of target species of fish will be sacrificed and fillet, liver, and ovary samples will be collected.

In the event that some fish species (e.g. channel catfish) prove difficult to collect with boat electro-shocking equipment, gill nets will be used. Gill nets consist of a length of netting with a diameter large enough for a fish to pass partially through. There is a float line on top, and a lead line on the bottom, allowing the net to remain suspended in the water column. Gill nets will be set before dusk and retrieved just after sunrise the following morning. Up to three gill net sample events will be performed, if necessary, to collect the appropriate number of fish for analysis. Fish visually observed to be decomposing will not be collected for sample analysis.

The fish captured will be observed for abnormalities, such as scoliosis, blind eye, parasites, fungus, or lesions. Fish collected for tissue samples will be weighed and measured.

Fish sampling techniques used and QA/QC procedures will follow TVA KIF-SOP-33, *Fish Sampling Using Boat-Mounted Electroshocker* and KIF-SOP-31, *Fish Sampling with Gill Nets*, to the extent practicable. The methods used for sampling, or the deviations made from them, will be documented in the field logbook.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Investigation Consultant, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Consultant will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

For purposes of tissue sampling, fish will be categorized into five distinct groups, representing specific trophic levels within the aquatic ecosystem. Each trophic level group will be represented by one specific species. The representative species for this SAP are consistent with TVA study protocols:

- Top Carnivores – largemouth bass (*Micropterus salmoides*)
- Invertivores – bluegill (*Lepomis macrochirus*)
- Bottom Feeding Invertivore – redear sunfish (*Lepomis microlophus*)
- Bottom Feeding Omnivore – channel catfish (*Ictalurus punctatus*)
- Planktivore (Forage Fish) –shad (*Dorosoma spp.*)

Except for shad, a minimum of six to eight individuals of each species will be collected from each sampling reach to obtain sufficient sample weight for analysis and to measure variability within the sampling reach. The six to eight individuals of each species will be processed into fillet, ovary, or liver tissues (as described below) and combined to form composite tissue samples for each species from each sampling reach. Whole fish composite samples of 10 – 20 shad will be obtained from each sampling reach and combined to form a composite sample from each reach. Female fish are preferred over males, so male fish will only be retained in the event that six to eight females of each species can't be captured in a sampling reach. Composite samples of six to eight individual fish of the same species are consistent with EPA guidance on fish tissue monitoring (EPA 2000) and recommendations for fish collection to compare to the fish tissue-based water quality standard for selenium (EPA 2016).

For the composite fish samples (all species except shad), two whole boneless and skinless fillets (one from each side of the fish) will be collected from each set of six to eight specimens and combined into one re-sealable sample bag. Ovaries from the female fish (provided the sampling occurs during spawning season when females are gravid and ovaries are large enough and obvious enough to collect) will be collected and combined into one re-sealable sample bag or sample jar. Livers will be collected from each specimen and combined into one re-sealable sample bag or sample jar. The fish tissues will be removed onsite by Field Sampling Personnel with TVA's permission. The samples will be kept on ice at six degrees Celsius (° C) until arrival at the analytical laboratory where they will be frozen.

One co-located sample will be collected from each sampling reach and will consist of additional composite fillets, ovaries, and liver tissues of one of the target species, preferably different target species at each stream sampling reach. Duplicate samples are discussed in Section 6.2.

The fish used in a composite sample must meet the following criteria:

- Be of the same species
- Meet legal requirements of harvestable size or weight
- Consistent with EPA guidance (EPA 2000 and 2016), the fish will be of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual
- Be collected as close to the same time as possible, but no more than one week apart. This assumes that a sampling team was unable to collect all fish needed to prepare the composite sample on the same day. If fish used in the same composite are collected on different days (no more than one week apart), individual fish will be kept on ice until all the fish to be included in the composite are available for delivery to the laboratory
- Six to eight individuals per composite (or 10-20 individuals for shad) are proposed for collection. However, individuals must be collected in sufficient numbers and of adequate size so that collectively, they will provide at least eight grams of material per sample (i.e. eight grams of fillet, eight grams of liver, and eight grams of ovaries) to allow analysis of the CCR Parameters

All fish collection, tissue sampling, processing, and shipment activities will be recorded in the field logbook and on field forms as specified by TVA-ENV-TI-05.80.02, *Sample Labeling and Custody*, and TVA-ENV-TI-05.80.03, *Field Record Keeping.*

5.2.5 Preservation and Handling

Once each composite fish tissue sample container is filled, a water proof sample label will be placed inside, the container will be sealed, the outside will be cleaned by wiping with a clean paper towel, a sample label will be attached to the outside of the container, and a signed and dated custody seal will be applied. Each sample container will be checked to ensure that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory.

Gel ice or loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Consultant Project Manager.

5.2.6 Sample Analyses

Composite fish tissue samples will be submitted for laboratory analysis of the following constituents, hereafter referred to as "CCR Parameters":

- Boron and calcium from 40 CFR Part 257 Appendix III
- 40 CFR Part 257 Appendix IV Constituents, excluding radium and fluoride
- Five inorganic constituents from Appendix 1 of TN Rule 0400-11-.04
- Strontium
- Percent moisture

The constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations) were added to the list of CCR constituents for analyses to maintain continuity with other TDEC environmental programs. The fish tissue analysis will not include dissolved oxygen, chloride, fluoride, pH, sulfate, or total dissolved solids which are on the federal CCR Appendices III and IV constituents lists, because the constituents are not analyzed in animal tissues. The individual constituents of the CCR Parameters to be analyzed for the fish tissue study are listed in Tables 2 through 4.

Once received and custody has been established, the analytical laboratory will homogenize composite tissue samples using a series of dicing and mechanical blending procedures. The samples will be composited and homogenized on a species and sampling reach specific basis, resulting in a separate homogenate composite fillet, ovary, and liver tissue sample for each species at each sampling reach. These homogenized tissue samples will be analyzed for percent moisture and CCR Parameters outlined in Tables 2 through 4 below. Table 5 provides the analytical laboratory methods, sample size, preservation requirements, container size and holding times for the analysis.

A portion of the composite fillets and ovaries will be retained by the laboratory, if sample size permits, in frozen sample storage for potential future analysis and labeled as a duplicate sample. In the event that any homogenized composite tissue (fillet, liver, or ovary) sample yields unexpected results, these frozen and stored samples will be used to validate, or contradict previous laboratory analysis. Long-term storage, up to one year if stored at or less than -20°C, and laboratory preparation of stored ovaries will follow protocols established by EPA (2016).

Table 2. 40 CFR Part 257 Appendix III Constituents[1]

Appendix III Constituents
Boron
Calcium

Notes [1] Total dissolved solids, chloride, fluoride, pH, and sulfate are included in 40 CFR Part 257 Appendix III Constituents; however, are not included in the CCR Parameters for fish tissue sampling.

Table 3. 40 CFR Part 257 Appendix IV Constituents[1, 2]

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium

Notes [1] Radium 226 and 228 Combined are included in 40 CFR Part 257 Appendix IV Constituents; however, are not included in the CCR Parameters for fish tissue sampling.

[2] Analysis of fluoride is not applicable to fish tissue samples.

Table 4. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents[1, 2]
Copper
Nickel
Silver
Vanadium
Zinc

Notes [1] Strontium will be analyzed as part of the CCR Parameters; however, is not included in the Appendices III or IV or TDEC Appendix I constituents.

Table 5. Specifications for TVA Fish Tissue Sample Collection Analysis

Matrix	Parameters	Analytical Methods	Sample Size [1]	Preservation Requirements (chemical, temperature, light protected)	Containers (number, size, and type)	Maximum Holding Time (preparation/analysis)
Fish Tissue	Constituents in Tables 2 – 4 (except mercury)	SW-846 6020A	5 g	Stored and shipped at 6°C Frozen to < - 10°C at laboratory Archived samples: Frozen to < - 20°C	Re-sealable plastic bags or laboratory supplied bottles	One Year
	Mercury	SW-846 7473	1 g			
	Percent Moisture	ASTM D2974 - 87	2 g			

Notes: [1] Sample size is a minimum.

5.2.7 Equipment Decontamination Procedures

Decontamination will be performed for fish tissue sampling and processing equipment and surfaces, dip nets, and temporary fish holding containers in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Sampling equipment will be decontaminated prior to use and between sampling reaches. Sampling tools in contact with fish tissues will be decontaminated prior to use, between samples, and between sampling reaches. Nitrile gloves used during preparation of fish tissue sampling, and any swabs, or other decontamination brushes and wash pans used will be disposed of as general trash. All general trash, including fish remains, will be containerized and disposed of in accordance with Section 5.2.8. Decontamination activities will be documented in the field logbook. Additional information regarding equipment decontamination procedures and QA/QC is located in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Fish remains
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination,* the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to fish tissue sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Consultant considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Two types of field QA/QC samples will be collected when collecting fish tissue samples in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below.

Field Duplicate Samples – One laboratory duplicate will be analyzed for each stream sampling reach and will consist of an additional sample from the composite fillet, ovary, and liver tissues of one species, preferably different species at each stream sampling reach. Duplicate samples will be prepared as blind duplicates. The duplicate sample will be analyzed for the same parameters as the primary sample.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected during each day of the fish tissue sampling activities. The equipment blank will be collected at a fish sampling reach by pouring laboratory-provided DI water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the field logbook. The sample will be analyzed for the same analytes as the fish tissue samples.

Homogenization blank samples from the analytical laboratory processing equipment will be obtained by running ice through the fish tissue blending apparatus into laboratory grade sample containers for analysis.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to ensure the label is not removed. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP. The overall project schedule may be adjusted to reflect seasonal restrictions to when SAPs can be implemented for sampling of fish tissue (April through October), fish ovary (April through June) and benthic/mayfly (June through August). Approval of the final EIP will dictate the actual start and completion dates on the project timeline.

Table 6. Preliminary Schedule for Fish Tissue SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Fish Tissue SAP Submittal		Completed
Prepare for Field Activities	20 Days	Following EIP Approval
Conduct Field Activities	45 Days	Following Field Preparation
Laboratory Analysis	45 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- The number and/or location of the proposed samples described in this SAP may have to be modified based on conditions encountered in the field. Any deviations from this SAP will be included in the EAR.

- The fish sampling methods and analysis described in this SAP may have to be modified based on conditions encountered in the field, number of target specimen captured, presence of ovaries in female fish, and ability to obtain required sample weight of tissues. Any deviations from this SAP will be discussed in the EAR.

- The anticipated schedule in Section 7.0 assumes that approval to proceed is provided such that sampling can be scheduled and conducted during the appropriate time of the year. If approval to proceed is received too late in the year, sampling will not proceed until the following year.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2010a. "TVA Kingston Standard Operating Procedures – TVA-KIF-SOP-33, Fish Sampling Using Boat-mounted Electro-shocker." June.

Tennessee Valley Authority (TVA). 2010b. "TVA Kingston Standard Operating Procedures – TVA-KIF-SOP-31 Standard Operating Procedure for Fish sampling with Gill Nets." August.

Tennessee Valley Authority (TVA). 2017a. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

United States Environmental Protection Agency (EPA). 2000. "Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2, Risk Assessment and Fish Consumption Limits, Third Edition, EPA 823/B-00/007." November.

United States Environmental Protection Agency (EPA). 2004. "National Functional Guidelines for Inorganic Data Review." October.

United States Environmental Protection Agency (EPA). 2016. "Aquatic Life Ambient Water Quality Criterion for Selenium (Freshwater)." https://www.epa.gov/sites/production/files/2015-10/documents/draft-aquatic-life-ambient-water-quality-criterion-for-selenium-freshwater-2015-factsheet.pdf. June.

United States Environmental Protection Agency (EPA). 2016. "Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion (Draft), EPA 820/F-16/007." September.

United States Environmental Protection Agency (EPA) Region 4. 2001. "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual." November.

United States Environmental Protection Agency (EPA) Region 4. 2011. "Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services, Revision 2.0." September.

ATTACHMENT A
FIGURE

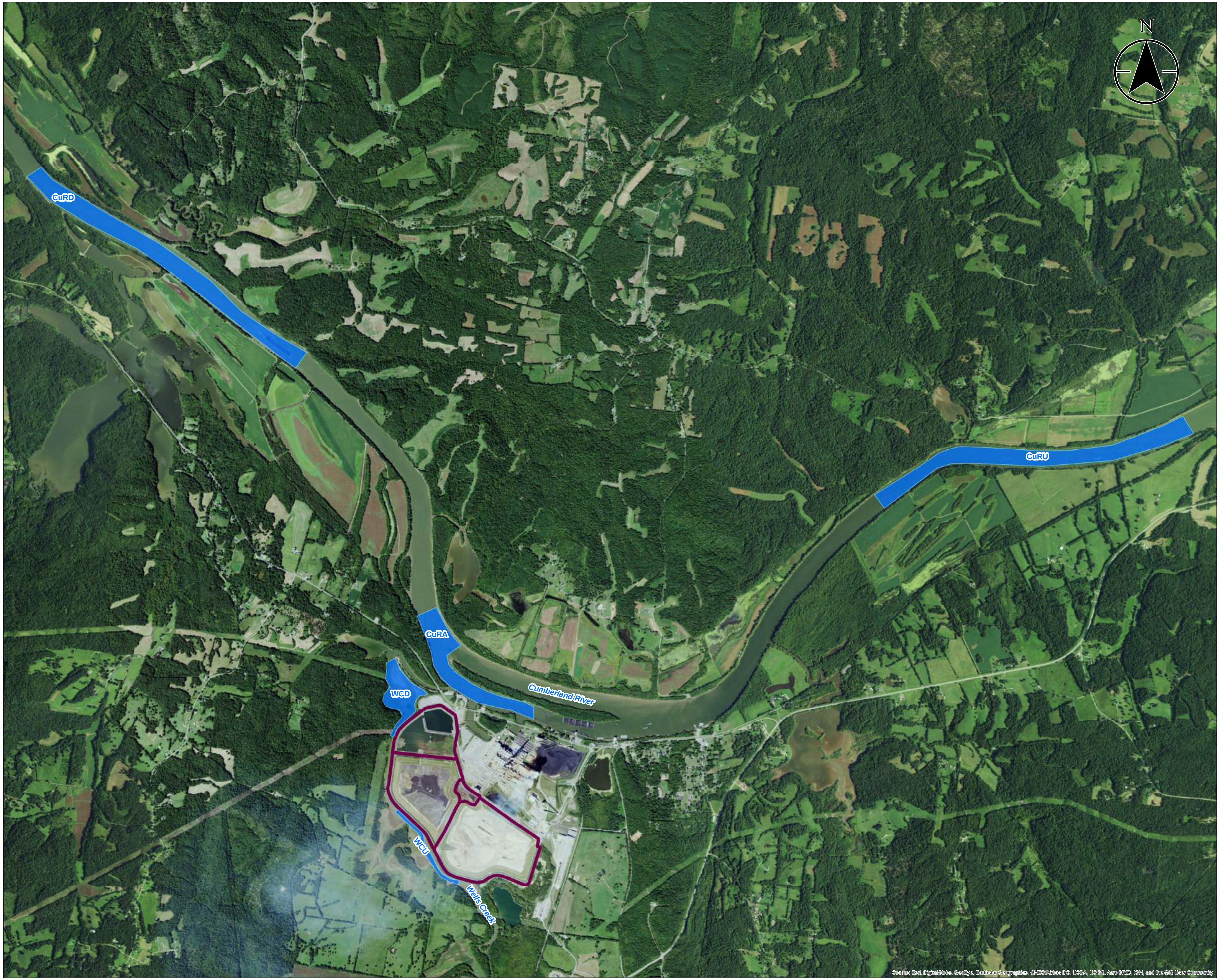


Figure No.
1

Title
Fish Sampling

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

Project Location
Stewart County, Tennessee

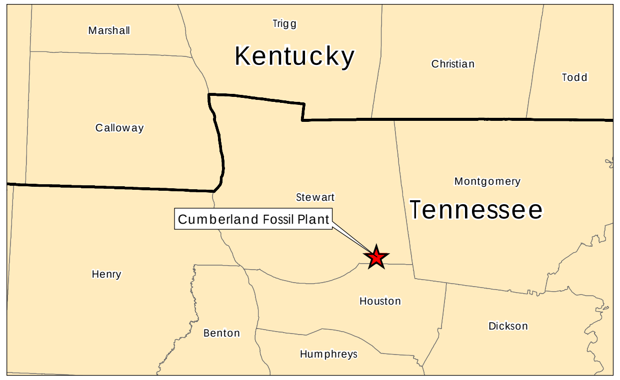
175566329
Prepared by TR on 2017-10-16
Technical Review by RD on 2017-10-16

0 1,500 3,000 4,500 6,000 Feet
1:18,000 (At original document size of 22x34)

Legend

Fish Sample Location
CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps (NAIP c. 2016)



ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Fish Tissue Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Boat and paddles
Depth finder
Anchor
Boat-mounted electro-shocker
Gasoline-powered generator
Control box (including isolation transformer)
"Dead-man" switch
Two outboard gas tanks
Positive and negative electrodes mounted on fiberglass poles
Gill nets (including spare nets)
Rope
Net hooks and net picks
Dragging hook for recovering lost nets
Marker floats (one per net)
Net anchors
Fiberglass fish club
Data logger
Galvanized net tubs
Live tank with water pump and aerator
Fillet knives
Fillet board
Knife sharpening equipment
900 mm measuring board
10 kg platform weighing scale
Scalers and spoons
Dip nets, long and short handled, insulated
Hand pails (approximately 13 liter)
5 gallon buckets
Waders, muck boots, knee boots, etc.
pH and conductivity meters
Thermometer
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX W
PUBLIC COMMENTS

Table 1
TVA Cumberland EIP Rev 3
Summary of Public Comments & TVA Responses
June 25, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (June 25, 2018)
1	General	All	NA	NA	NA	Do the precipitation figures that are called for take into consideration that future precipitation may be substantially more?	5/3/18	Martha Yanchyshyn	In accordance with industry standards and regulatory requirements, TVA's evaluation of all its facilities includes the collection of empirical data that represents current precipitation rates as well as the consideration of effects that may be caused by future more intense rainfall events.
2	General	All	NA	NA	NA	https://earthjustice.org/features/campaigns/photos-a-toxic-inheritance Not good at all........I am from Houston County and own land and have family living there so I have good reasons to be concerned................	5/24/18	Margaret Mann	These comments are noted. As part of the TDEC Order process, TVA will be conducting an Environmental Investigation (EI) as outlined in the Environmental Investigation Plan (EIP) and assessing potential risks that may result from the management and disposal of coal combustion residuals (CCR) at the Cumberland Fossil Plant. The results of the EI will be summarized in the Environmental Assessment Report (EAR). The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts to human health and the environment.
3	General	All	NA	NA	NA	The New Coal Crisis https://newrepublic.com/article/145425/new-coal-crisis-loosening-environmental-regulations-trump-risks-makinghealth-hazard-critical Is it true 1 in 50 will get cancer from dry particles of ash.......??	5/24/18	Margaret Mann	
4	General	All	NA	NA	NA	From The New York Times: Coal Ash Spill Revives Issue of Its Hazards The Tennessee Valley Authority has played down the risks of what may be the nation's largest spill of coal ash, but there are questions about its potential toxicity. https://www.nytimes.com/2008/12/25/us/25sludge.html Have you looked at the rate of CANCER in the areas around Cumberland.............	5/24/18	Margaret Mann	
5	General	All	NA	NA	NA	Check out this video on Knoxville News Sentinel: http://knoxnewww.ws/2uhgtpM <http://knoxnewww.ws/2uhgtpM> This could be our beautiful area in Stewart and Houston Co.....	5/24/18	Margaret Mann	

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (June 25, 2018)
6	General	All	NA	NA	NA	I am concerned about plans to leave Cumberland Fossil Plant CCRs at a site that is likely to have leakage that will pollute groundwater. My understanding is that the Wells Creek Structure has fractures several hundred feet deep that extend for miles -- covering up the coal ash will not stop or clean up pollution. I attended your very informative open house in Cumberland City May 3, but did not see my concerns above specifically addressed.	5/25/18	JoAnn McIntosh	TVA plans to use existing data as well as ongoing and planned studies to investigate potential fractures in the Wells Creek geologic structure below the Cumberland Fossil Plant site. These investigations include evaluation of fracturing and the effect of fractures on groundwater quality and flow direction. No decision has yet been made regarding leaving CCR in place in the existing units at the Cumberland plant. Following completion of the investigation, the final plans will be determined.

Table 1
TVA Cumberland EIP Rev 3
Summary of Public Comments & TVA Responses
June 25, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (June 25, 2018)
7a	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated May 25, 2018: (1) Timeline The Commissioner signed the Order on August 7, 2015. By the time TVA and TDEC respond to comments and finalize the EIP, it will have taken more than three years to delineate the scope and terms of the environmental investigation at Cumberland Fossil Plant. The timeline proposed by TVA and TDEC includes an additional two years until TDEC approves any Environmental Assessment Report prepared by TVA, and even longer before TDEC requires TVA to actually implement a corrective action plan at the site. In other words, it will have taken at least five years since the issuance of the Commissioner's Order to even begin a discussion about appropriate corrective action to address pollution we already know has occurred and is occurring at the site. We appreciate TDEC's diligence and thoroughness in working with TVA to develop the EIP. However, the record shows that TVA has repeatedly submitted manifestly inadequate EIP drafts, despite the relatively clear mandate of the Order to comprehensively investigate and address coal ash contamination at the Cumberland Fossil Plant. The record of TDEC's comments and TVA's successive draft EIP revisions speaks for itself. The EIP for the Cumberland Plant is the first of seven such investigations to be developed and implemented by TDEC and TVA. TDEC should not countenance continued foot-dragging by TVA, at either the Cumberland Plant or the other six sites subject to the Order, including the Allen Fossil Plant, Bull Run Fossil Plant, Kingston Fossil Plant, Johnsonville Fossil Plant, John Sevier Fossil Plant, and Watts Bar. The citizens of Tennessee have waited nearly a decade since the catastrophic Kingston coal ash for TVA to fulfill its promise to clean up its coal ash and protect our clean water. Another decade of waiting is unacceptable.	5/25/18	Southern Environmental Law Center	These comments are noted. The development of the EIP for the Cumberland Fossil Plant began immediately following the issuance of the TDEC Order. TDEC provided TVA with a list of general questions to be addressed. An Investigative Conference for the Cumberland Fossil Plant site was held to present TVA's initial responses to TDEC's list of questions. Following the Investigative Conference, TDEC issued an additional list of plant-specific requests. As TVA and TDEC have diligently worked together, the scope of the investigation has developed and evolved through three iterations of the EIP to ensure the plan represents a sound technical approach to understanding the conditions at the Cumberland Fossil Plant. Developing a comprehensive and sound technical plan for the environmental investigation ensures a conclusion to the TDEC Order process that adequately informs decisions about how to manage coal ash at the plant sites. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.

Table 1
TVA Cumberland EIP Rev 3
Summary of Public Comments & TVA Responses
June 25, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (June 25, 2018)
7b	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated May 25, 2018: (2) Lack of Analysis of Existing Information TVA already has significant existing data in its possession regarding issues such as hydrogeology, groundwater contamination, dike stability, and other subjects it is required to study under the Order. The EIP simply identifies and lists existing data sources and states that TVA plans to analyze this existing data over the next year. It should not have taken TVA three years to simply identify existing sources of information. Instead, TVA should have analyzed and discussed what it already knows based on existing data and identified discrete areas for additional investigation. TVA's apparent refusal to date to analyze data already in its possession has resulted in unnecessary delay and will continue to do so with respect to the EIP for the Cumberland site. In this EIP and EIPs for the other six sites, TDEC should require TVA to analyze and synthesize data it already possesses in the EIP itself, rather than deferring such analysis until later in the process. To the extent that TDEC is concerned about the quality of TVA's existing data, TDEC can identify such concerns as a basis for requiring further investigation. This process should happen at the outset of the EIP, not after the EIP has already been adopted and is being implemented by TVA.	5/25/18	Southern Environmental Law Center	These comments are noted. TVA is following the process established in the TDEC Order. After reviewing existing information and data, TVA and TDEC have identified additional investigations needed to understand the conditions and impacts at each site, and the EIP establishes the plan for these investigations. New and existing data will be subject to additional quality review processes documented in the Quality Assessment Project Plan to confirm the validity of the data. As required by the TDEC Order, TVA will evaluate and provide an analysis of both new and existing, validated data in the Environmental Assessment Report (EAR). The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.

Table 1
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Summary of Public Comments & TVA Responses
June 25, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (June 25, 2018)
7c	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated May 25, 2018: (3) Artificial Segregation of Data and Information Obtained in Other Regulatory Processes One of the stated purposes of the Order is to ensure that TVA implements the federal Coal Ash Rule in a manner that ensures coordination and compliance with Tennessee laws governing the management and disposal of coal ash, including the Tennessee Solid Waste Disposal Act, and Tennessee Water Quality Control Act. But the EIP makes little to no effort to analyze and synthesize data and analysis TVA is required to produce under the federal Coal Ash Rule. In some cases, TVA has already produced relevant analyses under the federal Rule. For example, TVA was required to produce a history of construction of the ash impoundments at Cumberland, and this history is available on its public website. The Order includes provisions for TVA to notify TDEC when TVA posts Coal Ash Rule information pursuant to the Rule. Why isn't this information being incorporated into the EIP? Again, if TDEC has concerns about the quality of TVA's Coal Ash Rule data and their adequacy to comply with TVA's obligations under state law, those concerns should be explicitly identified in the EIP and dealt with through additional investigation. The potentially relevant data sets and analysis from TVA's implementation of the Coal Ash Rule should not simply be ignored or segregated as irrelevant to the project of evaluating the scope of the impacts of TVA's coal ash management practices. Similarly, the EIP does not discuss how TDEC and TVA will meaningfully integrate TVA's upcoming assessments under the Coal Ash Rule into the EIP process. As an example, TVA is required to submit, for the Cumberland Plant, an assessment regarding the siting of existing surface impoundments in unstable areas by October 17, 2018. In contrast, the timeline TVA has submitted with the EIP indicates that TVA will not disclose and analyze this information for purposes of the Order until it submits its EAR one year later. The EIP also does not explain how data and corrective action processes required by TVA's assessment monitoring under the Tennessee Solid Waste Disposal Act will interact with the EIP and corrective action requirements in the Order. Nor does the EIP explain how information TVA discloses and analyzes under NEPA will be considered or integrated into these requirements.	5/25/18	Southern Environmental Law Center	These comments are noted. TVA is following the process established in the TDEC Order. Data collected for and during other regulatory programs, such as for purposes of the Federal CCR Rule, will be subject to additional quality review processes documented in the Quality Assessment Project Plan and will be evaluated along with data generated by the EI under the TDEC Order. TVA will provide an analysis of both new and existing, validated data in the EAR as required by the TDEC Order. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.

Table 1
TVA Cumberland EIP Rev 3
Summary of Public Comments & TVA Responses
June 25, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (June 25, 2018)
7d	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated May 25, 2018: (4) Lack of Transparency and Accessibility of Information A stated purpose of the Order is to develop a transparent process for investigating and remediating coal ash contamination at the seven sites that are subject to the Order. But most of the correspondence, data, and other information that has been or will be generated is not easily available to the general public. Both TVA and TDEC have well-established websites for hosting large amounts of information. TVA has a CCR Rule compliance website. TDEC Division of Solid Waste has a data viewer. Either of these platforms could be used to post correspondence and comments exchanged between these two public entities regarding implementation of the Order, as well as data that is generated as part of the investigation. Such a publicly-accessible site could also host important technical documents that serve as protocols for TVA's implementation of the Order. This is important because, in response to an open records request, we recently learned that not even TDEC appears to have all of the relevant protocols TVA will employ in its investigation. The EIP also states that TVA will submit periodic EIP progress reports. These reports are described as providing updates on timelines and milestones. To keep the public and TDEC adequately informed of current environmental conditions at the site, the reports should include interim analytical results and data. We note, for example, that TVA withheld from TDEC and the public for several months disclosure of arsenic contamination at 300 times the groundwater protection standard at the Allen Fossil Plant, even though the contamination put the City of Memphis's drinking water source at risk. We strongly suggest that TDEC prevent this type of behavior from recurring by requiring greater transparency in the EIP process.	5/25/18	Southern Environmental Law Center	These comments are noted. Both TDEC and TVA have shared pertinent information as the development of the EIP has progressed. This has included sharing formal communications between TDEC and TVA via each organization's website as well as through Southern Environmental Law Center's standing request to TDEC under the Tennessee Open Records Act. The final draft EIP and its appendices, including the Sampling and Analysis Plans, have been provided by TDEC to the Southern Environmental Law Center and other interested parties in advance and also have been posted to TVA's website for public access. Pursuant to the TDEC Order, there will be additional opportunities for public input and participation, including a public comment period for the Corrective Action/Risk Assessment (CARA) Plan. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.