Environmental Investigation Plan
Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

November 9, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	September 16, 2016
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	September 8, 2017
2	Addresses December 8, 2017 TDEC Review Comments and Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Addresses Applicable Programmatic Revisions and Issued for TDEC Approval	November 9, 2018

ENVIRONMENTAL INVESTIGATION PLAN
KINGSTON FOSSIL PLANT

TITLE AND APPROVAL PAGE

Title of Plan: Environmental Investigation Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Tennessee Valley Authority

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Bryan Wells
TVA Compliance Point of Contact — 11/6/18 Date

James R. Orr
TVA Technical Point of Contact — 10/31/18 Date

Mark G. Hedgpeth
Investigation Project Manager — 11/6/18 Date

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.10.31 17:12:12 -04'00'
QA Oversight Manager — Date

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Abbreviations

BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BTVs	Background Threshold Values
CARA	Corrective Action/Risk Assessment
CCR	Coal Combustion Residuals
CCR Parameters	40 CFR Part 257 Appendices III & IV and Copper, Nickel, Silver, Vanadium and Zinc
CCR Rule	EPA Final CCR Rule
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DMP	Data Management Plan
DPT	Direct Push Technology
EAR	Environmental Assessment Report
EI	Environmental Investigation
EIP	Environmental Investigation Plan
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GPS	Global Positioning System
KIF	Kingston Fossil Plant
KMP	Knowledge Management Portal
KRP	Kingston Recovery Project
LTM	Long-Term Monitoring

MCL	Maximum Contaminant Level
MNR	Monitored Natural Recovery
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
QA	Quality Assurance
QAPP	Quality Assurance Project Plan (KIF QAPP)
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
REV	Revision
RFAI	Reservoir Fish Assemblage Index
SAP	Sampling and Analysis Plan
SPP	Standard Programs and Processes
SPLP	Synthetic Precipitation Leaching Procedure
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TDEC Order	Commissioner's Order OGC15-0177
TOC	Total Organic Carbon
TVA	Tennessee Valley Authority
TWQC	Tennessee Water Quality Criteria

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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF EIP Revision (Rev) 0 to TDEC.

On June 22, 2017, TDEC issued a letter to TVA regarding the TDEC Order and attached to the letter were environmental investigation comments for the TVA KIF site. According to this letter and subsequent discussions between TVA and TDEC, the specific questions and tasks found in the June 22, 2017 TDEC letter were to supersede the original specific questions and tasks found in TDEC's June 14, 2016, letter. On September 8, 2017, TVA submitted the KIF EIP Rev 1 to TDEC.

On December 8, 2017, TDEC issued a letter to TVA regarding their review of the KIF Rev 1 EIP and attached to the letter were environmental investigation comments. TVA submitted Rev 2 on March 2, 2018, which addressed those TDEC comments. This KIF EIP Revision addresses the TDEC Rev 2 review comments received on May 2, 2018.

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, will provide the information necessary to assess the extent of soil, surface streams, and groundwater contamination by CCR. The responses and schedule set forth in this EIP correspond to each individual task in TDEC's information request letter for KIF dated June 22, 2017. The Environmental Assessment Report (EAR), to be completed at a later date, will provide the information to answer or resolve the questions in TDEC's request.

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 TDEC Order. During the meeting, TDEC submitted a list of questions for TVA to address at each investigation conference.
- On April 15, 2016, TVA provided TDEC with an Investigation Conference Data Transmittal. This transmittal included electronic and hard copies of supporting information files (and a file directory).
- TVA held the Investigation Conference at KIF on April 28, 2016. The Investigation Conference included a site reconnaissance and presentation that addressed the questions provided by TDEC on September 22, 2015.
- On June 14, 2016, TDEC provided an Investigation Conference Response Letter. The letter requested additional data, and the EIP.
- On September 16, 2016, TVA submitted Rev 0 of the EIP to TDEC.
- On June 22, 2017, TDEC provided a follow-up letter including a list of revised information requests specific to the KIF EIP. This letter also documents conference dates and EIP delivery dates. In addition to addressing the specific information request, TVA provided additional information that included further characterization of KIF. The deadline for the submittal of the revised KIF EIP was set for September 8, 2017.
- On September 8, 2017, TVA submitted Rev 1 of the EIP to TDEC.
- On December 8, 2017, TDEC provided Rev 1 review comments to TVA.
- On March 2, 2018, TDEC submitted Rev 2 of the EIP to TDEC.
- On May 2, 2018, TDEC provided Rev 2 review comments to TVA.
- TVA addressed TDEC's comments from the May 2, 2018 letter and submitted EIP Rev 3 and its implementation schedule to TDEC on June 15, 2018.
- TDEC approved EIP Rev 3 for public comment on June 29, 2018.
- In a letter dated September 28, 2015 from TDEC to the Southern Alliance for Clean Energy, TDEC added an opportunity for public involvement. TDEC hosted a meeting with interested parties on July 30, 2018, to discuss the proposed EIP before the public comment period stated in the Order.

- TVA provided public notice of the EIP published in a manner specified by TDEC and allowed a minimum of 30 days for public comment. The public comment period for EIP Rev 3 began on August 15, 2018 and concluded on September 28, 2018.
- TDEC and TVA hosted a public comment meeting in Harriman, Tennessee on August 30, 2018.
- On October 22, 2018 and November 6, 2018 TDEC and TVA reviewed proposed changes to be incorporated into EIP Rev 4.
- TVA provided responses to public comments to TDEC on October 29, 2018.

1.3 EIP IMPLEMENTATION (INVESTIGATION)

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

- TDEC will review and approve KIF EIP Rev 4, or will provide TVA a list of comments to be addressed in a subsequent future EIP revision.
- TVA will address additional comments from TDEC as they become available, submitting additional revisions and repeating the process until TDEC approves the EIP and schedule.
- 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.

1.4 KIF BACKGROUND INFORMATION

1.4.1 Site History

TVA constructed KIF from 1951 to 1954 and commenced operations in 1954. Construction of the perimeter containment dike system around the Ash Collection Pond was completed in 1958. TVA later divided the Ash Collection Pond to form the Dredge Cells, Ash Pond, and Stilling Pond.

In December of 2008, Dredge Cells 2 and 3 failed and resulted in a release of ash to the Emory and Clinch Rivers. This resulted in TVA and Environmental Protection Agency (EPA) signing an *Administrative Order and Agreement on Consent* (EPA 2009) that provided the regulatory framework for response and recovery actions under the Comprehensive Environment Response, Compensation, and Liability Act (CERCLA). TDEC also issued a Commissioner's Order to TVA (TDEC 2009a) requiring the comprehensive assessment, clean-up and restoration of areas impacted by the release. In accordance with these EPA and TDEC Orders, TVA submitted all plans, proposals, and reports associated with the response and recovery projects to EPA and TDEC for review and approval.

One of these plans, the Removal Action Work Plan (TVA 2012e), included a plan for Long Term Monitoring (LTM) of the river in conjunction with the recommended removal action of monitored natural recovery.

A corresponding LTM Sampling and Analysis Plan (SAP) was prepared to assess the effectiveness of the selected removal action and was approved by EPA and TDEC in May 2013 (TVA 2013b).

Phase 1 (the Time-Critical Removal Action) of the Kingston Recovery Project (KRP) involved dredging spilled ash from the Emory River and shipping it to a lined offsite landfill. Phase 2 (the Non-Time Critical Removal Action) involved removing ash from the Swan Pond Embayment and placing it in a re-engineered on-site ash disposal area. During Phase 2 TVA constructed the KRP Landfill to stack ash recovered from the North and Middle Embayments in the footprint of the original Dredge Cells.

The KRP Landfill occupies the footprint of the Dredge Cells and Ash Collection Pond, and was constructed with a perimeter wall containment system to withstand earthquake loads. During construction of the KRP Landfill, TVA received approval from EPA and TDEC to temporarily stage CCR in the Initial Ash Cell/"ball field area," now referred to as the Interim Ash Staging Area (a copy of the approval letter is provided in Appendix B). TVA completed cap and closure of the KRP Landfill in 2015.

In recognition of TVA's cleanup, ecological restoration, and community revitalization efforts at the Kingston Ash Recovery Project site, EPA Region 4 awarded TVA its Excellence in Site Reuse award in June 2015.

1.4.2 Current Operations and Closure Plans

Since the closure of the KRP Landfill in 2015, TVA has initiated closure projects for the Interim Ash Staging Area, Sluice Trench, and Stilling Pond. To prepare for the closure of the Stilling Pond, TVA constructed a new geomembrane-lined water quality channel to convey process water from the plant to a new geomembrane-lined Polishing Pond that treats process water prior to discharging to National Pollutant Discharge Elimination System (NPDES) Outfall 001.

The Polishing Pond was constructed over a segment of the dewatered Sluice Trench area. The Sluice Trench was partially excavated and geosynthetic clay and geomembrane liners were placed over the Sluice Trench within the limits of the Polishing Pond. A soil cap was constructed over a segment of the dewatered Sluice Trench outside the limits of the Polishing Pond. The remaining segments of the Sluice Trench were capped as part of the closure of the Interim Ash Staging Area. Following removal of temporarily staged ash to the permitted Peninsula Landfill, a soil cap was constructed over the Interim Ash Staging Area that also extended to the southeast over the Sluice Trench.

CCR excavated during the closure of the Interim Ash Staging Area, Sluice Trench, and construction of the water quality channel and Polishing Pond was placed in the permitted Peninsula Landfill.

The Stilling Pond closure project involved drawing down the pond, constructing an engineered closure cap, and constructing a drainage system to convey surface water run-on from the KRP Landfill, run-off from the closed Stilling Pond, and infiltration through the soil cover to the Emory River via a new outlet structure/NPDES outfall. In accordance with pre-Coal Combustion Residuals Rule (CCR) Rule commitments to the EPA (see letter dated December 16, 2015 Appendix B) TVA ceased receipt of CCR in the Stilling Pond prior to October 19, 2015 and ceased non-CCR wastewater flows on December 16, 2016. Due to the Stilling Pond receiving final waste and in accordance with 40 Code of Federal Regulations (CFR) 257.102(e) of the Final CCR Rule (CCR Rule), TVA was required to and completed initiation of closure activities for the Stilling Pond (see March 6, 2017 letter to TDEC in Appendix B). TDEC responded with a letter on May 3, 2017 (see letter in Appendix B) stating that comments would be provided and suggested a meeting to discuss the closure plan. TVA and TDEC conducted that meeting on May 19, 2017. As outlined in the commitment to EPA, construction of the Stilling Pond closure project has been completed. The In Service Date for the Closure was May 30, 2018.

1.4.3 Regulatory Framework

Table 1 summarizes permits relevant to this EIP issued by TDEC to TVA for the operation of KIF.

Table 1. Summary of Relative Permits Issued by TDEC

Permit No.	TDEC Division	Permitted Activities
TN0005452	Water	Discharges via NPDES Outfalls including Outfall 001 at the Stilling Pond
IDL 73-0094	Solid Waste	KRP Landfill Closure
IDL 73-0211	Solid Waste	Peninsula Landfill

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 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 (including the completed KRP which followed the December 2008 Dredge Cell failure) at KIF and has programs underway for the EPA 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 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 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 T. TVA will work with TDEC and revise the EIP until a final version is approved.

As stated in the June 14, 2016 Investigation Conference Response Letter, this Plan will address the:

- Stilling Pond
- Sluice Trench and Ballfield Area East of Sluice Trench (also referenced as the "historic Sluice Trench" by TDEC)
- Interim Ash Staging Area (also referenced as the "ball field" by TDEC)

These areas are shown on Figure 1 (below) and will collectively be referred to as the "Study Area" with responses included in Sections 3 and 4.

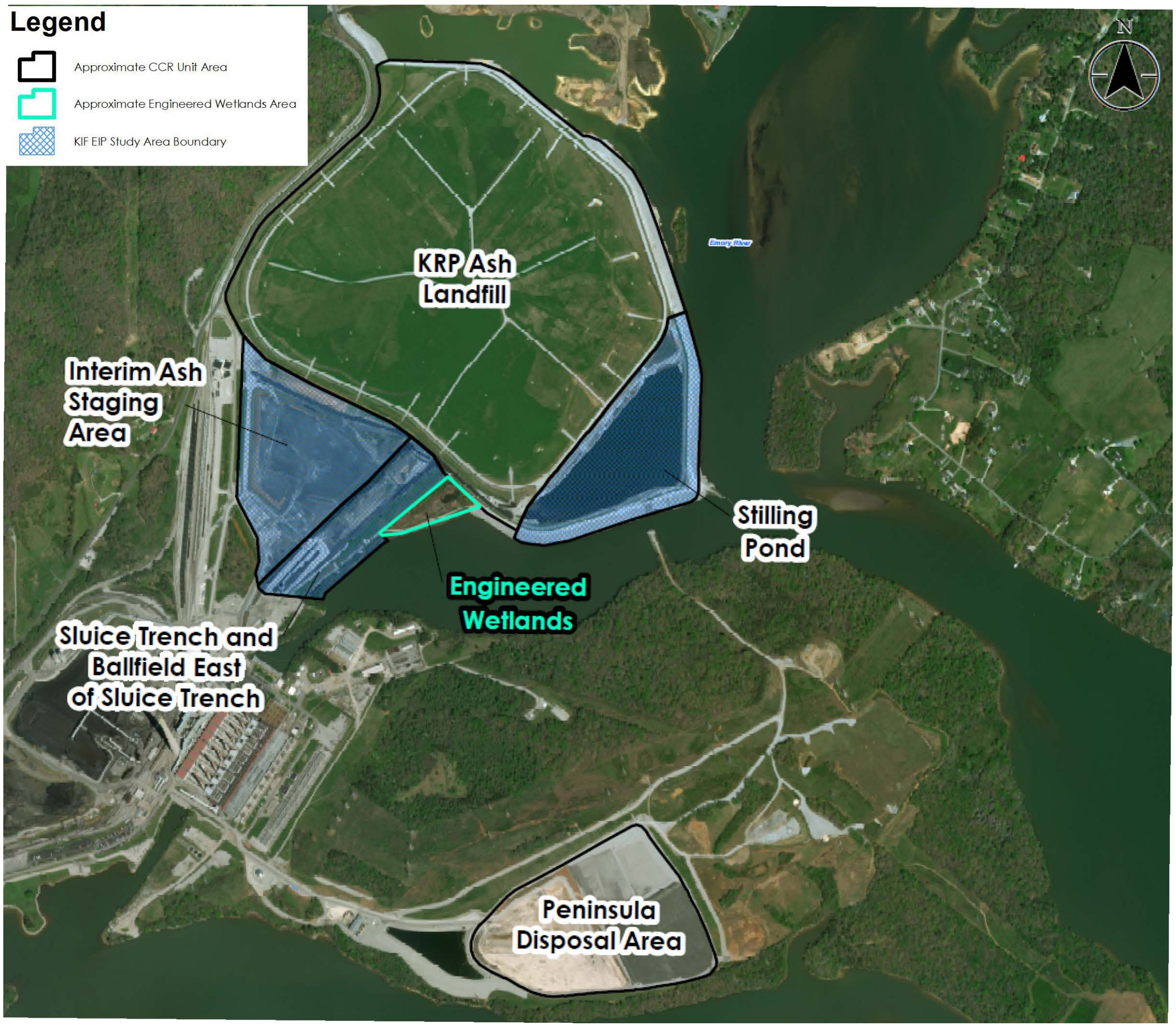

Figure 1. CCR Facilities at Kingston Fossil Plant

Section 3 includes the fifteen site-specific questions from TDEC's June 22, 2017 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 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, provided in Appendix A, 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 June 22, 2017 letter 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 reviews.

2.3 QUALITY ASSURANCE PROJECT PLAN

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

The KIF QAPP describes the QA implementation for the investigation and identifies the obligations of the various entities responsible for generating environmental data. The KIF 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 KIF 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, reduction, and management; and results reporting are stipulated therein.

The KIF 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 KIF QAPP appendices present requirements and quantitative objectives for analytical data for each investigation. Analytical data intended for use under the KIF investigation will be managed in a database in accordance with the Data Management Plan for the TVA Multi-Site Order.

2.4 DATA MANAGEMENT PLAN

In order to address the logistics and technical challenges of managing analytical data generated to address the requirements set forth in the TDEC Order, TVA has developed a Data Management Plan (DMP). On March 8, 2018, TVA submitted a revised DMP (Appendix D), which responded to comments provided by TDEC in an email dated February 7. 2018. The DMP has been developed to provide structure to support TVA and the EI/EAR Team in the pre-planning, analysis, and reporting activities identified as part of the TDEC Order.

The DMP is intended for use on TVA's seven Tennessee facilities associated with the TDEC Order, and includes the following items:

- Data Management Team structure
- Data Management Process and requirements
- EQuIS Quality and Data Management System
- System Management and Administration

Several datasets will be acquired and generated during the environmental investigations related to the TDEC Order. An EarthSoft EQuIS™ database will provide analytical data control, consistency, reliability, reproducibility, and a framework for validating analytical data throughout the life of the TDEC Order. The EQuIS database is the database for analytical chemistry and field parameter data. To support the wide-array of non-analytical data management needs related to the TDEC Order, a SharePoint-based knowledge management portal (KMP) for data access and document management has been developed. The KMP will integrate the EQuIS database, geographic information system database for geospatial data, and various other datasets of historical and EIP generated deliverables. The KMP will thus serve as the central access point for the TDEC Order data including EIPs, the environmental investigation data, and other data necessary for the EAR and Corrective Action/Risk Assessment (CARA) Plan.

3.0 TDEC SITE-SPECIFIC ENVIRONMENTAL INVESTIGATION REQUESTS

TDEC requested that TVA provide responses to the following information requests presented below in 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 SITE SPECIFIC INFORMATION

3.1.1 TDEC Site Specific Information Request No. 1

Existing or additional site characterization shall include a discussion of fluctuations in ground water elevations that may be connected to Watts Bar Lake levels, seasonal variations or other factors.

TVA Response

Hydrogeological investigation activities are currently in progress at KIF for many reasons. As part of these activities, TVA has established a surface water gauging station to measure the elevation of the Emory River near the southeast corner of the Study Area. This station is currently automated with instrumentation to record the elevation of the Emory River in 5-minute intervals and is stored in TVA's instrumentation database. Future groundwater and surface water elevation measurements will be collected in accordance with schedules included in the Groundwater Investigation SAP in Appendix F. TVA will also collect publicly available rainfall data during the investigation as part of the response to this request.

TVA will review existing and future groundwater, rainfall and surface water elevation data as part of the overall hydrogeological characterization. Hydrographs of groundwater levels will be compared to hydrographs of Watts Bar Lake elevations and the timing of rainfall events to evaluate if fluctuations in groundwater levels are correlated to changes in the elevation of Watts Bar Lake, seasonal precipitation amounts or other factors. New data and the results of the evaluation will be included in the EAR.

As discussed in Section 3.1.2, three-dimensional models will be developed for the CCR units in the Study Area. An analysis of correlations between groundwater, surface water and saturation levels in the CCR units, and seasonal variations will be incorporated into the three-dimensional models to estimate the volume of CCR material below groundwater levels and saturation levels within the CCR units. This information will be provided in the EAR.

3.1.2 TDEC Site Specific Information Request No. 2

Existing or additional site characterization shall estimate the amount of CCR material that is below the upper most aquifer for the Stilling Pond, historic Sluice Trench and the "ball field" temporary storage area. The upper most aquifer must be identified to accurately make this determination.

<u>TVA Response</u>

Hydrogeological Evaluation

Hydrogeological investigation activities have been conducted at KIF as discussed in Section 3.1.3. Monitoring well data from previous studies, ongoing monitoring and the Hydrogeological Investigation and Groundwater Investigation SAPs (Appendices G and F) will form the framework for developing a conceptual site model to characterize the site-specific hydrogeology, including an evaluation of groundwater elevations, in the Study Area. In addition, the Stilling Pond and Sluice Trench will be going through the CCR unit closure process in accordance with CCR Rule requirements. The conceptual site model results will be provided to TDEC in the EAR.

The objective of the Hydrogeological Investigation SAP (Appendix G) is to supplement the current Study Area monitoring well network (AD-1, AD-2, AD-3, 6AR and GW-2) by installing an additional background monitoring well (KIF-102) and four downgradient wells (KIF-103 through KIF-106). Additionally, groundwater levels will be measured at wells 22, 22B, 27A and 27B. The proposed wells will provide additional groundwater sampling locations in the same aquifer as the existing Study Area monitoring network to evaluate groundwater elevations upgradient and downgradient of the Study Area. The purpose of the Groundwater Investigation SAP (Appendix F) is to provide the procedures necessary to characterize and create baseline data for groundwater elevation data in the Study Area. New and existing data that meets the requirements of the KIF QAPP will be provided in the EAR.

Three-Dimensional Models

Section 3.1.5 and the Material Quantity SAP (Appendix H) describe the three-dimensional models that will be developed to answer TDEC's information requests regarding CCR material quantity, groundwater elevations, and subsurface conditions with respect to the Study Area. The Exploratory Drilling SAP (Appendix I) includes five proposed temporary well borings that will provide additional CCR material quantity, water level, and uppermost foundation soil information to develop the three-dimensional models.

Groundwater elevations estimated during the Hydrogeological Evaluation described above will be incorporated into the three-dimensional models to estimate the volume of CCR below groundwater levels. This information will be provided in the EAR.

After the ongoing and proposed hydrogeological investigative, exploratory drilling, and material quantity activities have been completed, TVA will incorporate pertinent data from these activities that meet the QA/QC requirements of the KIF QAPP into the characterization of CCR material that may be in contact with groundwater in the Study Area. TVA will also determine the amount of CCR that is below the upper most aquifer, in addition to the amount of CCR that is above the upper most aquifer. If data gaps exist after completion of the above referenced activities and others included in this EIP, then TVA, in communication with TDEC, will perform additional investigations to fill those data gaps. The results of these activities will be reported in the EAR.

3.1.3 TDEC Site Specific Information Request No. 3

TVA shall provide a schedule for the placement of any additional borings/monitoring wells proposed at the Kingston site as well as a map identifying the location all borings and monitoring wells that TVA plans to use as a part of its Environmental Investigation (existing and proposed). TVA shall present the reasons for selecting the location of additional boings/monitoring wells at the site. Further, TVA shall install/identify two ground water monitoring wells to serve as background ground water monitoring wells for the site. TVA shall have a TN Licensed Professional Geologist on site to log the installation borings and/or ground water monitoring to install borings and ground water monitoring wells as well as the method of construction for ground water monitoring wells. TVA shall propose a sampling plan to analyze soil, overburden and CCR material generated during on-site drilling for Appendix III and IV CCR constituents.

TVA Response

Hydrogeological investigation activities have been conducted or are in progress at KIF for many reasons as noted in Section 2.1. The locations of existing borings and wells are shown on Exhibits 1 and 2 (Appendix E). As part of TVA's investigations at KIF, one monitoring well (AD-1) was installed in unconsolidated materials above bedrock and is currently used as a background monitoring point for the Study Area. Three other monitoring wells (AD-2, AD-3 and 6AR) were previously installed in potential downgradient locations across the Study Area. In addition, well GW-2 was previously installed upgradient of the KRP Ash Landfill. Exhibit 2 (Appendix E) shows the locations of the monitoring wells.

Groundwater investigation activities have been ongoing at KIF since the 1970's. In 2004, a hydrogeological evaluation was completed for the Ash Disposal Area (KRP Ash Landfill and Stilling Pond) using existing data collected from soil borings, monitoring wells and piezometers for evaluations of soil properties, groundwater quality, groundwater elevations, groundwater flow and rates, and leachate seepage and mass loading modeling (TVA 2004). That investigation included the installation of soil borings and monitoring wells in the Study Area.

In 2011, a groundwater flow and transport modeling report was prepared (TVA 2011a). An addendum to this report was completed in 2013 (TVA 2013a). Existing data from soil borings, monitoring wells and piezometers were used in the modeling calculations to quantify ash-related constituent concentrations and mass loadings potentially entering the Emory River and Swan Pond Embayment through groundwater seepage from ash source areas, including the Study Area. Semi-annual and quarterly groundwater monitoring programs for the Ash Disposal Area and the Study Area, respectively, are in progress (TVA 2017b and 2017c). Groundwater monitoring reports for these programs include groundwater quality and groundwater elevation and flow data.

Additional reports that have characterized the geology of the Study area are summarized in Section 3.7.1.

The previous investigations and continuing groundwater monitoring have resulted in a characterization of the Study Area. In response to this request from TDEC, TVA proposes to supplement the existing Study Area groundwater monitoring network with four additional wells to be installed under the supervision of a Tennessee licensed Professional Geologist. One well (KIF-102) is proposed to serve as a background monitoring well for this investigation. The proposed background location was selected for four reasons: 1) it will provide a second location to collect samples of groundwater that will represent the quality of groundwater prior to passing beneath the Study Area; 2) it will provide a second potential background monitoring location to measure groundwater levels to evaluate groundwater flow direction; 3) it will provide an additional location to measure aquifer properties; and 4) borings logs from the proposed location indicate that the hydrogeologic setting is similar to that for existing downgradient wells and the new well will monitor the same hydrostratigraphic unit. The screened interval for the proposed well is proposed to be placed in the unconsolidated materials above bedrock.

Four additional wells (KIF-103 through KIF-106) are also proposed to evaluate groundwater quality and groundwater flow conditions downgradient of the Study Area near the Stilling Pond. The screened intervals for the proposed wells are proposed to be placed in the unconsolidated materials above bedrock at approximately 25 to 35 feet below ground surface in the same hydrostratigraphic unit as existing downgradient wells.

Groundwater elevation data from existing monitoring well and piezometer networks and soil boring logs from nearby monitoring wells and piezometers were evaluated for placement of the proposed well screen intervals. Additionally, groundwater levels will be measured at wells 22, 22B, 27A and 27B.

Groundwater level data from new and existing monitoring wells and piezometers will be included in the development of groundwater contour maps and evaluation of flow directions.

The Hydrogeological Investigation SAP (Appendix G) includes the installation and logging procedures to be completed with oversight from a Tennessee licensed Professional Geologist, along with proposed well locations and a schedule of these activities. The proposed monitoring well locations are also included in Exhibit 3 (Appendix E).

Groundwater samples will be collected bimonthly for one year (six sampling events) and analyzed for the CCR constituents 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) to evaluate groundwater chemistry. These constituents will be hereafter referred to as "CCR Parameters". In addition, groundwater samples will be analyzed for major cations/anions and total alkalinity (magnesium, potassium, sodium, carbonate, and bicarbonate). 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. Sampling procedures and parameters are provided in the Groundwater Investigation SAP provided in Appendix F. TVA will provide a summary of sampling results from the wells in the EAR.

TVA will review data collected during the environmental investigation to evaluate if the wells may be suitable for use in the groundwater monitoring network. TVA will continue to collect groundwater samples from the existing monitoring wells in accordance with existing commitments and review the analytical results. TVA will communicate proposed background and downgradient monitoring well locations to TDEC for comment.

Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the KIF QAPP will be utilized in the EAR.

After analyzing data from the proposed new wells, additional background and/or downgradient wells may be needed. If additional wells are needed, TVA will communicate with TDEC on the rationale and supporting data and information for selecting each background and downgradient location prior to finalizing the monitoring well network.

Soil samples will be collected from the proposed background monitoring well boring during installation and analyzed for CCR Parameters. Soil samples will also be collected near existing well AD-1 and analyzed for CCR Parameters to evaluate naturally-occurring levels in this potential background location. Soil sampling procedures and analytical methods are included in the Background Soil SAP (Appendix J).

After the ongoing and proposed hydrogeological investigations have been completed, TVA will incorporate pertinent data from these investigations that meet the QA/QC requirements of the KIF QAPP into the identification of proposed background and downgradient monitoring well locations. The proposed scope of work above is consistent with an initial phase that is needed to evaluate groundwater quality and flow direction in overburden above bedrock. Based on the results of the initial phase of work, if it is determined that there is a need to investigate vertical gradients and groundwater quality in bedrock, then TVA will prepare a modified investigation plan for TDEC review and comment. The results of investigations will be reported in the EAR.

Additionally, the Exploratory Drilling SAP is included in Appendix I, and includes five proposed borings with temporary well installations. Three of the temporary well borings will be within the Interim Ash Staging Area, and two will be within the Sluice Trench and Ballfield East of the Sluice Trench. Temporary well installations within these units will improve spatial coverage for CCR thickness, water levels, and uppermost foundation soil, as well as facilitate CCR material characterization and pore water sampling. The results of the Exploratory Drilling SAP investigation will be provided in the EAR.

3.1.4 TDEC Site Specific Information Request No. 4

TVA shall characterize the site's hydrogeology to better understand the cause of the Red-Water seeps at the East Dike/Engineered Red-Water Wetlands. The investigation should determine if the source might be either infiltration through the Interim Ash Staging Area (ballfield) or groundwater flow from offsite.

TVA Response

Hydrogeological investigations have been ongoing and will continue at the KIF plant as discussed in Section 3.1.3. Recent preliminary results from groundwater elevation data collected from shallow wells in March 2017 indicated that groundwater flow beneath the Interim Ash Staging Landfill and the KRP Ash Landfill is eastward and southeastward from Pine Ridge toward the Emory River (TVA 2017b and 2017c). As part of the hydrogeological investigations, TVA will evaluate the cause of fluctuations in groundwater levels, including well AD-2, due to surface water level fluctuations, seasonal effects, or other factors such as the recent remedy for addressing the red-water seep. In addition, the hydrogeological investigation will include an evaluation of the correlation between groundwater levels and seepage rates. TVA will continue hydrogeological investigations to further characterize the site's hydrogeology to evaluate the source of the red-water seeps at the East Dike/Engineered Red-Water Wetlands. After these investigations have been completed, the results will be provided in the EAR.

On June 27, 2017, TVA submitted to TDEC the preliminary engineering report titled "Seepage Mitigation Engineering Report, East Dike Seepage Mitigation Project" (AECOM 2017) for the East Dike seepage collection system planned at KIF to mitigate the seepage. The only active seeps located on exterior slopes in the EIP study area are located on the East Dike, south of the engineered wetlands. The system will collect and route seepage in those exterior dike slopes of the East Dike study area to the polishing pond for wastewater treatment prior to discharging through NPDES Outfall 001. NPDES sampling data is provided in Appendix K.

On July 28, 2017, TDEC approved an Aquatic Resource Alteration Permit (ARAP)/§401 Water Quality Certification for the proposed East Dike Seepage Mitigation Project. Following TDEC's approval, the Department of Army, Nashville District, Corps of Engineers, authorized the East Dike Seepage Mitigation Project proposal under the Nationwide Permit #3, Maintenance, which became effective March 19, 2017.

A second collection system was constructed as part of the Ball Field Closure Project (2017). This system replaced a gravity system that previously discharged to Outfall 007. The new system collects drainage from this lower area, southwest of the Bottom Ash Dewatering Facility, and discharges it to the water quality channel via force main where it is routed to the polishing pond before being discharged through Outfall 001.

A Seep SAP (Appendix R) and its associated seep investigation will be implemented at the study area as support for continued seepage mitigation efforts. The Seep SAP is discussed in Section 4.5.5.

3.1.5 TDEC Site Specific Information Request No. 5

TVA shall gather sufficient information to provide a three dimensional picture of the CCR material disposed in the Stilling Pond, Sluice Trench and "Ballfield" area. TVA shall gather enough information to determine the volume of CCR material disposed in each area.

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 material quantity, groundwater elevations, and subsurface conditions with respect to the Study Area.

Three-Dimensional Models

TVA will develop three-dimensional models of the Ballfield East of Sluice Trench and closed configurations of the Interim Ash Staging Area, Sluice Trench, and Stilling Pond depicting subsurface conditions from the ground surface to bedrock. The models will be developed using the data summarized below which includes data from the proposed temporary well borings as well as other relevant data collected during the EI.

1. The most recent aerial and topographic survey data and record drawings for the Polishing Pond and Interim Ash Staging Area closure projects will be used to model the soil cap constructed at the Interim Ash Staging Area and Sluice Trench and the upper CCR surface.

2. Aerial and topographic survey data, record drawings, and the proposed temporary well borings shown on Exhibit 4 (Appendix E) will be used to model the upper CCR surface of the Sluice Trench which was capped in 2017 and the Ballfield East of Sluice Trench. The upper CCR surface will correspond to the lowest contour of the Sluice Trench.

3. The most recent aerial and topographic survey data and record drawings for the Stilling Pond closure project will be used to model the engineered cap constructed at the Stilling Pond and the upper CCR surface.

4. Estimated groundwater elevations discussed in Section 3.1.2 will be incorporated into the models.

5. Pre-construction topographic information from drawings including TVA Drawings 10N200 R10 and 10N400 R6, the 1941 USGS Topographic Map of the Harriman Quadrangle, and data from existing borings shown on Exhibit 5 (Appendix E) that penetrated the lower boundary of the CCR surface will be used to model the lower CCR surface of the Study Area.

6. Data from existing borings that encountered foundation soils shown on Exhibit 6 (Appendix E) will be used to model the foundation soils underlying each site.

7. Data from existing borings that encountered top of bedrock shown on Exhibit 7 (Appendix E) will be used to model the foundation soils underlying the Study Area.

8. Top of bedrock elevations were recorded along the KRP Ash Landfill perimeter wall as it was constructed. This data along with data from existing borings that encountered top of bedrock shown on Exhibit 7 (Appendix E) and geologic lithology information discussed in Section 3.7.1 will be used to model the top of bedrock underlying the Study Area.

9. Observed piezometric levels of saturation discussed in Section 3.1.2 will be incorporated into the models.

As documented in the Evaluation of Existing Geotechnical Data (Appendix L), TVA evaluated the adequacy of the existing data listed above with respect to responding to information requests regarding three-dimensional models, CCR material quantity, and groundwater elevations. TVA also proposes temporary well borings as discussed in the Exploratory Drilling SAP (Appendix I) to improve spatial coverage for CCR thickness, uppermost foundation soil, and water levels, and to facilitate CCR material characterization and pore water sampling. TVA concluded that existing borings that encountered the lower boundaries of CCR and the foundation soils as well as top of bedrock shown in Exhibit 7 (Appendix E) provide sufficient spatial coverage to develop three-dimensional models of the facilities and volumetric estimates.

The three-dimensional models 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 may also be used to visualize the three-dimensional model of the facilities.

Drawings

After the three-dimensional models are finalized, they will be used to produce drawings of the Study Area Units showing the following:

- Subsurface material types, properties, and thickness from the ground surface to top of bedrock
- Final elevations of units
- Upper and lower CCR surfaces and CCR thickness for each facility
- 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
- Estimated extent of foundation soils between CCR and bedrock and estimated groundwater elevation

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
- 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
- Volume of CCR below the highest recorded groundwater surface

The combined total volume of CCR for all Study Area Units at KIF will also be estimated. These volumetric estimates will be calculated using three dimensional volumetric surfaces and average end cross-section volumes to validate the model and results.

Reporting

The results of the CCR material quantity assessment, including three-dimensional models of the facilities, drawings, and volumetric estimates will be incorporated into the EAR.

3.2 HYDROGEOLOGIC REPORT

3.2.1 TDEC Hydrogeologic Report Information Request No. 1

TVA shall collect sufficient data from existing and proposed ground water monitoring wells and from existing and proposed soil borings to allow TVA to determine the following results that will be included in the Environmental Assessment Report:

i. A ground water map for the site presenting the ground water elevation *ii. Ground water flow rate and direction; and*

iii. Location of ground water monitoring wells where the level of CCR constituents exceed the EPA CCR levels provided in Appendices III and IV of the rule;

TVA Response

As discussed in Section 3.1.2, TVA will use data obtained from the existing monitoring well network and the proposed new monitoring wells for the Study Area to develop a conceptual site model to characterize the site-specific hydrogeology. The conceptual site model will include groundwater elevation maps showing direction of groundwater flow and corresponding well locations. Previous studies were conducted to complete groundwater flow and transport modeling (TVA 2011a), which included hydraulic conductivity testing at the Study Area monitoring network wells (AD-1, AD-2, AD-3, 6AR and GW-2). Hydraulic conductivity testing will also be conducted at the proposed new wells to collect additional information to calculate the groundwater flow rates for the Study Area.

In addition, piezometers with vibrating wire transducers have been installed within the KRP Ash Landfill and Stilling Pond for other ongoing TVA projects. These vibrating wire piezometers are shown on Exhibit 8 included in Appendix E. 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.

Under the TDEC Order EI along with other CCR compliance programs, TVA is gathering information in several targeted areas including but not limited to groundwater flow direction and constituent levels. TVA feels the current investigative actions will characterize the groundwater in and around each CCR unit in the Study Area. As the EI progresses, TVA will communicate with TDEC and jointly determine if additional investigative actions are needed such as installing groundwater monitoring wells within the CCR units.

The results of the EI will be used to characterize the hydrogeology of the site, propose a monitoring well network and will include six bimonthly events of groundwater monitoring. TVA will follow the statistical procedures listed in 40 CFR 257.93. Because selection of the appropriate statistical method is dependent on the dataset under evaluation, the method cannot be selected prior to collection of the dataset. TVA will provide the basis for selection of statistical methods in the EAR. A figure showing analytical results at individual well locations will also be provided in the EAR.

3.3 WATER USE SURVEY

3.3.1 TDEC Water Use Survey Information Request No. 1

TVA shall conduct a water use survey as required by TDEC for the environmental investigation at other TVA Coal fired power plants. The survey shall include water wells and springs used by for either domestic or business purposes.

TVA Response

TVA's Water Use Survey SAP (Appendix M) includes details to complete a water use survey for the KIF Study Area. TVA will review existing documentation and the state database to identify existing water supply wells and springs within 1/2 mile of the boundary of the KIF Study Area (Exhibit 9, Appendix E), including water well inventory records on file with TDEC for Roane County. TVA will also review water supply information on file for the City of Kingston to identify water service hookup locations in the search area. TVA owned property will be included in the water use survey.

TVA will develop a field verification plan to demonstrate the procedure for conducting a water use survey for off-site water wells and springs used for domestic or business purposes. 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 KIF Study Area, and will consist of the following steps:

- Conduct a door-to-door survey to identify registered and unregistered springs 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 springs.
- Obtain permission (in writing) from the property owner to sample the water well(s) or springs, from the wellhead or closest tap, [Note: samples will not be collected without the well owner's approval].
- Take a global positioning system (GPS) reading of the verified water well(s) and of springs (e.g., pumps) for map updates.
- Update and prepare the field verification map and survey report after completion of the survey for inclusion in the EAR submittal to TDEC.

Property access and water well and spring sampling permission forms will be developed by TVA for use during field verifications. Details of sampling methods and analytical parameters are included in the Water Use Survey SAP (Appendix M).

In the event that TVA is unable to gain permission to enter a property for field verification of private water wells and springs, TDEC has offered assistance in field verifying the locations, well construction information, withdrawal rates, and collecting samples.

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

If results for CCR-related constituents are detected at levels exceeding maximum contaminant levels (MCLs) during the first round of sampling, confirmatory sampling will be performed. A final report and associated map showing the verified location(s) of water well(s) and springs with associated sampling locations (if sampling is required) will be provided in the EAR.

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

3.4 GROUND WATER MONITORING

3.4.1 TDEC Ground Water Monitoring Information Request No. 1

Due to the 2008 CCR release, there is extensive data for this site including ground water monitoring data. TVA should include a catalog of existing ground water monitoring wells that will be used in determining ground water flow rates, current ground water elevation and direction of ground water flow. TVA shall propose additional ground water monitoring wells, as needed, to accurately identify ground water quality, flow direction, velocity, quality and influence due to release of CCR constituents. TVA shall provide a ground water monitoring schedule that identifies the ground water monitoring wells that will be sampled, sampling methodology, sample collection and transportation, analytical methods used for analyses and the qualifications of the laboratory performing the analyses. All samples shall be analyzed for Appendix III and IV CCR constituents. Disposal units regulated by a landfill permit will need to incorporate the additional constituents through the end of post closure care period.

TVA Response

As mentioned in Section 2.1, several studies have been conducted and are ongoing at KIF. The existing Study Area monitoring network includes monitoring wells AD-1, AD-2, AD-3, 6AR and GW-2. As discussed in Section 3.1.3, one additional background monitoring well (KIF-102) and four downgradient wells (KIF-103 through KIF-106) are proposed for this investigation. TVA proposes to collect groundwater samples from these four new wells.

In addition, groundwater levels will be measured at wells 22, 22B, 27A and 27B or the replacement well for well 22 (well 22C), as discussed in Section 3.5.1, during the proposed sampling events to provide further characterization of groundwater flow directions. Historical groundwater quality and groundwater elevation data associated with the Study Area are provided in Appendix N. TVA may use these historical data for qualitative purposes, but only data evaluated in accordance with the KIF QAPP will be used quantitatively.

Data used for calculating groundwater flow direction and flow rates from existing monitoring wells will be evaluated and incorporated with new well data collected as part of this EI. New well data will be collected to characterize groundwater quality, groundwater flow direction, groundwater flow rates and potential CCR constituents related to KIF operations.

The Groundwater Investigation and Hydrogeological Investigation SAPs provide well locations to be sampled and tested, well installation and groundwater monitoring schedules, sampling methodology, sample collection procedures, analytical methods used for analyses and the qualifications of the laboratory performing the analyses (Appendix F and G, respectively). Groundwater samples will be analyzed for CCR Parameters, major cations/anions, and total alkalinity.

Existing monitoring wells proposed to be incorporated into the EI network are currently being monitored per requirements of the Ash Disposal Area TDEC Permit #IDL 73-0094 and for the Interim Ash Staging Area for closure monitoring. Initially, TDEC Appendix I parameters were sampled per the requirements of the Permit and Groundwater Monitoring Plan (TVA 2014b). In September and December 2016, Appendix III and IV constituents were incorporated into the Ash Disposal Area and Interim Ash Staging Area monitoring programs, respectively, and will continue to be sampled through the post closure care period (TVA 2016a and 2017a). Major cations/anions and total alkalinity are proposed to also be added to the Ash Disposal Area groundwater monitoring program analyte list after approval of the EIP. The results of this EI and data evaluation will be provided in the EAR.

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.

3.5 GROUND WATER – CHEMICAL AND PHYSICAL PROPERTIES

3.5.1 TDEC Ground Water – Chemical and Physical Properties Information Request No. 1

Ground Water samples analyzed from Monitoring Well KIF-22 exceeded the Drinking Water MCL for Arsenic. TVA suggested the AS levels were higher than TVA Kingston Fossil Plant Environmental Investigation Plan expected due to the influenced of Total Suspended Solids in the ground water samples taken. TVA shall provide a science based explanation of this statement. TVA should explain its position that the Stilling Pond is contributing to the AS levels in Monitoring Well KIF-22.

TVA Response

Monitoring well 22 is part of the network used to monitor the Ash Disposal Area and given its location, it may not provide representative groundwater analytical data for the Study Area. However, groundwater levels will be measured in well 22 to evaluate groundwater flow conditions for the Study Area.

Monitoring well 22 was installed in July 2002. Based on available data, the well was utilized for gauging of groundwater levels and collection of samples for general chemistry analysis. On March 27, 2009, TVA submitted correspondence to TDEC requesting that this well be added to the Ash Disposal Area monitoring network as a downgradient compliance well, replacing monitoring well MW-4A (TVA 2009). This request was approved by TDEC in correspondence dated April 1, 2009 (TDEC 2009b). Sampling of the well as a downgradient compliance well began in June 2009. Groundwater monitoring for the Ash Disposal Area is being conducted under TDEC Permit #IDL 73-0094 in accordance with TDEC Rule 0400-11-01-.04(7) and the approved Groundwater Monitoring Plan (TVA 2014b).

Based on the boring log and well construction diagram for well 22, the well screen was installed through fill material that contains a mixture of ash, sand, gravel, and clay (TVA 2009). The well 22 boring log and well construction diagram are included as Appendix O. Measured depths to groundwater in the well indicate that groundwater is in contact with this fill material. Fluctuations in arsenic concentrations at well 22 have been observed from June 2013 through April 2017 (TVA 2017c). TVA plans to address the arsenic concentrations observed in well 22 under the current Ash Disposal Area monitoring program by replacing well 22 with new well 22C in the same area to obtain data representative of groundwater conditions downgradient of the Ash Disposal Area. The location and construction details of new well 22C will be submitted to TDEC for review and approval as part of the groundwater monitoring network for the Ash Disposal Area.

After TDEC approval is received, TVA will sample well 22 and new well 22C simultaneously for a minimum of four independent events prior to replacing well 22. A summary of activities taken regarding well 22 under that program and the existing permit will be included in the EAR.

3.5.2 TDEC Ground Water – Chemical and Physical Properties Information Request No. 2

TVA shall determine if the level of the ground water at the TVA KIF site is controlled by the level of the Emory River. If the Emory River affects the ground water level, then TVA shall collect data to determine the extent of the impact of the Emory River on the ground water table below the TVA KIF site.

TVA Response

This request is similar to the Ground Water Monitoring request in Section 3.1.1. The scope of work to address this request is provided in Section 3.1.1.

3.6 STRUCTURAL AND SEISMIC STABILITY

3.6.1 TDEC Structural and Seismic Stability Information Request No. 1

Given the site stabilization work completed as a part of the CERCLA closure of the industrial landfill, additional analyses of the structural and seismic stability of the Stilling Pond is needed for the Stilling Pond once it is dewatered to determine if the Stilling Pond may be closed in place. TDEC has reviewed EPA's comments about the seismic stability of the Stilling Pond. TDEC concurs with EPA's statement "the underlying potential for liquefaction-induced failure of these units remains a concern". The Stilling Pond at KIF is one of the units referenced.

TVA Response

TVA has completed design and environmental work to support closure of the Stilling Pond in place. In a letter to EPA dated May 1, 2015, TVA committed to close the Stilling Pond by April 17, 2018, based on the 2014 seismic stability results of the unit (as it existed at the time) that did not meet the EPA's 2011 seismic assessment criteria (Appendix B). TVA understands it is performing this work at risk, as discussions between TVA and TDEC concerning seismic stability of Dike C are ongoing.

In a letter to TDEC dated March 6, 2017 (Appendix B), TVA reiterated plans to close the Stilling Pond with CCR in place by April 17, 2018. A closure plan for the KIF Stilling Pond was included with the letter. On May 16, 2017, TVA provided a summary of static and seismic performance of the closed Stilling Pond to TDEC. The locations of stability cross sections are shown on Exhibit 10 (Appendix E). The results of the static stability analyses indicated that the design meets acceptance criteria for long-term loading conditions. The results of the seismic analyses indicated that soil liquefaction is expected and that lateral spreading is expected to cause moderate displacements and cracking. However, it does not indicate there would be a release of CCR from the Stilling Pond to the Emory River. Analyses show that the stored CCR will remain within the current facility footprint (Stantec 2017a). On May 19, 2017, TVA met with TDEC to review the closure design and its seismic performance.

The previous design analyses relied on previously obtained subsurface data and laboratory test results to characterize the geotechnical conditions. Prior field and laboratory studies were generally focused on static stability, and did not specifically target parameters that are used in a seismic assessment. Given that conservative assumptions about liquefaction triggering and residual strengths resulted in lateral spreading deformations which TVA determined to be tolerable, additional seismic explorations were not completed. However, based on TDEC's most recent information requests under this Multi-Site Order process, the request presented in Section 3.6.3 states that the seismic performance (i.e., predicted lateral spreading displacements) for the closed facility is not considered acceptable by TDEC. Given this response, TVA has chosen to complete (as part of the closure design process) a new design basis for seismic performance. As such, a re-evaluation of the closure design is warranted, additional field and laboratory studies are needed, and different engineering analyses are necessary. Specific items to be performed in the reassessment include the following:

- Additional site explorations, including penetration resistance data
- Additional laboratory testing
- Reassessment of the analysis cross sections and assigned soil parameters
- Updated liquefaction screening and triggering assessment
- Updated residual strength estimates
- Updated seismic slope stability analyses
- Updated predictions of seismic deformations of the Stilling Pond perimeter
- A revised Calculation Package for the Stilling Pond closure project

The closure design analyses will include both static and seismic slope stability analyses, and will satisfy the requirements of the TDEC Order General Guidelines as discussed in Section 4.4.6, Section 4.4.12, and the Stability SAP (Appendix P).

In addition to the closure design analyses above, as part of TVA's ongoing efforts to comply with 40 CFR 257.73 of the CCR Rule, structural stability assessments will be performed for the Stilling Pond as discussed in Section 4.4.13.

Summaries of the referenced geotechnical documents are presented in Appendix L. Based on the amount and context of data that will become available through the closure design and CCR Rule processes, no additional work is anticipated under the Multi-site Order to answer this information request. The expected duration to provide the requested information will be linked to the closure process. The re-evaluation of the engineering and closure design will be included in the EAR.

3.6.2 TDEC Structural and Seismic Stability Information Request No. 2

TVA shall provide a description of the methods it will employ to conduct seismic stability analyses, specifically, embankment liquefaction potential analysis for the Stilling Pond. TVA shall provide a schedule for conducting this analysis.

TVA Response

Refer to the response in Section 3.6.1.

3.6.3 TDEC Structural and Seismic Stability Information Request No. 3

It is our understanding that TVA has conducted seismic analyses for the Stilling Pond area and that if the Stilling Pond were closed in place there would be movement of Stilling Pond during a seismic event. TDEC cannot approve closure of the Stilling Pond in place, if the seismic and structural stability of the Stilling Pond does not meet the criteria established in the U.S. Environmental Protection Agency Coal Combustion Residual Rule, even if the Stilling Pond may not be "specifically" subject to those rules.

TVA Response

Refer to the response in Section 3.6.1.

3.7 SITE GEOLOGY

3.7.1 TDEC Site Geology Information Request No. 1

Due to the 2008 CCR release, there is extensive data for this site including subsurface geology. TVA should include a catalog of existing ground water monitoring wells and soil borings subsurface geological conditions and stability and characteristics of local hydrogeology.

TVA shall propose the location and construction of additional ground water monitoring wells and soil borings that will provide data to fully characterize the geology of this site.

TVA Response

As discussed in Section 3.4.1, several hydrogeological investigation studies have been conducted and are ongoing at KIF. The existing Study Area monitoring network includes monitoring wells AD-1, AD-2, AD-3, 6AR and GW-2. As discussed in Section 3.1.3, one additional background monitoring well (KIF-102) and four downgradient wells (KIF-103 through KIF-106) are proposed for this investigation. Additionally, groundwater levels will be measured at wells 22, 22B, 27A and 27B. Historical groundwater quality and groundwater elevation data associated with the Study Area are provided in Appendix N. Proposed and existing monitoring wells associated with this investigation are shown on Exhibits 2 and 3 (Appendix E). Additional information related to the hydrogeological investigations is included in Section 3.4.1.

As discussed at the Investigation Conference, the Study Area is underlain by the Conasauga Shale and Rome Formations (see geologic map on Exhibit 11, Appendix E). Both formations are predominantly shale and siltstone with minor amounts of limestone and dolomite. With regard to characterizing the lithology and geologic structure at this site, TVA plans to use the following information sources to respond to this information request:

- Geologic Lithology Information: Descriptions of the site geology including bedrock geology and faulting were provided in TVA (1982), AECOM (2009), Stantec (2009), and Stantec (2013) as part of the Investigation Conference Data Transmittal. The geotechnical exploration to support the construction of the Kingston Plant was presented in the Investigation Conference (Slide 36) and is documented in TVA (1964). A summary of geologic formations at KIF was presented in the Investigation Conference (Slide 20) which was developed using references based on the East-Central Sheet Geologic Map of Tennessee (Hardeman, 1966). Additional sources include TVA (1951 and 2015a) and Moore et al. (1993).

- Geophysical Test Results: As part of the Perimeter Containment System Design documented in Stantec (2013), geophysical testing was performed to characterize the shear wave velocity of bedrock underlying the Dredge Cells. The bedrock underlying the Dredge Cells is similar to that underlying the Study Area.

- Rock Core Data: Rock coring was performed in 9 borings at the Stilling Pond dikes (Stantec, 2009) and 33 borings along the perimeter of the failed Dredge Cell (S&ME 2010 and 2011; Stantec 2012a). As documented in Stantec (2013), rock coring was performed in 7 borings by AECOM in 2009 and 12 borings by S&ME in 2010 along the perimeter of the failed Dredge Cell. Additional rock core data from four borings is also available from the work to support closure design of the Interim Ash Staging Area (AECOM 2016a). Rock coring was also performed to install monitoring wells 22B and 27B along Dike C, AD-3 on the East Dike, and GW-1 along Swan Pond Road.

Summaries of the referenced geotechnical documents are presented in Appendix L. Plan view locations of borings that reached top of rock and borings that included rock coring are shown on Exhibit 7 (Appendix E). Based on the amount and context of data available to support a response, no additional field work is anticipated to answer this information request. TVA will summarize the geologic information referenced herein in the EAR.

3.7.2 TDEC Site Geology Information Request No. 2

TVA shall collect sufficient data to prepare a three dimensional picture of the subsurface environment from ground surface to bedrock. This shall include the depth of CCR material and native soil, sand and rock, the physical characteristics of these materials and any geologic anomalies discovered during investigation.

TVA Response

Section 3.1.5, the Exploratory Drilling SAP (Appendix I), and the Material Quantity SAP (Appendix H) describe how new and existing data will be used to develop a three-dimensional model and drawings that show geologic anomalies (if identified), subsurface material types, properties, and thickness from the ground surface to top of bedrock in the Interim Ash Staging Area, Sluice Trench, and Stilling Pond.

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 KIF 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 KIF 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

TDEC has requested the characterization of the local soils in a one-mile radius of KIF to evaluate the background levels of constituents of concern, previously defined as CCR Parameters.

TVA has prepared a Background Soil SAP (Appendix J) to characterize background soils on TVA property in the vicinity of the TVA KIF 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. Soil samples will be analyzed for the CCR Parameters to determine the naturally occurring levels. Additionally, the surficial soil (i.e., top six inches) at each location will be collected and analyzed for percent ash, to determine the presence or absence of windblown CCR.

This Background Soil SAP (Appendix J) establishes the procedures necessary to conduct investigation activities associated with the sampling and analysis of background soils. Exhibit 12 (Appendix E) depicts the locations of twelve proposed background soil sampling locations.

Exhibit 13 (Appendix E) 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. The locations were selected based on access, current hydrogeologic knowledge, sample location criteria previously set forth by TDEC, and when feasible, proximity to existing or proposed background groundwater monitoring wells (location BG-04 is positioned adjacent to proposed background monitoring well KIF-102, while BG-05 is located adjacent to existing background monitoring wells AD-1 and GW-1).

Proposed sampling locations were evaluated for past placement of CCR material on those areas as well as potential impacts from the Dredge Cell failure and to our knowledge, CCR material has not been placed in any of these areas. Areas known or expected to be in contact with CCR constituents during rain events, flood events, or currently being influenced by groundwater flow from KIF were additionally excluded.

Prior to mobilization for sample collection, the sampling locations will be verified using GPS. If necessary, sampling points may be slightly adjusted for safe equipment access. If required, sampling points will be changed to the closest possible location that can be safely accessed.

If a proposed boring location is discovered to have accessibility restrictions related to agricultural, cultural, biological, or other similar limiting factors, then a replacement boring will be proposed at a location that will meet the study's goals with approval from TDEC.

An initial grab sample, representing the surficial soils, will be collected by hand auger and submitted for laboratory analysis of percent ash by polarized light microscopy. Borings will then be advanced using a direct push technology (DPT) drill rig equipped with five-foot, 3.25 inch outside diameter probe rods, or equivalent technology. In collecting soil samples, borings will be extended until refusal. Grab samples will be collected from the mid-point of each five-foot boring interval. The mid-point for grab samples will be the mid-point based on recovery. Composite samples are not proposed.

If soils are expected to be hard to recover during core retrieval core catchers will be used to prevent loss of sample material. Composite samples are not 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 to be analyzed for CCR Parameters. A complete description of the sampling methods and protocols is provided in the Background Soil SAP (Appendix J).

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

TVA will review historical soil analytical data previously analyzed for CCR Parameters. This includes analytical data from historical surficial soil samples collected as part of the CERCLA emergency response activities, surficial soil samples collected independently by TVA from residential properties affected by fly ash, and soil samples collected during the installation of background monitoring well KIF-101. The CERCLA data was reported in the Final CERCLA Emergency Response Report, Revision 0, dated February 20, 2009 (Tetra Tech 2009), and consists of thirteen five-point composite surficial soil samples collected by EPA contractor Tetra Tech EM, Inc., from public and residential shorelines along the Emory and Clinch Rivers. Four of these samples were collected upstream of the site in an effort to determine background soil concentrations. The samples collected independently by TVA were likewise five-point composites of surficial soil with two in background locations and thirteen from properties affected by fly ash. These samples were analyzed for multiple parameters, including the majority of the CCR Parameter metals. Exhibit 14 (Appendix E) depicts the locations of the thirteen CERCLA soil data points collected by EPA contractor Tetra Tech EM, Inc.

Soil samples collected as part of these efforts will be reviewed in accordance with the KIF QAPP and analytical results will be compiled in the EAR, if the quality of the data is acceptable.

Once sampling has been completed and analytical results have been received, the analytical data for background soil, as well as the CERCLA and TVA soil data 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 will be calculated for each soil horizon and/or geologic unit using a statistical population consisting of a minimum of ten soil samples from each unit. If a particular horizon or geologic unit is under represented in the statistical population, additional borings will be installed.

BTVs are calculated using sampling data collected from un-impacted site-specific reference areas and represent an upper threshold of background concentration(s) expected to exist naturally in the environment.

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 2015).

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

A CCR Material Characteristics SAP was developed for the KIF study area to supplement existing CCR leachability data (Appendix S). The SAP includes characterization of leachability at the remaining locations of the study area (i.e., Sluice Trench and Ballfield East of the Sluice Trench, and the Interim Ash Staging Area).

Samples of CCR material will be collected during installation of the temporary wells, from both saturated and unsaturated zones in the CCR unit. The proposed temporary wells locations are provided in Exhibit 4 in Appendix E. 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. Filtered and unfiltered pore water samples will be collected from the phreatic zone at the base of the unit to obtain in-situ leaching information for the material. The data obtained will be evaluated with historical leachability and characterization data, which is summarized in the following paragraphs.

Immediately after the KIF Dredge Cell failure, TVA, TDEC, and EPA performed soil and ash sampling in the former Dredge Cell, in the embayment, and from private residences during December 2008 and January 2009.

On December 27, 28, and 29, 2008 and January 2, 2009, TVA collected eight ash samples from private residential properties adjacent to the site, analyzing them for total metals and Toxicity Characteristic Leaching Procedure (TCLP) metals. On January 6 and 7, 2009, TDEC collected two ash samples from the Dredge Cell, and ten ash samples from surrounding residential properties for a total of 12 ash samples. These samples were also analyzed for TCLP metals. EPA also collected two 10-point composite samples from the onsite ash pile and three grab samples of ash from the roadway, analyzing them for TCLP metals.

Finally, starting in April 2009, ash samples were collected and analyzed for hazardous waste characterization purposes for test loading activities under a TDEC Commissioner's Order, and in accordance with the Final Ash Disposal Sampling Plan, TVA Kingston Plant, Kingston, Tennessee. Therefore, beginning on April 27, 2009 and continuing through the completion of ash shipments to the Arrowhead Landfill in Uniontown, Alabama, 109 dredged ash samples were collected from the Interim Ash Staging Area and analyzed for the TCLP metals in accordance with hazardous waste characterization protocols. Throughout the analyses period, six of the eight TCLP metals were detected, with concentrations consistently below the regulatory hazardous waste threshold values, indicating the ash is not considered a hazardous waste under the Resource Conservation and Recovery Act (RCRA), but instead a non-hazardous solid waste.

Jacobs (2010) provides the following evidence regarding the leachability of metals from ash under the site-specific conditions at KIF:

- An EPA Science Panel's review of potential selenium issues after the ash spill concluded that metals are not readily leaching off the ash particles spilled into the river, based on available surface water monitoring data.
- The U.S. Army Engineer Research and Development Center tested samples of ash taken from the Dredge Cell, Emory River, and Stilling Pond using sequential extraction procedures which were designed to remove metals from the ash with increasingly more "aggressive" solvents. Study results demonstrated that site-specific metals (such as arsenic and selenium) did not easily become mobile in normal aqueous environments, and therefore, do not readily leach from the ash.
- Results of TCLP testing of ash samples for waste characterization purposes have shown that the TCLP leachate does not exceed regulatory hazardous waste threshold limits, indicating the ash is not a hazardous waste under RCRA.

In November 2017, three CCR/ash and pore water samples were collected from the base of the KIF Stilling Pond. The CCR/ash samples were analyzed for total CCR Parameters, total organic carbon (TOC), and SPLP. The unfiltered and filtered pore water samples were analyzed for the CCR Parameter concentrations for total and dissolved pore water samples, total and dissolved iron and manganese, and TOC. In addition, arsenic speciation was conducted on both the total and dissolved pore water samples to determine concentrations of arsenate and arsenite. Details of the sampling and field testing work plan are provided in (Stantec, 2017b).

In addition to having leachability data available for evaluation, the groundwater monitoring well network surrounding the CCR units will monitor the groundwater for CCR Parameters. The groundwater monitoring protocols will be relied on for the detection and assessment of any CCR Parameters identified in the groundwater, and for use in developing any necessary corrective actions. Leachability data will be evaluated and 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

Watts Bar Dam was completed in January 1942 and impounded Watts Bar Lake adjacent to the KIF site before plant construction began in 1951. Power generation began with the first unit in 1954. The 1941 *USGS Topographic Map of the Harriman Quadrangle*, provided as Exhibit 15 (Appendix E), shows the area surrounding the plant before the CCR units were constructed. The Geologic Map of the Harriman Quadrangle, Tennessee (Moore, 1993) shows geologic features at the site. Additional site geologic information is provided in Section 3.7.1. TVA will review the maps during the Investigation and summarize surface water features such as springs and the original flow of surface streams identified on the topographic maps in the EAR.

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.

TDEC General Guidelines For EIP
November 9, 2018

TVA Response

TVA plans to use information from the documents detailed below to summarize the design and materials used to construct the original Ash Pond which was later divided to construct the Stilling Pond, Interim Ash Staging Area, and Sluice Channel. TVA will also use this information to identify the original surface elevation at the location of the Stilling Pond, Interim Ash Staging Area, and Sluice Channel.

- **Pre-construction Topographic Maps:** TVA will use maps referenced in Section 4.1.3 which show pre-construction topography to estimate the original surface elevations at the location of the CCR units.
- **Construction Drawings:** Drawing 10N200 provides a general plan view of KIF. Drawing 10N400 (Rev 6) shows a plan view and typical sections of the dikes that formed the Ash Pond and Initial Ash Disposal Area/Interim Ash Staging Area (Dike B, Dike C, North Dike and East Dike). Drawings 10N420 through 10N424 include a plan view, typical sections, and details for the divider dike that formed the Stilling Pond and the raising of Dike C.
- **Geotechnical Reports:** Geotechnical reports summarized in the Evaluation of Existing Geotechnical Data (Appendix L) provide information including dike configurations and material classifications.

These documents will be provided in the EAR. TVA will summarize the design and materials used to construct the original Ash Pond and identify the original surface elevation at the location of the CCR units in the EAR.

Based on the amount and context of data available to support a response, no additional field work is anticipated at this time to answer this information request.

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 of CCR material at each site.

TVA Response

As discussed in Section 3.1.5, 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 material quantity, groundwater elevations, and subsurface conditions with respect to the Study Area. TVA will develop three-dimensional models, volumetric estimates, and drawings of the Study Area Units as described in Section 3.1.5.

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 for a water balance analysis for active surface impoundments is not applicable at KIF. The Stilling Pond has been drawn down and is no longer in use.

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.

TDEC General Guidelines For EIP
November 9, 2018

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

TVA Response

This request is similar to Information Request No. 1 in Section 3.3.1. Refer to Section 3.3.1 for the response to this request.

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

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 wells installed for CCR Rule, TDEC permitting requirements, Federal permitting and program commitments, and closed groundwater monitoring wells at the site. This information is provided in Appendix N in tabular form. Additional historical information is included in Section 3.1.3. This data has been collected for a variety of reasons since approximately 1976. TVA may use these historical data for qualitative purposes, but will use such data only after evaluating it in accordance with the KIF QAPP. A figure showing existing and closed monitoring wells that correspond to the tables is included in Exhibit 16 (Appendix E).

In addition to the analytical data, the construction and location of newly installed and closed groundwater monitoring wells and information will be researched, collected, reviewed, and compiled into a report to be provided in the EAR.

Historically, no springs have been located on site and are not currently anticipated to be encountered. If observed, TVA's inspection program will identify and document the new springs around the CCR units. If found, the newly identified springs will be added to the groundwater monitoring plan in the monitoring networks, as described in Sections 3.1.3 and 3.4.1.

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 information request is similar to TDEC Information Request 3 in Section 3.1.3. Refer to Section 3.1.3 for the response to this request.

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 information request is similar to TDEC Information Request 3 in Section 3.1.3. Refer to Section 3.1.3 for the response to this request.

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

This Information Request is similar to other information requests that are addressed in Sections 3.1.3 and 3.4.1. Refer to those sections and the Hydrogeological Investigation SAP (Appendix G) for details on proposed drilling, logging, well construction and well development methods.

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 monitoring plan proposed for the environmental investigation is described in Section 3.1.3. In addition, the Groundwater Investigation SAP (Appendix F) provides the methods that TVA will use to collect groundwater samples, analytical methods, chain-of-custody procedures, packaging, shipping, and transportation requirements. Additional information regarding laboratories to be used for analysis of the samples is provided in the KIF QAPP (Appendix C).

Historically, no springs have been located on site and are not currently anticipated to be encountered. If observed, TVA's inspection program will identify and document the new springs and they will be added to the groundwater monitoring plan for the groundwater monitoring network.

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

The request regarding the estimation of the amount of CCR material below the groundwater surface is similar to the information requested in Sections 3.1.2 and 3.1.3. Refer to those sections for preparation of groundwater contour maps and estimating the three-dimensional profile of CCR material.

The request regarding the collection of pore water samples is similar to the information requested in Section 4.1.2. Existing leachability data will be evaluated and addressed in the EAR as discussed in Section 4.1.2.

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

As discussed in Section 3.1.3, the initial phase of the environmental investigation is to characterize the site by assessing current subsurface conditions in the Study Area. Potential groundwater impacts will be identified by collecting background and downgradient groundwater samples. TVA will use industry-accepted methods for delineating the extent of CCR Parameters, 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 the Hydrogeological Investigation SAP (Appendix G). 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

Existing geological characterization data, including boring logs from previous geotechnical work and related reports (e.g., TVA 1951,1964, 1982, 2015a; AECOM 2009, 2016a; Stantec 2009, 2012a, 2013; S&ME 2010, 2011), as well as construction and facility performance records will be reviewed. The review will focus on information related to geologic lithology, geologic features, solution channeling, and/or springs at the KIF site. The response will discuss how the geologic lithology influences the construction and performance of the different units.

Available information indicates that the CCR units within the KIF Study Area are underlain (from top to bottom) by bedrock of the Conasauga Shale and Rome Formations. Both formations are predominantly shale and siltstone, with minor amounts of limestone and dolomite. These formations are underlain by various limestone units, but they are over 1,000 feet below the shale units. Any potential karstic activity in the limestone units would not affect stability of the CCR units (AECOM 2009).

No known geologic sinkholes or karst features have been identified at the KIF Study Area in the available historical construction reports, drawings, inspections, or geotechnical explorations. Further, natural seeps or springs have not been identified within the KIF Study Area. Karstic and sinkhole features have historically been identified just downstream of the KIF Study Area, where soil units on the peninsula are directly underlain by the Knox Group Limestone (TVA 1951, AECOM 2009). These features are not expected to affect the stability of the disposal units in the study area at KIF. Note that the difference in the uppermost bedrock type between the Study Area and the peninsula is due to regional thrust faulting and the regional strike and dip of the formations.

A summary of the pertinent existing and new information will be provided in the EAR.

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

The information required for this response is similar to that for D.1 (Section 4.4.1). TVA will use existing data and reports to describe the geologic structure beneath the CCR units with a focus on faults, fractures, and bedding planes.

The locations of known faults near KIF will be provided based on existing literature. Observations regarding fractures and bedding planes identified in rock cores collected during previous investigations (TVA 1951, AECOM 2009, Stantec 2009, S&ME 2010, S&ME 2011, Stantec 2012a, Stantec 2013, AECOM 2016a) will be summarized in the EAR. TVA will use this and other information from historical construction reports, drawings, inspections, and explorations to describe the geologic structure below KIF, including the proximity of faults below the CCR units and the degree of infilling of fractures and bedding planes.

The understanding of the geologic structure will be combined with hydrogeological information to evaluate its influence on groundwater flow. This evaluation will be provided in the EAR.

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

As described in Section 3.1.5, 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 material quantity and subsurface conditions. The scope of the Material Quantity SAP includes modeling subsurface conditions from final grade to bedrock. The Material Quantity SAP describes how existing and new top of bedrock data will be incorporated into three-dimensional models of the units to develop top of bedrock contours.

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

TVA will use the following data to describe how the original Ash Pond was divided into individual units, including what is now known as the Interim Ash Staging (Ballfield) Area, Sluice Trench and Ballfield East of Sluice Trench, and Stilling Pond.

- **Construction Drawings:** As provided to TDEC in the Investigation Conference Data Transmittal, drawing 10N200 provides a general plan view of KIF; drawing 10N400 (Rev 6) shows a plan view and typical sections of the dikes that formed the Ash Pond and Initial Ash Disposal Area/Interim Ash Staging Area (Dike B, Dike C, North Dike and East Dike; drawings 10N420 through 10N424 include a plan view, typical sections, and details for the divider dike that formed the Stilling Pond and the raising of Dike C; and record drawings for the Dike C Buttress Project (Stantec 2011) are also available.

- **Geotechnical Reports:** As provided to TDEC in the Investigation Conference Data Transmittal, TVA submitted geotechnical reports for the Dredge Cells (MACTEC, 2004), Dike C [TVA (1975) and Stantec (2009)], Root Cause Analysis (AECOM, 2009), Interim Ash Staging Area [(MACTEC, 2009) and Geosyntec (2010a, 2010b, and 2012)] and Dredge Cell Closure Perimeter Containment System (Stantec, 2013). These reports include stability cross sections which depict the original and modified embankment configurations of the Ash Pond and/or material classifications and consistency descriptions. Boring data from these geotechnical reports can also be used to describe the structural changes made to divide the original Ash Pond into individual units. Additional geotechnical data from ongoing work to support closure of the Interim Ash Staging Area documented in AECOM (2016a) will also be available. Boring locations from AECOM (2009), MACTEC (2009), Stantec (2009), Geosyntec (2010a), and Geosyntec (2012) are presented on Exhibit 1 (Appendix E).

- **Archived Documents:** TVA will review its archives to attempt to locate additional construction documents, record drawings, and geotechnical data to describe how the original Ash Pond was divided into individual units. TVA will also review its archives for construction documentation for the Sluice Channel.

TVA will describe how the original Ash Pond was divided into individual units in the EAR.

Based on the amount and context of data available to support a response, no additional field work is anticipated at this time to answer this information request.

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 condition is not applicable to the Study Area since no such interface exists for these units.

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

As described in Section 3.6.1 and in the Stability SAP (Appendix P), new stability analyses will be performed where necessary to address this information request. Otherwise, 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 L (Evaluation of Existing Geotechnical Data) demonstrate that existing data is representative and suitable to support the stability analyses.

The load cases to be evaluated 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
- Seismic, pseudostatic global stability
- Seismic, pseudostatic veneer stability
- Seismic, post-earthquake global stability (includes a preceding liquefaction triggering assessment)

The proposed assessment framework will comply with the overall goals of the TDEC Multi-site Order as outlined in several Information Requests in Section D of the General Guidelines for EIPs and the site-specific request in Section 3.6.1. In general, the program may consist of geotechnical explorations (field and laboratory), followed by analysis. Data from previous geotechnical explorations (field and laboratory) and existing static/seismic stability analyses are available to fulfill certain components of this information request. Specific data that is available for each unit is described below. Where proposed below, the stability evaluation analysis methodology and acceptance criteria are in the Stability SAP (Appendix P). The analyses will be submitted in the EAR.

Based on the amount and context of data available to support a response, no additional field work is anticipated to answer this information request.

Stilling Pond: TVA is reassessing the seismic performance of the closure design. The revised Calculation Package for the Stilling Pond closure project will include updated global and veneer stability analyses and will fulfill this data request for the Stilling Pond. The expected schedule to provide the stability analyses for the closed-in-place condition will be linked to the submittal of closure design documents to TDEC. A summary of these analyses will be included in the EAR.

Sluice Trench and Ballfield East of Sluice Trench: Existing analyses are available for the Sluice Trench and Ballfield East of Sluice Trench, from the following sources:

- Geosyntec (2010a): Static long-term global slope stability analysis of the East Dike, located at the perimeter of the Sluice Trench

- Geosyntec (2010b): Static long-term and seismic (pseudostatic) short-term global slope stability analyses of the East Dike, located at the perimeter of the Sluice Trench

- Geosyntec (2012): Static long-term global slope stability analysis of the East Dike, located at the perimeter of the Sluice Trench, incorporating results of additional geotechnical exploration

- AECOM (2016b): Static long-term and seismic (pseudostatic and post-earthquake) short-term global stability analyses of the East Dike and Polishing Pond (closed conditions), incorporating results of additional geotechnical exploration

The available analyses of the Drainage and Flow Management Project (i.e., Polishing Pond and Water Quality Channel) (AECOM 2016a, 2016b) did not include static long-term or seismic veneer stability analyses. Further, these available analyses did not include geometry changes from recent construction of a graded filter along the outslope of the

East Dike (AECOM 2017). Therefore, new static (global and veneer) and seismic (global and veneer) stability analyses and liquefaction triggering analyses for the existing (with graded filter) conditions will be performed. These analyses will be performed in accordance with the Stability SAP (Appendix P). A summary of these analyses will be included in the EAR.

Interim Ash Staging Area: Static and seismic slope stability analyses are not needed for the Interim Ash Staging Area.

The closure design of the Interim Ash Staging Area (AECOM 2016a, 2016b) generally leveled the site to conform to the surrounding grades, with gentle slopes (3% maximum) and small perimeter ditches to promote surface drainage. Due to the higher surrounding grade, flat closure grading, and containment toward the east by the Polishing Pond, the closure documents demonstrate adequate performance of the CCR containment area without the need for static or seismic slope stability calculations.

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

Stilling Pond, Sluice Trench and Ballfield East of Sluice Trench, Interim Ash Staging Area: The units are not permitted CCR landfills, and do not have a drainage layer within the units; therefore, this information request does not apply to these units. The closure design of the units does not include drainage layers within or below CCR in the final configuration.

However, to evaluate phreatic levels within the Sluice Trench and Ballfield East of Sluice Trench and the Interim Ash Staging Area, the Exploratory Drilling SAP (Appendix I) includes temporary wells as shown on Exhibit 4 (Appendix E). TVA concluded that existing information from the ongoing closure will provide sufficient data for the Stilling Pond.

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

The Stilling Pond, Sluice Trench and Ballfield East of Sluice Trench, and Interim Ash Staging 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 § 257.53. Therefore, this information request does not apply to KIF.

Regarding the Stilling Pond, Sluice Trench and Ballfield East of Sluice Trench, and Interim Ash Staging 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 this exclusion is 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. Similarly, the requirements of this rule do not apply to inactive CCR landfills—which are CCR landfills that do not accept waste after the effective date of the regulations. The Agency is not aware of any damage cases associated with inactive CCR landfills, and as noted, the risks of release from such units are significantly lower than CCR surface impoundments or active CCR landfills. In the absence of this type of evidence, and consistent with the proposal, the Agency has decided not to cover these units in this final rule."

Throughout their service life, TVA has constructed and operated the Stilling Pond, Sluice Trench and Ballfield East of Sluice Trench, and Interim Ash Staging Area in compliance with the state and/or federal regulatory frameworks in effect at the time.

The Stilling Pond and Sluice Trench and Ballfield East of Sluice Trench are surface impoundments that no longer impound water as defined by the CCR Rule. The Interim Ash Staging Area is an inactive landfill as defined by the CCR Rule. The CCR Rule became effective in 2015, and does not apply retroactively to these units.

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

Stilling Pond: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths for CCR materials were developed based on historical data (including laboratory testing results), typical values, and published correlations to field testing data as described in the Evaluation of Existing Geotechnical Data (Appendix L). Stantec (2017a) considered prior drilling and testing results in the vicinity of this unit (AECOM 2009; Stantec 2009). Stantec (2011) and AECOM (2016a) considered results from additional drilling and testing, and leveraged prior reports to assign CCR shear strengths for analyses. Boring locations from available studies are shown on Exhibit 1 (Appendix E).

As discussed in Section 3.6.1, TVA is updating the design calculations for the ongoing Stilling Pond closure project. Revised shear strengths and stability analyses will be included in the update. A review of the preliminary stability analyses for the ongoing closure design shows that due to the location of the sluiced ash in the cross sections, this material did not significantly influence the global or veneer slope stability for closed conditions. When evaluating the suitability of existing and ongoing stability analyses to address the TDEC Order information requests, the use of shear strengths based on previous studies and typical/published values will be considered. Factors to be considered include the sensitivity (or lack thereof) of the analysis to the strength and the degree of conservatism of the assigned strength value relative to the site-specific material.

The EAR will present a summary of the updated analyses, along with historical data and characterization of the CCR shear strengths for this unit.

Sluice Trench and Ballfield East of Sluice Trench: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths for CCR materials were developed based on historical data (including laboratory testing results), typical values, and published correlations to field testing data as described in the Evaluation of Existing Geotechnical Data (Appendix L). MACTEC (2009) considered drilling and testing results in the vicinity of this unit. Geosyntec (2010a, 2010b, 2012), AMEC (2012), AMEC Foster Wheeler (2015), and AECOM (2016a, 2016b) considered results from additional drilling and testing, and leveraged prior reports to assign CCR shear strengths for analyses. Boring locations from available studies are shown on Exhibit 1 (Appendix E).

A review of the referenced existing stability analyses shows that due to the location of the CCR materials in the cross sections, this material could influence the slope stability results in the vicinity of the unit. When evaluating the suitability of existing stability analyses to address the TDEC Order information requests, the use of shear strengths based on previous studies and typical/published values will be considered.

Factors to be considered include the sensitivity (or lack thereof) of the analysis to the strength and the degree of conservatism of the assigned strength value relative to the site-specific material.

The EAR will present a summary of the historical data and characterization of the CCR shear strengths for this unit.

Interim Ash Staging Area: TVA performed design work to support the recent closure of this unit. The closure design generally leveled the site to conform to the surrounding grades, with gentle slopes (3% maximum) and small perimeter ditches to promote surface drainage. Due to the higher surrounding grade, flat closure grading, and containment toward the east by the Polishing Pond, the closure design documents demonstrate adequate performance of the CCR containment area without the need for static or seismic slope stability calculations, and the characterization of CCR strengths within the unit is not required to address this request.

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 4.4.8, none of the KIF CCR units in the Study Area meet the definition of an overfill per the CCR Rule. Therefore, this information request does not apply to KIF.

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

Interim Ash Staging Area: The Interim Ash Staging Area does not constitute a dam, as defined by TVA Standard Programs and Processes (SPP) manual on Dam Safety (TVA-SPP-27.0). There are no perimeter dikes that would constitute dams under Federal Emergency Management Agency (FEMA) guidelines, which consider both dam height and impounding capacity.

The above-listed unit at KIF does not have the capacity to impound 50 acre-feet or more, thus does not meet the definition of a dam. Therefore, this information request does not apply to the Interim Ash Staging Area.

Stilling Pond, and Sluice Trench and Ballfield East of Sluice Trench: The perimeter dikes of the Stilling Pond and the Sluice Trench and Ballfield East of Sluice Trench have historically been included in TVA's Dam Safety Program. TVA has applicable SPPs that govern the safety analysis for dams and impoundments. TVA utilizes procedural standards for managing dam safety activities and support. Objectives of the program include:

- 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 4.4.6 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 TDEC 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 provided 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

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).

As noted in Section 4.4.6, an industry-standard structural stability evaluation will be performed. The evaluation will consider static and seismic slope stability, as well as liquefaction triggering, as applicable. Existing and proposed seismic stability assessments are outlined in Section 4.4.6. Proposed analyses will be performed per the Stability SAP (Appendix P). Existing and proposed slope stability analysis cross section locations are shown in Exhibit 10 (Appendix E). Results will be presented in the EAR.

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

As part of TVA's ongoing efforts to comply with the CCR Rule, structural stability assessments will be performed for the Stilling Pond and the Sluice Trench and Ballfield East of Sluice Trench. With respect to structural integrity, these assessments consider 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
- Sudden drawdown assessment (slope stability)

Regarding the closed condition of the Stilling Pond, the ongoing closure design reassessment (see Section 3.6.1) will address many aspects of structural integrity listed in the CCR Rule CFR 257.73(d) such as settlement, erosion protection, vegetative cover, and spillway adequacy.

The Interim Ash Storage Area is not subject to the CCR Rule for active units (see Section 4.4.8). While this unit is not subject to CFR 257.73(d) or (e), closure documents for the Interim Ash Staging Area addressed many aspects of structural integrity listed in the CCR Rule CFR 257.73(d) such as settlement, erosion protection, vegetative cover, and spillway adequacy (AECOM 2016a).

A summary of the above-mentioned studies will be provided in the EAR.

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. 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 257.73(e) such as static and seismic stability. The Stability SAP (Appendix P) for the Study Area (described in Section 4.4.6) will present the analysis methodology and acceptance criteria for the evaluation.

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

TVA will review the available bedrock data from several sources, including historic geologic lithology data and mapping, construction data, and rock core data, to evaluate the ability of the geologic formations underlying the Study Area to provide structural stability for these units in their existing (i.e., closed) condition. Relevant information from Sections 4.4.1 and 4.4.2, including results of proposed investigations, will also be taken into consideration. This evaluation will be provided in the EAR.

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

TVA used hydraulic and mechanical dredging to complete time-critical removal actions of approximately 3.5 million cubic yards of ash and sediment from the Emory River between May 2009 and December 2010. Following completion of the KRP time-critical removal action, extensive sampling of remaining ash deposits, submerged sediment, seasonally-exposed sediment, and benthic invertebrates was conducted at locations in the Emory, Clinch, and Tennessee Rivers as described in TVA (2010). The associated sampling methodologies, data, etc. for activities conducted in 2009 through 2011 were presented in TVA (2012c and 2012d).

In August 2012, a Baseline Ecological Risk Assessment (BERA) (ARCADIS 2012) was approved by the EPA. The BERA evaluated the potential ecological effects on biota from ash residuals in the river system based on sediment toxicity tests conducted using sediments and water collected from the Emory and Clinch Rivers.

The results of the toxicity testing and comparison of the concentrations of metals in the ash/sediment to published ecological screening levels identified arsenic and selenium as the constituents of concern for ecological receptors.

In addition to direct toxicity to benthic invertebrates, the BERA identified the potential for arsenic and selenium to bioaccumulate through the aquatic/riparian food-chain.

Based on the results of the previous sampling activities, the BERA, and modeling conducted to predict future ash deposition, TVA proposed Monitored Natural Recovery (MNR) of the river system as the preferred removal action to achieve Remedial Action Objectives. A LTM SAP was prepared to describe a monitoring program to document the effectiveness of the approved removal action. The LTM SAP describes data quality objectives, sampling design, and sampling procedures for data collections necessary to assess the effectiveness of the MNR strategy.

The sampling activities outlined in the LTM SAP, which included evaluations of sediment quality, benthic invertebrate community composition, and benthic invertebrate bioaccumulation, were implemented beginning in 2013, with annual reporting of results to TDEC and EPA (e.g., TVA 2015c and 2016b). Based on the 2014-2015 data and the observed spatial and temporal trends, it appears that MNR is proving to be effective in quickly restoring the river system to pre-spill conditions.

Consequently, there have been no changes in the risk management recommendations related to benthic invertebrates provided in the BERA, and the only change in the long-term monitoring requirements established in the LTM SAP has been elimination of tree swallow monitoring, which was approved by EPA March 21, 2016.

Since the LTM SAP has already been implemented successfully, no further sampling plans will be developed. Exhibit 17 (Appendix E) depicts the historic sediment sampling locations for KIF.

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

A Sediment SAP will not be developed due to the amount of existing sediment data available, as described in Section 4.5.1. Existing sediment data will be evaluated and addressed 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

Existing sediment data 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 based on the data.

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

During the time-critical removal action period, May 11, 2009 through December 2010, TVA collected more than 2,500 surface water samples and TDEC independently collected several hundred more (TVA 2011b). TVA conducted surface water monitoring at five locations on the Emory River, four locations on the Clinch River, and two locations on the Tennessee River, a total of 11 sampling locations, encompassing approximately 14 miles of the river system, both upriver and downriver of the Site. TVA's samples were analyzed for total suspended solids and for total and dissolved forms of 24 different metals and metalloids along with field water quality parameters.

From August 31, 2010 to October 21, 2010, TVA implemented a SAP for the surface water portion of the River System Engineering Evaluation/Cost Analysis that evaluated alternative removal actions for approximately 500,000 cubic yards of residual ash in the Emory and Clinch Rivers. During that exercise, TVA collected 296 surface water samples from 11 fixed station monitoring locations that were sampled once each week for eight weeks.

These samples were analyzed for total and dissolved metals, hardness as calcium carbonate, total suspended solids, total dissolved solids, and dissolved organic carbon (Jacobs 2012b). Exhibit 18 (Appendix E) depicts the historic surface water sample locations for KIF.

The Baseline Human Health Risk Assessment (BHHRA) indicated no unacceptable cancer risk or non-cancer hazard to any human receptor due to exposure to residual ash. There were also no constituents of concern for residential use of surface water, nor recreational exposure, due to non-cancer effects (Jacobs 2012a).

Several ash-related constituents (including arsenic) were detected in the surface water at concentrations exceeding reference concentrations. However, no constituent in either mid-depth or epibenthic surface water in the downstream reaches exceeded Tennessee Water Quality Criteria (TWQC). Arsenic, lead, and mercury concentrations exceeded TWQC infrequently during storm event sampling, but after being evaluated in the BHHRA and BERA, surface water was not identified as a pathway contributing to risk to either human or ecological receptors, and no removal action was recommended to manage this pathway (TVA 2012a).

Fifteen sampling events from October 2010 to May 2011 were evaluated for the Non-Time-Critical Removal Action Surface Water Monitoring Plan and showed a downward temporal trend in concentrations of ash-related constituents, and that there was little, if any, change in water quality of the Emory River adjacent to KIF (TVA 2012b).

No additional field work is anticipated based on the abundance of available data. Existing data will be summarized 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
TVA has developed a SAP to characterize seeps for the CCR Parameters (Appendix R). An investigation of the study area will be conducted for active seeps. Seep water and soil samples will be collected from any identified active seeps and analyzed for the CCR Parameters. The analytical results 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. A seep history is included in Appendix Q.

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

1. Research and review existing documentation on the location of historical seeps
2. Investigate site for active seeps
3. Identify location of active seeps on a map
4. Implement Seep SAP (Appendix R) based on active seep location map
5. Collect seep soil and/or water samples from active seeps
6. Record sample location using GPS
7. Analyze seep soil and/or water samples (taken from active seeps) for CCR Parameters per the Seep SAP in accordance with the KIF QAPP
8. Review and evaluate existing and new analytical data
9. Prepare the EAR

As part of the Seep SAP (Appendix R), a seep investigation will be conducted to discover whether active seeps or continued seepage from mitigated seep areas are present, along with a focus on repaired seep areas. 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 may require the use of a boat since mitigation riprap often extends to the bank and/or waterline. 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 statistically 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 included in the EAR. 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 R). Once sampling is complete and analytical results have been received, the CCR parameter analyses for the seep samples will be evaluated in accordance with the KIF QAPP and reported in the EAR.

Surface Stream Characterization Study and Associated SAP

A Surface Stream SAP will not be developed due to the sufficient amount of existing surface stream data available, as described in Section 4.5.4. Existing surface stream data will be evaluated and addressed 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

Existing surface stream data will be used to develop a map identifying stream sampling points and the results of the analyses. Any analytical results from implementation of the Seep SAP will be used to develop a map identifying the seep sampling points and the results of the analyses. The location of any public water intakes within 1 mile of the downstream side of the TVA site will be provided on a map and included in the EAR.

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

Spring Sports Fish Surveys have been completed annually or biennially at KIF since 2002. A comparison of pre-Dredge Cell failure and post-Dredge Cell failure data collected from the surveys from 2002 to 2011 indicated that the immediate area adjacent to KIF, as well as downstream in Watts Bar Reservoir, showed no clear evidence of adverse effects associated with the Dredge Cell failure (Baker 2011a). Findings from the most recent surveys performed in 2015 were similar to previous years (Arcadis 2016). It was determined that residual ash remaining at KIF does not appear to be posing a long-term risk to sport fish in the Emory and Clinch Rivers. The Spring Sports Fish Surveys are ongoing.

Fish community surveys were completed biennially from 2001 to 2007 upstream and downstream of KIF using TVA's Reservoir Fish Assemblage Index (RFAI) methodology (Baker 2011b). After the Dredge Cell failure, sampling was conducted annually and an additional location was added at the area of the Dredge Cell failure and subsequent dredging. A comparison of pre-Dredge Cell failure and post-Dredge Cell failure survey data (Autumn 2001 to 2010) indicated that there may have been some adverse impact to the fish community immediately after the Dredge Cell failure based on stress due to habitat disruption and increased parasite loads (Baker 2011b). However, no long-term impacts were indicated and the area near KIF continues to support species of fish in numbers and conditions typically observed in the area before the Dredge Cell failure.

failure (Baker 2011b). Over the 10 sample years (11 surveys) for the Clinch River sites, RFAI ratings varied between "good" and "fair" with no apparent relation to the Dredge Cell failure. The RFAI results over the 10 years indicate the fish assemblages near KIF continue to be representative of those observed prior to the Dredge Cell failure (Baker 2011b). Beginning in 2013, the sampling was reduced again to biennially as part of the LTM SAP. The most recent fish community survey was performed in 2015.

Fish reproduction studies have been performed by the Oak Ridge National Laboratory (ORNL) in the vicinity of KIF since the first breeding season (spring 2009) after the Dredge Cell failure (Arcadis 2016). Statistical analyses of fish reproductive data collected from 2009 through 2013 indicate that the residual ash from the Dredge Cell failure is unlikely to pose significant long-term risks to the reproductive success of fish populations in the Watts Bar Reservoir. Results from the most recent (2015) reproductive evaluation found no differences in reproductive function of the three species, largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus), and redear sunfish (Lepomis microlophus) resulting from the residual ash in the river (Arcadis 2016). More recent data collected for reproductive studies was being analyzed at the time of the report.

Fish bioaccumulation studies have been performed by ORNL at KIF since the Dredge Cell failure (Arcadis 2016). Bioaccumulation of metals and metalloids were measured in fillets of largemouth bass, bluegill, and redear sunfish. A comparison of the data across all studies showed selenium concentrations in all species and all tissues were on average higher at ash-affected locations than at reference locations; however, concentrations continue to be well below toxicity and risk guidelines. Selenium concentrations appear to have declined slightly in largemouth bass and redear sunfish over time. Arsenic concentrations in fillets of all species have been variable over time but show no increasing or decreasing trends.

Fish health studies have been performed by ORNL at KIF since 2009 and have varied from year to year in scope of the assessments (Arcadis 2016). In 2014, the fish health evaluation was limited to visual inspection of bluegill, redear sunfish, and largemouth bass collected near the Dredge Cell failure site in conjunction with the fish bioaccumulation studies (Arcadis 2015). There was no evidence of anomalies. A statistical temporal analysis was also conducted on fish health. Overall, ORNL's findings suggested a lack of consistent evidence of compromised health of the fish correlated with the Dredge Cell failure.

In 2015, the fish health study evaluated a variety of health metrics that assessed physiological and energetic responses in fish (Arcadis 2016). Samples from bluegill, redear sunfish, and largemouth bass collected from reference locations and impacted locations were evaluated in conjunction with the spring fish bioaccumulation studies. Blood analyses and a full suite of health parameters were measured, as specified in the LTM SAP. Similar to previous years of study, there were no significant differences in any of the fish health metrics evaluated from impacted locations compared to metrics from reference locations in 2015.

Based on the numerous fish studies completed at KIF since the Dredge Cell failure, the lack of evidence of impacts from the Dredge Cell failure on the fish, and ongoing fish studies being conducted by TVA and ORNL annually or biennially, additional sampling is not needed. Exhibit 19 (Appendix E) depicts the historic fish sampling locations for KIF.

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

Sediment, benthic, mayfly, and fish tissue SAPs are not proposed for the site, due to the sufficient amount of information collected, reviewed, and compiled during the various time-critical and non-time-critical removal activities for the 2008 Dredge Cell failure as discussed in Sections 4.5.1, 4.5.4, and 4.5.7.

5.0 ENVIRONMENTAL ASSESSMENT REPORT

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 the June 22, 2017 letter.

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 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.

6.0 REFERENCES

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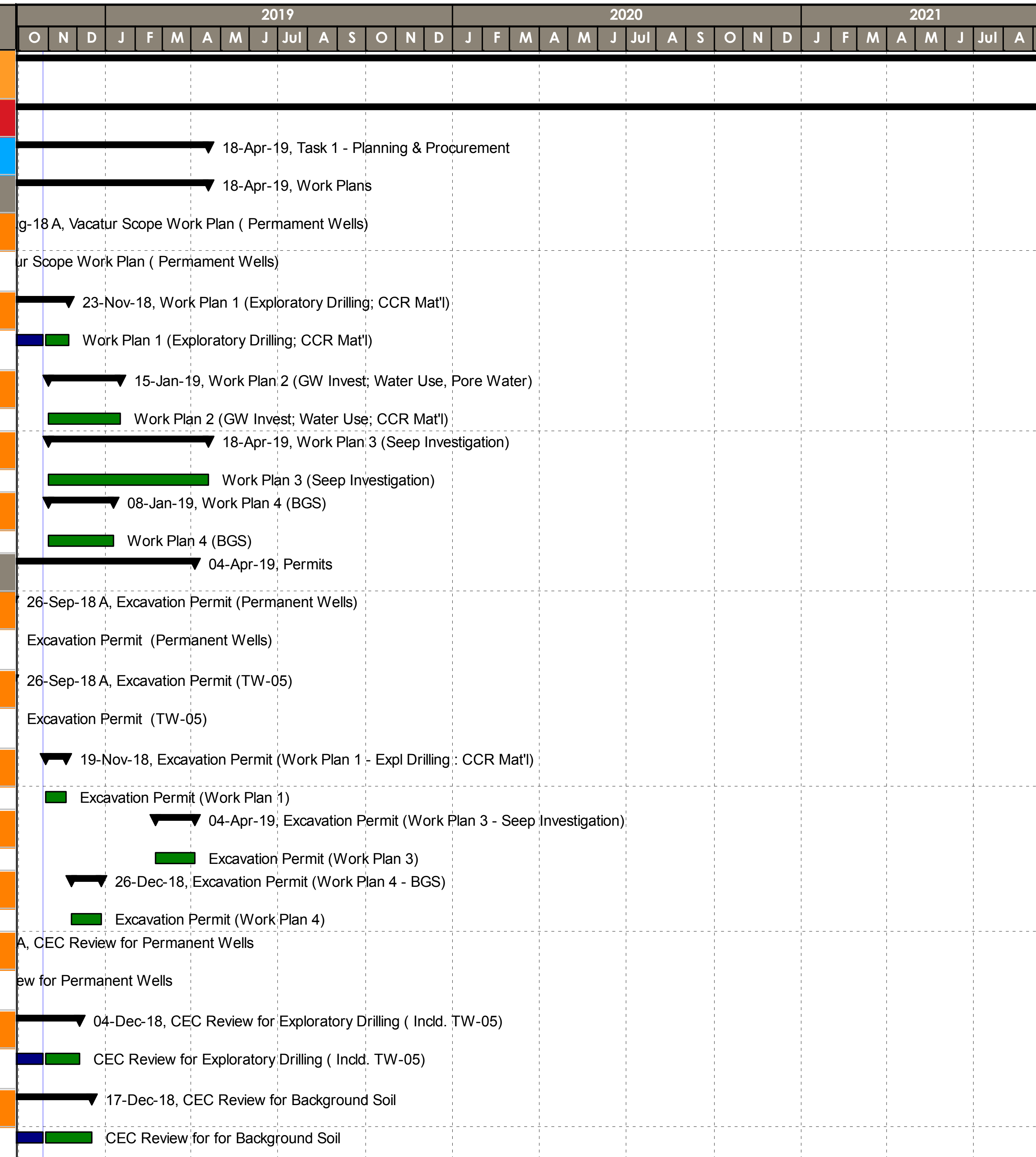
APPENDIX A
SCHEDULE

ST612102-003 TDEC Order KIF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
	TDEC Order KIF Phase 2	728d	18-Apr-18 A	21-Sep-21
	Environmental Investigation	728d	18-Apr-18 A	21-Sep-21
	Task 1 - Planning & Procurement	118d	18-Apr-18 A	18-Apr-19
	Work Plans	118d	18-Apr-18 A	18-Apr-19
	Vacatur Scope Work Plan (Permament Wells)	0d	18-Apr-18 A	07-Aug-18 A
STN-04140	Vacatur Scope Work Plan (Permament Wells)	0d	18-Apr-18 A	07-Aug-18 A
	Work Plan 1 (Exploratory Drilling; CCR Mat'l)	18d	17-Sep-18 A	23-Nov-18
STN-11015	Work Plan 1 (Exploratory Drilling; CCR Mat'l)	18d	17-Sep-18 A	23-Nov-18
	Work Plan 2 (GW Invest; Water Use, Pore Water)	50d	01-Nov-18	15-Jan-19
STN-11115	Work Plan 2 (GW Invest; Water Use; CCR Mat'l)	50d	01-Nov-18	15-Jan-19
	Work Plan 3 (Seep Investigation)	115d	01-Nov-18	18-Apr-19
STN-11315	Work Plan 3 (Seep Investigation)	115d	01-Nov-18	18-Apr-19
	Work Plan 4 (BGS)	45d	01-Nov-18	08-Jan-19
STN-98390	Work Plan 4 (BGS)	45d	01-Nov-18	08-Jan-19
	Permits	108d	06-Jul-18 A	04-Apr-19
	Excavation Permit (Permanent Wells)	0d	13-Aug-18 A	26-Sep-18 A
STN-12420	Excavation Permit (Permanent Wells)	0d	13-Aug-18 A	26-Sep-18 A
	Excavation Permit (TW-05)	0d	13-Aug-18 A	26-Sep-18 A
STN-12520	Excavation Permit (TW-05)	0d	13-Aug-18 A	26-Sep-18 A
	Excavation Permit (Work Plan 1 - Expl Drilling : CCR M	15d	29-Oct-18	19-Nov-18
STN-12115	Excavation Permit (Work Plan 1)	15d	29-Oct-18	19-Nov-18
	Excavation Permit (Work Plan 3 - Seep Investigation)	30d	22-Feb-19	04-Apr-19
STN-12315	Excavation Permit (Work Plan 3)	30d	22-Feb-19	04-Apr-19
	Excavation Permit (Work Plan 4 - BGS)	22d	26-Nov-18	26-Dec-18
STN-98470	Excavation Permit (Work Plan 4)	22d	26-Nov-18	26-Dec-18
	CEC Review for Permanent Wells	0d	06-Jul-18 A	09-Jul-18 A
TVA-12615	CEC Review for Permanent Wells	0d	06-Jul-18 A	09-Jul-18 A
	CEC Review for Exploratory Drilling (Incld. TW-05)	25d	12-Sep-18 A	04-Dec-18
TVA-12915	CEC Review for Exploratory Drilling (Incld. TW-05)	25d	12-Sep-18 A	04-Dec-18
	CEC Review for Background Soil	34d	12-Sep-18 A	17-Dec-18
TVA-12715	CEC Review for for Background Soil	34d	12-Sep-18 A	17-Dec-18



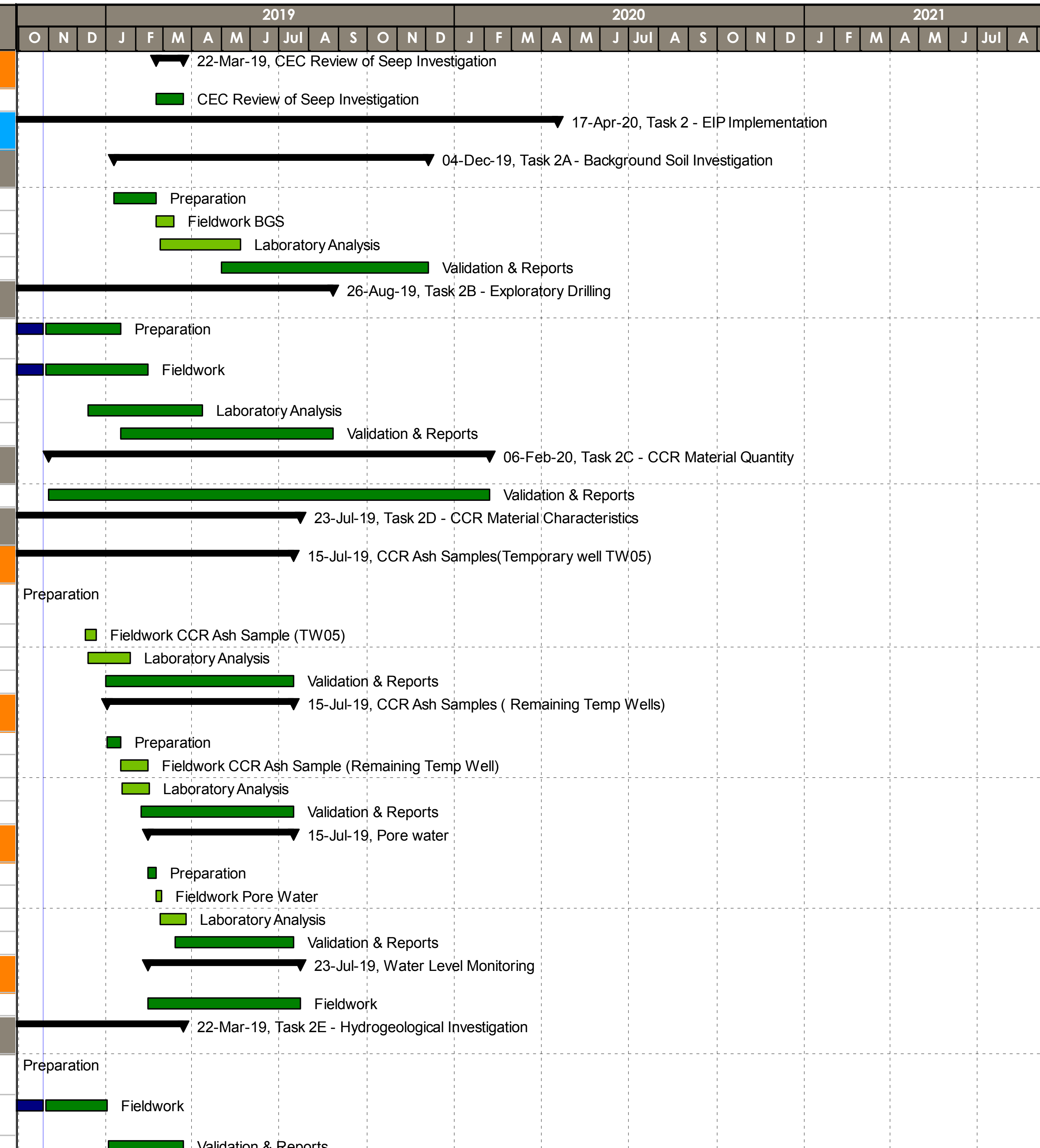
Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

Layout: Execution Schedule EIP (WBS) TDEC

Data Date:27-Oct-18
Print Date:07-Nov-18

ST612102-003 TDEC Order KIF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
CEC Review of Seep Investigation		21d	22-Feb-19	22-Mar-19
TVA-12815	CEC Review of Seep Investigation	21d	22-Feb-19	22-Mar-19
Task 2 - EIP Implementation		369d	17-Sep-18 A	17-Apr-20
Task 2A - Background Soil Investigation		228d	09-Jan-19	04-Dec-19
STN-21096	Preparation	31d	09-Jan-19	22-Feb-19
STN-21010	Fieldwork BGS	13d	22-Feb-19	12-Mar-19
TVA-21020	Laboratory Analysis	61d	26-Feb-19	21-May-19
STN-21098	Validation & Reports	150d	01-May-19	04-Dec-19
Task 2B - Exploratory Drilling		208d	17-Sep-18 A	26-Aug-19
STN-22096	Preparation	53d	17-Sep-18 A	15-Jan-19
STN-22097	Fieldwork	73d	24-Sep-18 A	13-Feb-19
STN-22040	Laboratory Analysis	83d	12-Dec-18	11-Apr-19
STN-22098	Validation & Reports	155d	16-Jan-19	26-Aug-19
Task 2C - CCR Material Quantity		316d	01-Nov-18	06-Feb-20
STN-23098	Validation & Reports	316d	01-Nov-18	06-Feb-20
Task 2D - CCR Material Characteristics		156d	17-Sep-18 A	23-Jul-19
CCR Ash Samples(Temporary well TW05)		150d	17-Sep-18 A	15-Jul-19
STN-29196	Preparation	0d	17-Sep-18 A	21-Sep-18 A
STN-98380	Fieldwork CCR Ash Sample (TW05)	10d	10-Dec-18*	21-Dec-18
TVA-98355	Laboratory Analysis	30d	12-Dec-18	25-Jan-19
STN-29198	Validation & Reports	136d	31-Dec-18	15-Jul-19
CCR Ash Samples (Remaining Temp Wells)		135d	02-Jan-19	15-Jul-19
STN-24096	Preparation	11d	02-Jan-19	16-Jan-19
STN-24010	Fieldwork CCR Ash Sample (Remaining Temp Well)	20d	16-Jan-19	13-Feb-19
TVA-24020	Laboratory Analysis	20d	18-Jan-19	15-Feb-19
STN-24098	Validation & Reports	111d	06-Feb-19	15-Jul-19
Pore water		105d	14-Feb-19	15-Jul-19
STN-24094	Preparation	6d	14-Feb-19	22-Feb-19
STN-24110	Fieldwork Pore Water	5d	22-Feb-19	28-Feb-19
TVA-24120	Laboratory Analysis	20d	26-Feb-19	25-Mar-19
STN-24099	Validation & Reports	86d	14-Mar-19	15-Jul-19
Water Level Monitoring		111d	14-Feb-19	23-Jul-19
STN-24097	Fieldwork	111d	14-Feb-19	23-Jul-19
Task 2E - Hydrogeological Investigation		99d	17-Sep-18 A	22-Mar-19
STN-25096	Preparation	0d	17-Sep-18 A	21-Sep-18 A
STN-25030	Fieldwork	44d	24-Sep-18 A	02-Jan-19
STN-25098	Validation & Reports	55d	03-Jan-19	22-Mar-19



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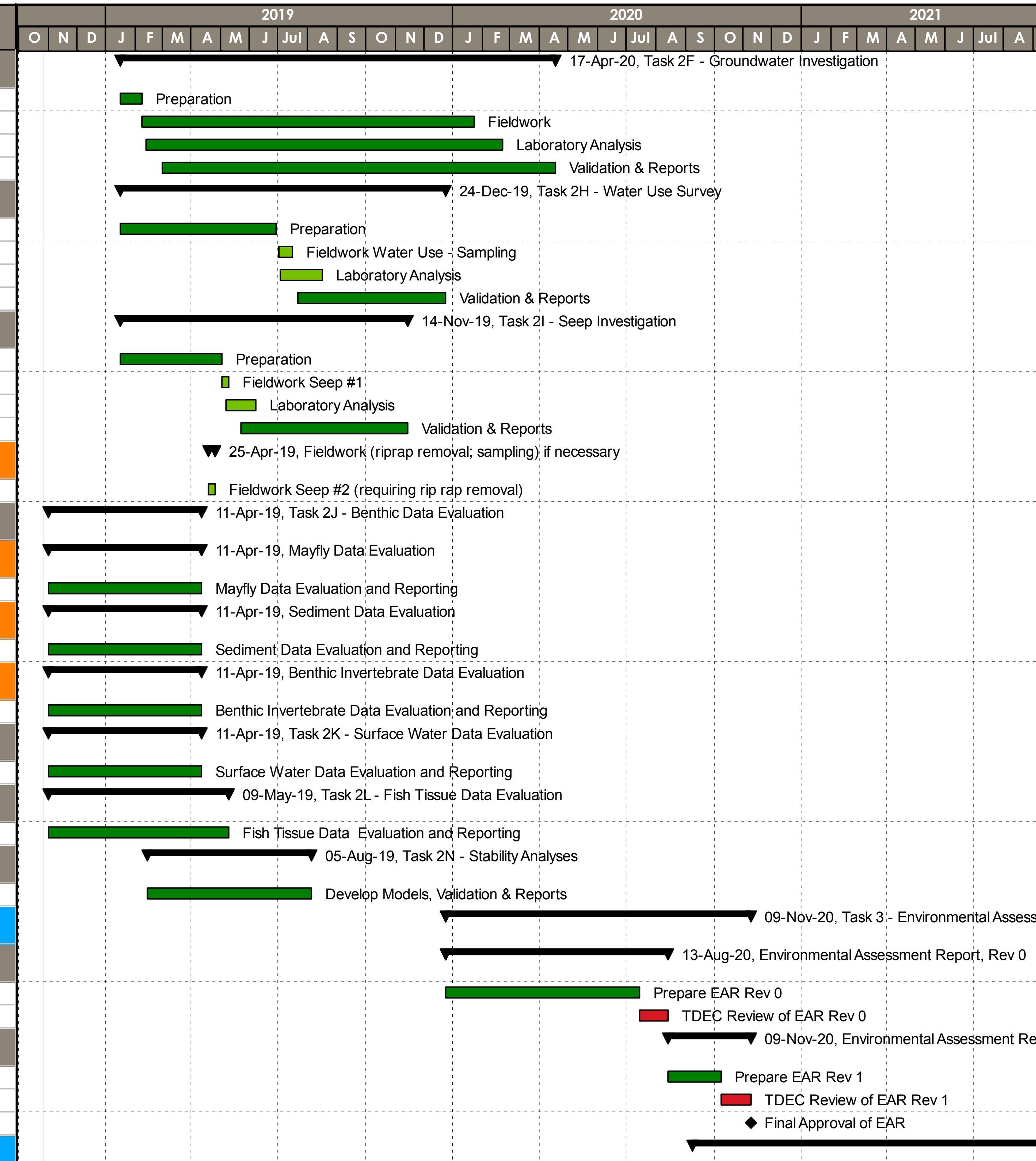
Data Date:27-Oct-18
Print Date:07-Nov-18

ST612102-003 TDEC Order KIF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
Task 2F - Groundwater Investigation		316d	16-Jan-19	17-Apr-20
STN-26096	Preparation	16d	16-Jan-19	07-Feb-19
STN-26097	Fieldwork	240d	08-Feb-19	23-Jan-20
STN-26098	Laboratory Analysis	258d	12-Feb-19	21-Feb-20
STN-26099	Validation & Reports	286d	01-Mar-19	17-Apr-20
Task 2H - Water Use Survey		237d	16-Jan-19	24-Dec-19
STN-28096	Preparation	115d	16-Jan-19	28-Jun-19
STN-28130	Fieldwork Water Use - Sampling	10d	01-Jul-19	15-Jul-19
TVA-28140	Laboratory Analysis	32d	03-Jul-19	16-Aug-19
STN-28098	Validation & Reports	108d	22-Jul-19	24-Dec-19
Task 2I - Seep Investigation		210d	16-Jan-19	14-Nov-19
STN-29096	Preparation	76d	16-Jan-19	03-May-19
STN-29110	Fieldwork Seep #1	5d	03-May-19	09-May-19
TVA-29120	Laboratory Analysis	23d	07-May-19	07-Jun-19
STN-29098	Validation & Reports	121d	23-May-19	14-Nov-19
Fieldwork (riprap removal; sampling) if necessary		5d	19-Apr-19	25-Apr-19
STN-29180	Fieldwork Seep #2 (requiring rip rap removal)	5d	19-Apr-19	25-Apr-19
Task 2J - Benthic Data Evaluation		110d	01-Nov-18	11-Apr-19
Mayfly Data Evaluation		110d	01-Nov-18	11-Apr-19
STN-29200	Mayfly Data Evaluation and Reporting	110d	01-Nov-18	11-Apr-19
Sediment Data Evaluation		110d	01-Nov-18	11-Apr-19
STN-29300	Sediment Data Evaluation and Reporting	110d	01-Nov-18	11-Apr-19
Benthic Invertebrate Data Evaluation		110d	01-Nov-18	11-Apr-19
STN-29400	Benthic Invertebrate Data Evaluation and Reporting	110d	01-Nov-18	11-Apr-19
Task 2K - Surface Water Data Evaluation		110d	01-Nov-18	11-Apr-19
STN-29500	Surface Water Data Evaluation and Reporting	110d	01-Nov-18	11-Apr-19
Task 2L - Fish Tissue Data Evaluation		130d	01-Nov-18	09-May-19
STN-29600	Fish Tissue Data Evaluation and Reporting	130d	01-Nov-18	09-May-19
Task 2N - Stability Analyses		120d	14-Feb-19	05-Aug-19
STN-29798	Develop Models, Validation & Reports	120d	14-Feb-19	05-Aug-19
Task 3 - Environmental Assessment Report (EAR)		222d	24-Dec-19	09-Nov-20
Environmental Assessment Report, Rev 0		162d	24-Dec-19	13-Aug-20
STN-31096	Prepare EAR Rev 0	140d	24-Dec-19	14-Jul-20
STN-31150	TDEC Review of EAR Rev 0	22d	15-Jul-20	13-Aug-20
Environmental Assessment Report, Rev 1		60d	14-Aug-20	09-Nov-20
STN-32096	Prepare EAR Rev 1	39d	14-Aug-20	08-Oct-20
STN-32170	TDEC Review of EAR Rev 1	21d	09-Oct-20	09-Nov-20
STN-32180	Final Approval of EAR	0d		09-Nov-20
Task 10 - CARA		261d	08-Sep-20	21-Sep-21



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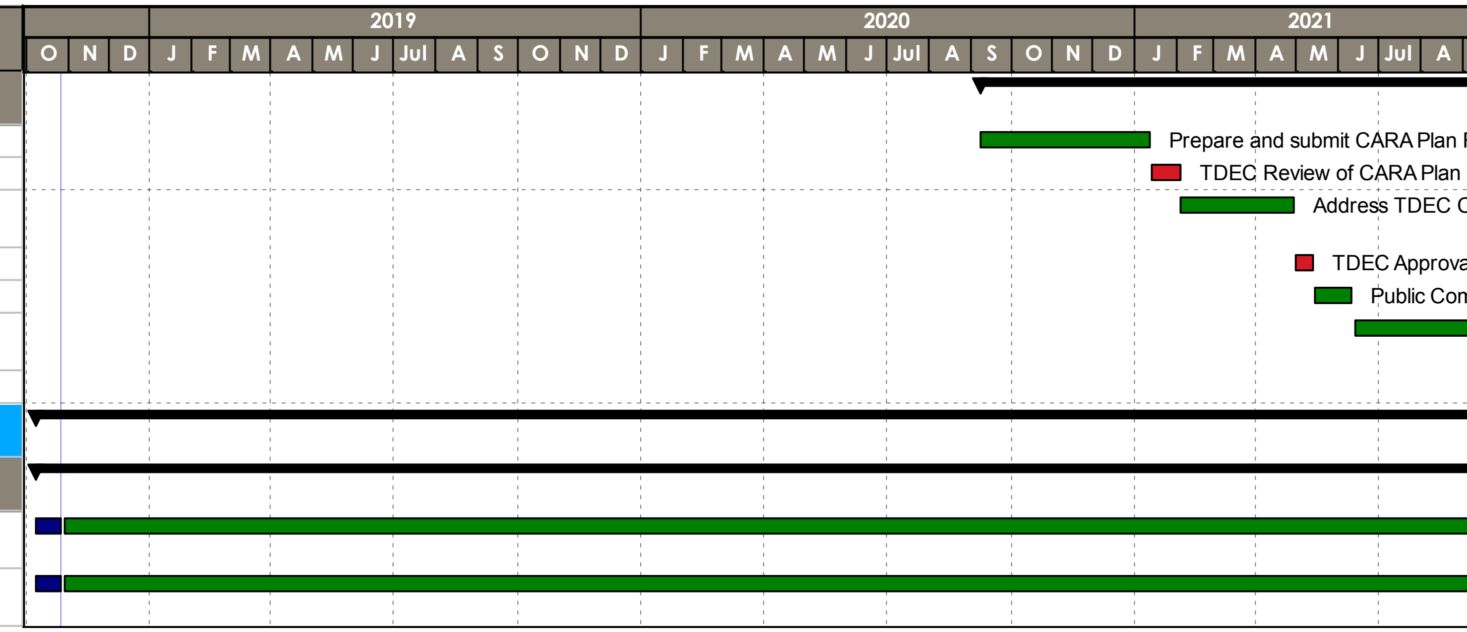
Data Date:27-Oct-18
Print Date:07-Nov-18

ST612102-003 TDEC Order KIF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
Meetings & Deliverables		261d	08-Sep-20	21-Sep-21
STN-98254	Prepare and submit CARA Plan Rev 0 for TDEC Review	86d	08-Sep-20	12-Jan-21
TVA-98255	TDEC Review of CARA Plan Rev 0	15d	13-Jan-21	03-Feb-21
STN-98256	Address TDEC Comments on CARA Plan Rev 0, Prepare and submit Rev 1 to TDEC	60d	04-Feb-21	29-Apr-21
TVA-98295	TDEC Approval of CARA Plan Rev 1	10d	30-Apr-21	13-May-21
STN-98296	Public Comment Period	20d	14-May-21	11-Jun-21
STN-98298	Address Public Comments on CARA Plan Rev 1 and Prepare CARA Plan Rev 2 for TDEC	60d	14-Jun-21	07-Sep-21
TVA-98345	TDEC Final Approval of CARA Plan Rev 2	10d	08-Sep-21	21-Sep-21
Task 11 - Project Communications & Reporting		728d	09-Oct-18 A	21-Sep-21
TDEC Updates		728d	09-Oct-18 A	21-Sep-21
TVA-96110	TDEC Monthly Progress Reports	728d	09-Oct-18 A	21-Sep-21
TVA-96120	TDEC Progress Update Meetings (Quarterly)	728d	09-Oct-18 A	21-Sep-21



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

Layout: Execution Schedule EIP (WBS) TDEC

Data Date:27-Oct-18
Print Date:07-Nov-18

APPENDIX B
REGULATORY CORRESPONDENCE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

June 13, 2013

OFFICE OF
SOLID WASTE AND
EMERGENCY RESPONSE

VIA E-MAIL

Ms. Cynthia Anderson, Senior Manager, Water and Waste Compliance
Fossil Generation Development & Construction
Tennessee Valley Authority
1101 Market Street, BR 4A
Chattanooga, TN 37402-2801

Re: Request for Action Plan regarding Tennessee Valley Authority - Kingston Fossil Plant

Dear Ms. Anderson,

On September 19, 2011 the United States Environmental Protection Agency ("EPA") and its engineering contractors conducted a coal combustion residual (CCR) site assessment at the Tennessee Valley Authority - Kingston Fossil Plant facility. The purpose of this visit was to assess the structural stability of the impoundments or other similar management units that contain "wet" handled CCRs. We thank you and your staff for your cooperation during the site visit. Subsequent to the site visit, EPA sent you a copy of the draft report evaluating the structural stability of the units at the Tennessee Valley Authority - Kingston Fossil Plant facility and requested that you submit comments on the factual accuracy of the draft report to EPA. Your comments were considered in the preparation of the final report.

The final report for the Tennessee Valley Authority - Kingston Fossil Plant facility can be accessed at the secured link below. The secured link will expire on July 31, 2013.

Here is the link: http://www.yousendit.com/download/UVJnT0NkOW44NVhOTzhUQw

This report includes a specific condition rating for each CCR management unit and recommendations and actions that our engineering contractors believe should be undertaken to ensure the stability of the CCR impoundment(s) located at the Tennessee Valley Authority - Kingston Fossil Plant facility. These recommendations are listed in Enclosure 1.

Since these recommendations relate to actions which could affect the structural stability of the CCR management unit(s) and, therefore, protection of human health and the environment, EPA believes their implementation should receive the highest priority. Therefore, we request that you inform us on how you intend to address each of the recommendations found in the final report. Your response should include specific plans and schedules for implementing each of the recommendations. If you will not implement a recommendation, please provide a rationale. Please provide a response to this request by **July 15, 2013**. Please send your response to:

Mr. Stephen Hoffman
U.S. Environmental Protection Agency (5304P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

If you are using overnight or hand delivery mail, please use the following address:

Mr. Stephen Hoffman
U.S. Environmental Protection Agency
Two Potomac Yard
2733 S. Crystal Drive
5th Floor, N-5838
Arlington, VA 22202-2733

You may also provide a response by e-mail to hoffman.stephen@epa.gov, dufficy.craig@epa.gov, kelly.patrickm@epa.gov and englander.jana@epa.gov.

You may assert a business confidentiality claim covering all or part of the information requested, in the manner described by 40 C. F. R. Part 2, Subpart B. Information covered by such a claim will be disclosed by EPA only to the extent and only by means of the procedures set forth in 40 C.F.R. Part 2, Subpart B. If no such claim accompanies the information when EPA receives it, the information may be made available to the public by EPA without further notice to you. If you wish EPA to treat any of your response as "confidential" you must so advise EPA when you submit your response.

EPA will be closely monitoring your progress in implementing the recommendations from these reports and could decide to take additional action if the circumstances warrant.

You should be aware that EPA will be posting the report for this facility on the Agency website shortly.

Given that the site visit related solely to structural stability of the management units, this report and its conclusions in no way relate to compliance with RCRA, CWA, or any other environmental law and are not intended to convey any position related to statutory or regulatory compliance.

Please be advised that providing false, fictitious, or fraudulent statements of representation may subject you to criminal penalties under 18 U.S.C. § 1001.

If you have any questions concerning this matter, please contact Mr. Hoffman in the Office of Resource Conservation and Recovery at (703) 308-8413. Thank you for your continued efforts to ensure protection of human health and the environment.

Sincerely,
/Suzanne Rudzinski/, Director
Office of Resource Conservation and Recovery

Enclosure

Enclosure 1

Tennessee Valley Authority - Kingston Fossil Plant Recommendations (from the final assessment report)

CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit, October 21, 2011, and review of technical documentation provided by the Tennessee Valley Authority (TVA).

Conclusions Regarding the Structural Soundness of the Management Unit(s)

Dike C impounding Ash Pond C and the dike impounding the Gypsum Disposal Facility appear to be structurally sound based on a review of the engineering data provided by the owner's technical staff and Dewberry's engineers' observations during the site visit. Remediation of Dike C was substantially complete in each area at the time of the site visit. However a 2009 geotechnical report indicated slope Factors of Safety less than the required minimum value of 1.5. The 2011 design report for the remediation measures includes updated slope stability analyses demonstrating the long term Factors of Safety were equal to or greater than 1.5.

No liquefaction evaluation was performed for the dikes of Ash Pond C or the Gypsum Disposal Facility. TVA stated during the site visit that they plan on performing such analyses upon closure of Ash Pond C, and Phase 1 of the Gypsum Disposal Facility. Phase 2 of the Gypsum Disposal Facility has been redesigned and is being constructed to accept dry product only.

Results of a Dewberry qualitative evaluation of liquefaction potential of - at the CCR impoundments identified a concern pertaining to the embankment and foundation soils at Ash Pond C. Without information concerning potential releases of CCR as a result of liquefaction under seismic conditions, for dikes that could fail, such as Ash Pond C, the dikes cannot be rated Satisfactory. No concerns were indentified for the embankments or underlying soils at the Gypsum Disposal Facility.

Conclusions Regarding the Hydrologic/Hydraulic Safety of the Management Unit(s)

Hydrologic and hydraulic analyses provided to Dewberry indicate that Ash Pond C has adequate impoundment capacity to contain the 1 percent probability storm without overtopping either the Ash Pond or an adjacent Settling Pond. The analyses indicate that the 6-hour Probable Maximum Precipitation (PMP) event would result in overtopping the Ash Pond embankment. However, subsequent analyses indicate that the Ash Pond has adequate capacity to store one-half the 6-hour PMP event without overtopping. Capacity to store one-half the 6-hour PMP event meets the design requirements of the current Tennessee dam safety regulations for intermediate, significant hazard potential dams.

The Hydrologic and hydraulic analyses indicate the Gypsum Disposal Facility stormwater pond can retain the 1/3 – six-hour PMP event without overtopping which is the design event required by Tennessee dam safety regulations for Small, Significant hazard dams.

Conclusions Regarding the Adequacy of Supporting Technical Documentation

The supporting technical documentation is inadequate, due to the lack of quantitative analysis of liquefaction potential. Engineering documentation reviewed is referenced in Appendix A.

Conclusions Regarding the Description of the Management Unit(s)

The description of the management unit provided by the owner was an accurate representation of what Dewberry observed in the field.

Conclusions Regarding the Field Observations

Dewberry staff was provided access to all areas in the vicinity of the management unit required to conduct a thorough field observation. The visible parts of the embankment dikes and outlet structure were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability although visual observations were hampered by the presence of thick vegetation in some areas. Embankments appear structurally sound. There are no apparent indications of unsafe conditions or conditions needing remedial action.

Conclusions Regarding the Adequacy of Maintenance and Methods of Operation
The current maintenance and methods of operation appear to be adequate for Ash Pond C and the Gypsum Disposal Facility. There was no evidence of significant embankment repairs or prior releases observed during the field inspection**.**

Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program
The surveillance program appears to be adequate. The management unit dikes are instrumented. The Ash Pond C embankments are monitored with piezometers and slope inclinometers. The Gypsum Disposal Facility is monitored with piezometers.

Classification Regarding Suitability for Continued Safe and Reliable Operation
The Ash Pond C is rated FAIR and the Gypsum Disposal Facility is rated SATISFACTORY for continued safe and reliable operation based on visual assessment and the pertinent technical documentation provided. Implementation of the recommendations described in 1.2 would help improve the ratings.

RECOMMENDATIONS

Recommendations Regarding Continued Safe and Reliable Operation
It is anticipated that both Ash Pond C and the Gypsum Disposal Facility will be considered SATISFACTORY for continued safe and reliable operations upon:
A determination that there is no liquefaction potential for soils and materials at the management units, particularly Ash Pond C, under the design seismic event.

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402

Brenda E. Brickhouse
Vice President
Environment

June 4, 2014

Mr. Stephan Hoffman
U.S. Environmental Protection Agency
Two Potomac yard
2733 S. Crystal Drive
5th Floor, N-5838
Arlington, Virginia 22202-2733

Dear Mr. Hoffman:

TENNESSEE VALLEY AUTHORITY (TVA) – KINGSTON FOSSIL PLANT (KIF) - SEISMIC RISK ASSESSMENT FOR OPERATING CONDITIONS – STILLING POND (POND C) -

Enclosed for your review is a seismic risk assessment competed by Stantec Consulting Services for the operating conditions of TVA's KIF Plant's Stilling Pond (Pond C). This report is in response to United States Environmental Protection Agency (EPA) request that TVA provide additional evaluation. In EPA's final review and report, KIF Stilling Pond (Pond C) received a *Fair* rating due to questions regarding the potential for liquefaction for soils and materials at the management unit. In accordance with the Action Plan, TVA hired Stantec Consulting Services to develop a seismic risk assessment for operating conditions of KIF Stilling Pond (Pond C).

The assessment was completed by Stantec Consulting Services, Inc. and included evaluation of liquefaction potential, post-earthquake stability and deformation analysis, followed by a review of seismic related failure consequences and presented results relating to the probability of failure for the Stilling Pond during the remaining active life of the impoundment.

As presented in the enclosed report, the analysis indicates the primary seismic failure mode is associated with liquefaction of alluvial sands located beneath the stilling pond and the perimeter dike. Based on the probability of occurrence of a seismic event capable of producing liquefaction failure of the facility (once in 591 years), combined with the remaining service life of the impoundment (4 years) Stantec has estimated there is a 0.68% chance of a seismic failure. The report further points out the probability decreases over time as the remaining life approaches zero.

This is the first of several reports regarding seismic risk assessments which are underway for other plant sites. In the coming months, TVA will forward reports for impoundments at Bull Run, Colbert, and Widows Creek Fossil Plants. We appreciate the opportunity to work with EPA through this process of review and recommendations regarding the structural stability of TVA's impoundments. EPA's evaluation of the quality of our impoundments has verified that TVA is pursuing the appropriate corrective actions at our fossil sites TVA will continue to assess and improve the integrity of our coal combustion residual (CCR) impoundments and will address the appropriate closure of these facilities, including future structural stability. The results of this study will be utilized in this regard.

If you have questions or need additional information, please contact Sam Hixson at (423) 751-6705 or Amos Smith at (423) 751-7636 in Chattanooga, or by email at swhixson@tva.gov or alsmith@tva.gov.

Sincerely,

Brenda E. Brickhouse

Enclosures

cc: Mr. Patrick J. Flood, P.E.
Director, Division of Solid Waste Management
Tennessee Department of Environment
and Conservation
L&C Tower, 5th Floor
401 Church Street
Nashville, Tennessee 37243

ALS:SMF
Enclosures
cc (Enclosures):

Mr. Patrick J. Flood, P.E.
Director, Division of Solid Waste Management
Tennessee Department of Environment
and Conservation
L&C Tower, 5th Floor
401 Church Street
Nashville, Tennessee 37243

J. A. Birdwell, WT 6A-K
D. L. Bowling, Jr., WT 7D-K
B. E. Brickhouse, BR 4A-C
J. C. Kammeyer, LP 5D-C
B. C. Portis, OMA 1A-WDC
M. S. Turnbow, LP 5G-C
EDMS, WT CA-K

Probability of Seismic Failure during Remaining Service Life

TVA Kingston Fossil Plant Stilling Pond

Harriman, Roane County, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

May 12, 2014

Stantec Consulting Services Inc.
Design with community in mind
www.stantec.com

Stantec
Stantec Consulting Services Inc.
10509 Timberwood Circle, Suite 100, Louisville KY 40223-5301

May 12, 2014 rpt_002_175553016

Mr. Michael S. Turnbow
Tennessee Valley Authority
1101 Market Street, LP 2G-C
Chattanooga, Tennessee 37402-2801

Re: Probability of Seismic Failure during Remaining Service Life
Kingston Fossil Plant Stilling Pond
Harriman, Roane County, Tennessee

Dear Mr. Turnbow:

Stantec Consulting Services Inc. has completed an evaluation to estimate the probability of seismic failure during the remaining service life of the stilling pond at TVA's Kingston Fossil Plant. This evaluation is in response to the recently completed *CCR Impoundment Assessments* conducted by the United States Environmental Protection Agency, where it was recommended that liquefaction assessments and corresponding impacts (for operating conditions) be evaluated for this facility. The enclosed report contains the results of Stantec's evaluation.

We appreciate the opportunity to assist TVA with this effort. If you have any questions or need additional information, please call.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Randy L. Roberts
Randy L. Roberts, PE
Principal

Stephen H. Bickel
Stephen H. Bickel, PE
Senior Principal

Alan Rauch
Alan F. Rauch, PhD, PE
Principal

/cdm

Executive Summary

Stantec Consulting Services Inc. has completed an evaluation to estimate the probability of seismic failure for the stilling pond at TVA's Kingston Fossil Plant during the remaining service life of the stilling pond. This evaluation is in response to the recently completed *CCR Impoundment Assessments* conducted by the United States Environmental Protection Agency, where it was recommended that liquefaction assessments and corresponding impacts (for operating conditions) be evaluated for this facility.

Seven potential seismic failure modes were identified and evaluated. Based on further review and analyses, the primary seismic failure mode (resulting in a release of ash during an earthquake) is associated with liquefaction of alluvial sands found beneath the stilling pond and the perimeter dike.

A simplified analysis was then used to estimate the annual probability that an earthquake would cause a dike failure and a release of ash. The analyses identified limiting earthquakes, defined as seismic events just strong enough to liquefy the alluvial sands and cause a failure. To properly account for the site-specific hazards, limiting earthquakes were identified for two seismic source zones. The likelihood of a seismic failure was then computed based on the probabilities for occurrence of the limiting earthquakes.

The results indicate that every year there is approximately a 0.17% chance that an earthquake could occur that is strong enough to trigger liquefaction and failure of the perimeter dike. This corresponds to a recurrence interval of 591 years. The stilling pond has a remaining service life of four years. In that time, there is a 0.68% chance that an earthquake large enough to cause a failure could occur. The total probability of a seismic failure decreases over time, as the remaining life approaches zero.

Probability of Seismic Failure during Remaining Service Life
TVA Kingston Fossil Plant Stilling Pond
Harriman, Roane County, Tennessee

Table of Contents

Section **Page No.**

Table of Contents
(Continued)

List of Tables

Table of Contents
(Continued)

List of Appendices

Probability of Seismic Failure during Remaining Service Life
TVA Kingston Fossil Plant Stilling Pond
Harriman, Roane County, Tennessee

1. Background

1.1. Facility Description

The stilling pond at TVA's Kingston Fossil Plant is located on the eastern side of the coal combustion products (CCPs) storage complex. In plan, the stilling pond has a triangular footprint (see the site map in Appendix A). Originally part of the larger ash pond, the stilling pond was separated by the construction of an interior divider dike. The stilling pond is bordered on two sides by the Emory River, within the reservoir formed by Watts Bar Dam on the Tennessee River.

To the west, the stilling pond abuts the former ash pond, which has been filled and is currently being capped. The ash pond closure project included the construction of a stabilized perimeter along the common border with the stilling pond. On this alignment, a series of parallel, transverse walls (4 feet thick, 60 feet long, and spaced 19 feet apart) were built beneath a compacted clay perimeter berm. The cement-bentonite walls are embedded 4 feet into the shale bedrock. Designed to withstand a large magnitude earthquake, the stabilized perimeter will retain the stored CCPs even if the saturated ash and deeper alluvial sands liquefy. Hence, if a strong earthquake occurs at Kingston, the closed ash pond should not impact the stilling pond.

The stilling pond is retained by Dike C on the other two sides, on the eastern and southern reaches. Dike C was built in three stages:

- The "starter dike" (lower portion) was built upon the natural alluvial soils in the 1950s.
- The "raised dike" (upper portion) was completed in the 1970s, with an upstream clay embankment built on a bottom ash subgrade.
- In 2009 and 2010, a "rockfill buttress" was built on the outboard slopes along the length of Dike C.

There are CCPs, mostly sluiced ash, in the bottom of the stilling pond. The depth of the ash varies significantly across the stilling pond, but has a typical thickness of about 10 feet, with an average top elevation of roughly 745 feet. This is about 8 feet above winter pool in Watts Bar Lake, but about 20 feet below the crest of Dike C.

1.2. Seismic Performance

The ash in the stilling pond and the underlying alluvial sands are vulnerable to liquefaction in a large earthquake. The loss of soil strength in the foundations could undermine Dike C, causing inward and/or outward slope failures. The resulting deformations could result in the discharge of stilling pond water and ash to the Emory River. Hence, as long as the stilling pond pool is retained behind Dike C, there is a quantifiable risk that an earthquake will cause the release of ash.

The seismic risks are reduced by the rockfill buttress on the lower section of Dike C. The top of the ash deposits in the stilling pond is, on average, about 9 feet below the crest of the rockfill. As long as the lower starter dike remains intact during an earthquake, the ash in the stilling pond will be retained. In addition, the stilling pond is operated at a water elevation of 754.7 feet, less than a foot above the crest of the rockfill buttress at elevation 754 feet. If the upper, raised dike fails, a small volume of suspended ash could be released with pond water that overtops the lower starter dike. However, a large volume of CCPs would be released only if the lower starter dike fails.

The analyses presented here were undertaken to estimate the probability of a seismic failure over the remaining service life for the Kingston stilling pond, for the current configuration and operating conditions. More specifically, the analyses attempt to quantify the probability of an earthquake severe enough to cause the failure of Dike C, with consequent release of ash retained in the stilling pond.

2. Approach

2.1. Seismic Failure Modes

Here, seismic “failure” is defined as the release of CCPs from the Kingston stilling pond, resulting from a breach of Dike C during or immediately after an earthquake. The following potential failure modes were specifically considered:

(a) Failure due to liquefaction of alluvial sands

If extensive liquefaction occurs within the saturated alluvial sands, a deep-seated failure of Dike C can be expected. The lower starter dike and the raised dike would both fail, with the immediate release of ash retained in the stilling pond. Liquefaction of the ash in the stilling pond (including the ash subgrade beneath the raised dike) is assumed to always accompany liquefaction of the deeper alluvial sands.

(b) Failure due to liquefaction of ash subgrade under the dikes

A liquefaction-susceptible horizon of bottom ash is found in the subgrade under the raised portion of Dike C. If an earthquake liquefied this material (and the ash deposits in the stilling pond), but not the deeper alluvial sands, the starter dike and rockfill buttress should remain intact and retain the ash deposits. Liquefaction of the ash subgrade may cause a partial collapse of the raised portion of Dike C, as the upper raised dike slid inward, into the stilling pond. A limited volume of pond water, containing an unknown fraction of suspended ash, would overtop the intact, lower starter dike and rockfill buttress. Liquefaction of the ash deposits in the stilling pond is assumed to always accompany liquefaction of the bottom ash subgrade.

(c) Failure due to liquefaction of ash deposits only

Compared to the other CCP and soil materials, the very loose ash deposits within the stilling pond are more vulnerable to liquefaction. The ash deposits will probably liquefy in much smaller seismic events, where the ground motions are not strong enough to liquefy the native alluvial sands or the ash subgrade material. However, as long as the perimeter dikes remain, the liquefied ash deposits in the pond will be retained. This potential failure mode can be dismissed without further analysis.

(d) Failure due to inertial loading of the dike slopes

For weaker earthquakes that do not cause widespread liquefaction, the dynamic loads could cause excessive deformations within the dike slopes. A breach could result from mass displacements that open large cracks through the dike, or from crest settlements that allow the pond to overtop the remnant dike material. Pseudostatic slope stability analyses were used to check the potential for this failure mechanism.

(e) Failure due to settlements of the raised dike

Dynamic loading of the dike and foundation soils may lead to crest settlements, even in the absence of a slope failure. For a pond elevation of 754.7 feet, overtopping would not occur unless Dike C settled over ten feet. Given the modest height of the embankment, settlements this large are highly unlikely and this failure mechanism can be dismissed without further analysis.

(f) Failure of the starter dike due to erosion from overtopping flows

If the raised section of Dike C slid into the stilling pond, some of the retained water might overflow the top of the starter dike and rockfill buttress. Such flows may erode the lower dike, leading to a greater volume of released CCP material. However, the flows over Dike C would be limited, as the stilling pond is operated at just 0.7 feet above the crest of the rockfill buttress. The dike outslopes are also armored with the rockfill buttress, which is highly resistant to erosion. Hence, this failure mechanism can be dismissed.

(g) Failure due to seepage through transverse cracks

Smaller deformations might cause transverse cracking across the dike embankment, opening potential seepage paths. However, the rockfill buttress on the outer slope includes a filter zone that would effectively limit the progression of erosion along a crack. In addition, there would be an opportunity to lower the pool before seepage through a damaged Dike C led to a release. This failure mechanism can be dismissed.

Only slope failures resulting from liquefaction of the ash subgrade and/or alluvial sands, or inertial loading during the earthquake, (*a, b,* and *d* above) appear likely to cause the release of significant ash from the Kingston stilling pond. Hence, this seismic analysis focuses on failure modes related to liquefaction and slope stability.

2.2. Analysis Steps

The probability that an earthquake would cause a failure and ash release from the Kingston stilling pond was estimated via a simplified analysis, as follows:

1) Typical cross sections and potential failure modes were identified.
2) A site-specific, probabilistic seismic hazard study was completed. Based on an understanding of the regional source zones, the probability of earthquake occurrence and the potential severity of shaking at the site were quantified.
3) For the predicted bedrock accelerations, ground surface accelerations were computed for the site-specific soil conditions.
4) The available Standard Penetration Test data (SPT blowcounts) were evaluated to determine if liquefaction would occur in the ash and alluvium, during a given earthquake.
5) The weakest, limiting earthquake that would trigger liquefaction was identified; larger earthquakes (events with a longer return period) would also cause liquefaction.
6) The post-earthquake strengths of the soils and ash were estimated, including for zones that are predicted to liquefy.
7) Post-earthquake slope stability analyses were completed to determine if liquefaction would trigger a dike failure and the release of ash.
8) Pseudostatic analyses were completed to check if an earthquake too small to cause liquefaction would cause excessive deformations in the perimeter dike.
9) The annual probability of a seismic failure was computed as the inverse of the return period for the limiting earthquake. The Poisson model was then used to compute the probability that an earthquake would cause the release of ash over the remaining service life of the stilling pond.

The analysis separately considered two seismic source scenarios (New Madrid events and earthquakes from other sources). The potential for liquefaction in the ash and alluvial sands, or only in the ash in a smaller earthquake, was also explicitly considered.

2.3. Uncertainties

The simplified analysis used to compute the probability of seismic failure is approximate. The natural randomness in the seismic hazards (aleatory variability) was modeled, but the uncertainties associated with the input parameters and the methods of analysis (epistemic uncertainty) were not quantified. Rigorous consideration of such uncertainties would result in a somewhat different annual probability of failure. However, consideration of these uncertainties is not anticipated to substantially change the general conclusions of this study.

3. Conditions and Assumptions

3.1. Service Life

Based on information provided by TVA, the Kingston stilling pond is assumed to remain in service for another four (4) years.

3.2. Water Levels

Water levels in the stilling pond are controlled by the outlet structure. Based on information provided by TVA, the stilling pond is currently operated at a water surface elevation of 754.7 feet. Minor fluctuations occur due to runoff.

On the outboard side of Dike C, water levels in the Emory River are controlled by Watts Bar Dam, which is located 44 river miles downstream on the Tennessee River. At the dam, the normal operating pool ranges between elevation 740 and 741 feet during the summer (May through October), and elevation 735 and 737 feet during the winter (December through March).

Winter pool levels were considered in the stability assessment, because lower river levels are more critical for stability of Dike C. Due to the backwater effects, local water levels at Kingston are a little higher than at the dam. Hence, the Emory River level was assumed to be at elevation 737 feet for the seismic assessment.

In the liquefaction and stability analyses discussed below, static pore water pressures were computed using a specified phreatic surface. Between the water levels in the pond and the river, the location of the phreatic surface across each section was determined using a two-dimensional seepage model. Where possible, these results were checked against the available piezometer readings.

3.3. Cross Sections

The base of the starter dike is at about elevation 735 feet, where it is founded on alluvial lean clay. The lean clay overlies an alluvial silty sand deposit, consisting of silty sand, sand with silt, fine grained sand, and some gravel. Note that in some areas, the alluvial lean clay horizon is absent, and the starter dike is founded on the alluvial sands. The top of shale bedrock ranges from roughly elevation 700 to 715 feet. The thickness of the foundation soils varies between about 20 and 40 feet along the alignment.

The clay starter dike was built to a crest elevation of about 751 feet, which is 14 feet above winter pool in Watts Bar Lake. At some sections, compacted ash was used to build the upper portions of the starter dike. The raised clay dike was constructed to a crest elevation of 765 ft. Built upstream, the raised dike is founded on a bottom ash subgrade. The outboard toe of the raised dike adjoins the inboard portion of the starter dike.

After the 2008 failure of the Kingston dredge cell, the full length of Dike C was buttressed with a rockfill berm. The rockfill buttress was designed to address concerns for seepage and static slope stability, but was not evaluated for seismic performance. Completed in 2010, the rockfill buttress has a crest elevation of 754 feet, about 3 feet over the crest of the starter dike. The outslope of the buttress is sloped at 6H:1V on the eastern dike, and 4H:1V on the southern dike.

Two typical cross sections were analyzed for seismic performance:

- The cross section at Station 119+69 which is typical of Dike C on the southern boundary of the stilling pond.
- The cross section at Station 132+37 which is typical of Dike C on the eastern boundary of the stilling pond.

The locations of the cross sections are noted on the site plan in Appendix A. The subsurface horizons and material extents were estimated based on historical design drawings for the dikes, plus data from site explorations. Note that the alluvial lean clay horizon is present at Station 119+69, but is absent at Station 132+37. Boring logs from the subsurface explorations are provided in Appendix B. The two cross sections are depicted in the graphical output from the slope stability analyses in Appendix F. Key elevations are summarized in Table 1.

Table 1. Key Elevations for Kingston Stilling Pond Dikes

<table>
<tr><th rowspan="2">Location</th><th rowspan="2">Notes</th><th>Station 119+69</th><th>Station 132+37</th></tr>
<tr><th colspan="2">Elevations in Feet (NGVD29)</th></tr>
<tr><td>Crest of Raised Dike</td><td rowspan="3"></td><td>765</td><td>765</td></tr>
<tr><td>Crest of Rockfill buttress</td><td>754</td><td>754</td></tr>
<tr><td>Crest of Starter Dike</td><td>751</td><td>751</td></tr>
<tr><td>Top of Alluvial Deposits</td><td rowspan="2">On baseline at approximate centerline of raised dike crest</td><td>735</td><td>731</td></tr>
<tr><td>Top of Bedrock</td><td>715</td><td>700</td></tr>
<tr><td>Top of Ash in Stilling Pond</td><td>Rough average</td><td colspan="2">745</td></tr>
<tr><td>Stilling Pond Water Level</td><td></td><td colspan="2">754.7</td></tr>
<tr><td rowspan="3">Emory River Water Level (Watts Bar Lake)</td><td>Summer Pool</td><td colspan="2">740 to 741</td></tr>
<tr><td>Winter Pool</td><td colspan="2">735 to 737</td></tr>
<tr><td>Assumed in analysis</td><td colspan="2">737</td></tr>
</table>

3.4. Soil and Ash Materials

The following soil, ash, and rock materials are found in the cross sections of the stilling pond dikes:

- Dike embankment materials representing the three stages of construction, for the starter dike (clay and compacted ash), raised dike (clay and bottom ash subgrade), and rockfill buttress (coarse aggregate and stone rip rap).
- Ash pond deposits, mostly coal fly ash with some bottom ash, that were hydraulically placed or sluiced into the stilling pond. A thin, sensitive, stratified clay and silt layer is found at the base of the pond deposits.
- Native alluvium, consisting of several feet of lean clay (Station 119+69 only) that is underlain by a thicker, variable deposit of silty sands (with sandy silts, fine sands, and some gravel).
- The bedrock surface under the stilling pond is weathered shale of the Conasauga Shale formation.

The raised dike was built upstream (i.e., inboard) of the starter dike, and bears upon about 7 to 12 feet of ash. The boring logs (Appendix B) indicate that this material is mostly bottom ash and, based on the SPT blowcounts, has a medium density. Prior to constructing the raised dike, bottom ash was apparently used to fill and improve the subgrade. The ash subgrade is thus identified as a stronger material, separate from the loose ash deposits in the stilling pond.

The sensitive silt/clay layer under the ash was identified as a contributor to the 2008 failure of the adjacent ash dredge cell (AECOM 2009). The sensitive silt/clay is thin (less than 1 foot thick), and may not exist in areas of the stilling pond that were dredged in the past. However, lacking exploration data inside of the containment dikes, the layer was assumed to exist across the footprint of the stilling pond.

The material zones assumed in the stability analyses are listed in Table 2. In some cases, multiple sublayers and embankment zones were identified on the basis of boring logs or historical drawings, but the same properties (Section 6) were assigned for the stability analyses. For example, the alluvial sands grade from gravelly sands to sandy silts, but the available data were insufficient to justify different parameters for each sublayer. The sublayers were modeled in the analysis cross sections, but the same engineering parameters were used throughout the alluvial sands. Similarly, the clayey embankment materials in the dikes were assigned the same strength properties.

Table 2. Soil and Ash Materials

Location	Material Zone
Pond Deposits	Hydraulically Placed Ash
	Sensitive Silt/Clay
Rockfill Buttress	Rockfill Buttress
Raised Dike	Raised Clay Dike
	Ash Subgrade
Starter Dike	Compacted Ash
	Starter Clay Dike
	Gravel to Clayey Gravel
Native Alluvium	Lean Clay Foundation Soil
	Silty Sand to Sandy Silt
	Fine Grained Sand
	Silty Sand with Gravel

4. Seismic Hazards

4.1. Regional Seismic Sources

Seismicity in the TVA service area is attributed to the New Madrid fault and smaller, less concentrated crustal faults. Located in the western region, along the borders of Tennessee, Kentucky, Missouri, and Arkansas, the New Madrid source zone is capable of producing large magnitude earthquakes (M > 7). Events of this size would produce relatively long durations of strong ground shaking across the entire Tennessee River Valley. Fortunately, large magnitude New Madrid events are infrequent. Other source zones that may represent significant seismic risks for TVA facilities include those in eastern Tennessee, along the Wabash River Valley, and less significant sources throughout the region. While the maximum earthquake magnitudes associated with these other sources are smaller, compared to the New Madrid events, larger site accelerations can result from the closer proximity to TVA facilities.

These two earthquake scenarios generate significantly different seismic hazards at a given locality and were considered separately. To appropriately capture the influence of each, the assessment was completed independently for:

- New Madrid events
- events from “All Other Sources”

The total probability for a seismic event at a site is the summation of probabilities due to either of these two sources.

4.2. Site-Specific Probabilistic Hazards

The site-specific seismic hazards at the Kingston site were quantified by AMEC Geomatrix, Inc. (Oakland, California) in 2010 and 2011 for TVA. Ground motion time histories were not predicted. The key data sets generated by AMEC Geomatrix are:

- Accelerations at the top of hard rock for two different seismic source zones (New Madrid Source and all other sources).
- Peak accelerations and spectral accelerations, assuming 1%, 3%, 5%, 7%, and 10% damping.
- Values for return periods ranging from 100 years to 2,500 years (1.0% to 0.04% annual probability of exceedance).
- Seismic hazards deaggregated into appropriately sized bins of magnitude and epicentral distance.

This input information, as utilized for the seismic evaluation, is provided in Appendix C.

4.3. Representative Magnitude

The liquefaction analyses require pairing ground accelerations with representative earthquake magnitudes, for each return period and seismic source. The deaggregation results were used to select appropriate, representative earthquake parameters. A weighted average method was used to derive representative magnitudes for each earthquake scenario provided by AMEC Geomatrix. Linear interpolation was then used, when necessary, to derive acceleration and magnitude pairs at intermediate return periods.

Earthquake magnitudes (M) are expressed as moment magnitudes. A representative magnitude (M_{rep}) for each earthquake scenario (one return period for a particular source zone) was derived by computing a weighted average as follows:

$$M_{rep} = \frac{\sum_{i=1}^{i=n}\left(\frac{(\%Contribution\ from\ M_i)\cdot M_i}{MSF_i}\right)}{\sum_{i=1}^{i=n}\left(\frac{(\%Contribution\ from\ M_i)}{MSF_i}\right)}$$

M_i = magnitude bin from the deaggregation (magnitudes were broken into bins of 0.1 M). The minimum magnitude considered in the hazard model is 5.0.

%Contribution from M_i = percentage of the total hazard that is due to earthquakes of magnitude M_i.

MSF_i = magnitude scaling factor for magnitude M_i earthquake. The MSF is an index used in liquefaction analysis to relate magnitude to duration, or cycles of loading. Per Youd et al. (2001), MSF = $10^{2.24} / M_i^{2.56}$.

4.4. Peak Acceleration at the Ground Surface

The peak horizontal accelerations obtained from the seismic hazard study (Section 4.2) represent accelerations at the top of hard bedrock (PGA_{rock}). For the assessment of liquefaction potential, estimates are needed of the peak horizontal acceleration at the ground surface (PGA_{soil}).

Depending on the site and ground motion characteristics, peak accelerations may be amplified or attenuated (deamplified) as the energy propagates upward through the soil profile. Numerical, equivalent-linear elastic, ground response analyses can be used to model the propagation of ground motions and compute the cyclic stresses at various locations in the soil profile. This approach was not feasible for this study, because bedrock acceleration time histories for the range of earthquake scenarios that were considered were not available.

A simpler approach was used to compute peak accelerations at the ground surface. Developed for TVA by Dr. Gonzalo Castro and GEI Consultants, and implemented by Stantec in a spreadsheet, this iterative method mimics what would be performed via conventional, one-dimensional, equivalent-linear elastic methods. The thickness and properties of the site-specific foundation soils are appropriately considered. The method does not use ground motion time histories, but does require response spectra for various levels of damping, which were generated by AMEC Geomatrix. The use of GEI's iterative method for the ground response analysis is documented in Appendix D.

For a representative soil profile, unit weight, elastic stiffness (small-strain shear modulus or shear wave velocity), modulus reduction, and damping parameters are assigned based on estimated properties and published correlations. An iterative process is then used to estimate the PGA_{soil} at the top of ground, resulting from the PGA_{rock} for a given earthquake. The iterative calculations were completed using a spreadsheet. The final results for the Kingston stilling pond are provided in Appendix D.

5. Liquefaction Analysis

5.1. Liquefaction Factor of Safety

The potential for triggering liquefaction was assessed for each earthquake scenario. The seismic excitation or load was quantified in terms of the Cyclic Stress Ratio (CSR, Section 5.2). The soil strength was estimated using the Standard Penetration Test (SPT) blowcount to compute a Cyclic Resistance Ratio (CRR, Section 5.3). The factor of safety against liquefaction is defined as:

$$FS_{liq} = \frac{CRR}{CSR}$$

Based on the precedent set by Seed and Harder (1990), computed factors of safety were interpreted as follows:

- Soil will liquefy where $FS_{liq} \leq 1.1$
- Expect substantial soil softening where $1.1 < FS_{liq} \leq 1.4$
- Soil does not liquefy where $FS_{liq} > 1.4$

5.2. Cyclic Stress

The cyclic stress ratio (CSR) represents an index of the stresses imparted to the soil during an earthquake. The CSR may be estimated using the "simplified method", as described by Seed and Idriss (1971):

$$CSR = 0.65\left(\frac{PGA_{soil}}{g}\right)\left(\frac{\sigma_v}{\sigma'_v}\right)r_d$$

Here, g is the acceleration due to gravity. The ground surface acceleration (PGA_{soil}) was determined using the method described in Section 4.4. The relationship for the stress reduction coefficient (r_d) recommended by Youd et al. (2001) was used in the analysis. The ratio of total vertical stress to effective vertical stress was calculated assuming that the conditions at the time of SPT boring are representative of in-service conditions at the time of the earthquake.

5.3. Cyclic Resistance

The liquefaction resistance of the foundation soils and ash deposits was quantified based on Standard Penetration Test (SPT) data, using the consensus "NCEER Method" (Youd et al. 2001). The cyclic resistance ratio (CRR) of the soil in a M7.5 earthquake was obtained as:

$$CRR_{7.5} = \frac{1}{34-(N_1)_{60-CS}} + \frac{(N_1)_{60-CS}}{135} + \frac{50}{\left[10\cdot(N_1)_{60-CS}+45\right]^2} - \frac{1}{200}$$

Values of SPT blowcounts measured in borings at the site were corrected to normalized, clean-sand equivalent values of $(N_1)_{60\text{-}CS}$ using the recommended correction and normalization factors. However, to avoid inappropriately inflating the cyclic resistance, the NCEER fines content adjustment was not applied where zero blowcounts ("weight of hammer" or "weight of rod") were recorded.

Saturated fly ash is thought to be more susceptible to liquefaction than indicated by the empirical NCEER method. The value of CRR computed in the above equation is based on the observation of liquefaction in natural soils, mostly silty sands. Given the spherical particle shape and uniform, small grain size of fly ash, the NCEER procedure may give CRR values that are too high for saturated fly ash. Lacking better methods of analysis, the lower-bound, "clean sand" base curve (Youd et al. 2001) was assumed to apply for fly ash. Within the liquefaction calculations, this was accomplished for these materials by neglecting the fines content adjustment to the normalized penetration resistance.

The cyclic resistance was adjusted to account for the duration of shaking (earthquake magnitude), overburden pressure, and shear stress:

$$CRR = CRR_{7.5} \cdot MSF \cdot K_{\sigma} \cdot K_{\alpha}$$

Per Youd et al. (2001), the magnitude scaling factor was computed as: $MSF = 10^{2.24}/M_{rep}^{2.56}$, where the representative earthquake magnitude (M_{rep}) was determined as discussed in Section 4.3. The correction factors K_{σ} and K_{α} were computed using the relationships recommended by Idriss and Boulanger (2008).

5.4. Liquefaction Assessment

CRR and CSR values were computed for each measured SPT blowcount and earthquake scenario (magnitude and acceleration). Data were taken from the 22 borings summarized in Table 3 (the boring logs are provided in Appendix E). All of these borings were advanced from the crest of the starter dike (prior to addition of the rockfill buttress) or the crest of the raised dike on Dike C; no data were available for locations within the stilling pond or the Emory River. The resulting FS_{liq} values, for the available blowcounts in the evaluated cross sections, were then plotted versus elevation (see Appendix E).

The computed values of FS_{liq} were compared to the guidance limits of 1.1 and 1.4 (Section 5.1). Values of FS_{liq} computed throughout a soil deposit or cross section (at specific SPT locations) were reviewed in aggregate. Small pockets of liquefied material in isolated locations, often associated with individual low blowcounts, are unlikely to induce a larger failure and were considered tolerable. Problems associated with soil liquefaction are indicated where continuous zones of significant lateral extent exhibit low factors of safety (FS_{liq} less than 1.1). A judgment was made to determine if a particular earthquake event would or would not cause liquefaction in the soil or ash deposit.

Penetration test data were not available to quantify the liquefaction resistance of the ash deposits in the stilling pond. The ash in the pond is mostly fly ash and is significantly looser, so is assumed to liquefy in any event that would liquefy the ash subgrade under the raised dike. However, as noted in Section 2.1, liquefaction of the ash deposits alone would not undermine the perimeter dikes and is not considered a failure mode.

There is also a lack of data for the compacted ash found in some locations within the starter dike. This material is relatively dense due to compaction, and much of it is unsaturated. The compacted ash in the dikes was thus assumed to not liquefy.

Table 3. Boring Data Used in the Liquefaction Analysis

Boring No.	Northing (feet)	Easting (feet)	Surface Elevation (feet)	Top of Rock Elevation (feet)	Bottom of Hole Elevation (feet)
STN-18	555204.87	2442894.11	751.0	702.5	679.5
STN-19	555204.68	2442842.94	765.6	701.1	700.6
STN-23	555020.22	2442857.46	764.7	703.7	702.7
STN-24	554803.45	2442843.16	765.1	701.6	700.9
STN-26	554624.86	2442889.00	750.0	696.0	692.7
STN-27	554601.77	2442850.67	765.1	700.1	697.6
STN-28	554406.25	2442841.10	764.8	700.5	700.2
STN-29	554155.15	2442854.72	764.7	697.2	697.0
STN-31	553954.94	2442758.22	749.5	696.5	695.5
STN-32	553994.90	2442746.44	764.8	696.3	695.8
STN-34	553853.66	2442184.35	764.7	699.7	688.7
STN-36	553776.74	2442198.78	751.9	712.4	707.9
STN-37	553799.90	2442184.40	763.8	712.8	709.6
STN-38	553730.83	2441988.70	764.1	715.1	712.8
STN-41	553583.10	2441510.71	752.7	714.7	689.7
STN-42	553623.48	2441513.69	764.7	713.7	713.2
STN-62	555020.69	2442907.23	749.8	702.8	700.8
STN-63	554822.75	2442910.57	750.0	702.5	701.0
STN-64	554411.29	2442911.08	749.4	702.9	693.9
STN-65	554147.51	2442915.09	748.6	700.6	698.6
STN-66	553888.83	2442564.24	750.9	695.9	693.9
STN-69	553607.58	2441718.01	752.3	707.3	692.8

5.5. Limiting Earthquake for Liquefaction

Liquefaction assessments were completed for each earthquake scenario, which are defined in terms of the site acceleration, return period (or probability of exceedance), and representative earthquake magnitude. Plots of FS_{liq} versus elevation were compared to identify the “limiting event”, or smallest earthquake (shortest return period), that would cause liquefaction in the ash or sand. Earthquakes smaller than the limiting event are not expected to cause liquefaction, will have lesser accelerations, and will occur more frequently (shorter return periods and higher annual probabilities). Compared to the limiting event, stronger earthquakes are less frequent and less probable, have longer return periods, and generate larger accelerations that will cause liquefaction.

The results for the various conditions are tabulated in Appendix E. Limiting earthquakes were identified individually for each analyzed cross section, for soil profiles representing an inward or outward dike failure. The limiting events are defined in terms of a return period and associated values of moment magnitude, peak acceleration on rock, and peak acceleration on soil (computed as described in Section 4.4). From these results, average return periods were then determined for liquefaction of the ash subgrade or alluvial sands, for limiting events in the two seismic source zones. Plots of FS_{liq} versus elevation are provided in Appendix E for these four limiting events.

The limiting earthquakes for liquefaction are summarized here in Table 4. The average annual probability of exceedance is related to the average return period using the Poisson model (Section 9.1). Consistent with the way the seismic hazards were defined, limiting events were identified separately for New Madrid earthquakes or events originating from all other sources. This allowed for the correct consideration of the earthquake magnitude (representing the duration of strong shaking) and peak accelerations in the analysis.

The assessment separately considered the potential for liquefaction in the ash subgrade and the deeper alluvial sands. However, the results show no significant difference in the seismic load required to liquefy the ash or sands:

- A moment magnitude 7.6 New Madrid earthquake that generates a peak acceleration (on rock) of about 0.02 g or greater would liquefy both the ash subgrade and the alluvial sands.

- For moment magnitude 6 earthquakes originating elsewhere (all other sources), liquefaction would be triggered in the ash and sands at a bedrock acceleration of about 0.08 g (the values of 0.0763 g and 0.0787 g listed in Table 4 are not computationally different).

Hence, the likelihood that the ash subgrade will liquefy is about the same as the likelihood that the deeper sands will liquefy. Note that the New Madrid events, which have much larger earthquake magnitudes, will trigger liquefaction at a lower acceleration because the duration of strong shaking will be much longer.

Next, post-earthquake stability analyses (Section 7) were checked to determine if a dike failure would result from liquefaction. The limiting seismic events were then related to the probability of seismic failure, as discussed in Section 9.

Table 4. Limiting Earthquakes that Cause Liquefaction

Earthquake Source =	New Madrid Event		All Other Sources	
Liquefied Material =	Ash Subgrade & Alluvial Sands	Ash Subgrade	Ash Subgrade & Alluvial Sands	Ash Subgrade
Average Return Period (years)	984	959	1497	1568
Average Annual Probability of Exceedance	0.102%	0.104%	0.067%	0.064%
Peak Acceleration on Rock (g)	0.0203	0.0193	0.0763	0.0787
Peak Acceleration on Soil (g)	0.039	0.039	0.073	0.080
Representative Magnitude (M_w)	7.59	7.60	6.05	6.05

6. Soil Strengths

Unit weights and undrained strength parameters are summarized in Table 5 for each of the material zones in the analyzed cross sections. Residual strengths of the liquefied soils are summarized in Table 6.

Table 5. Summary of Undrained Soil Strengths

Material Zone in Stability Analysis		Unit Weight (pcf)	Consolidated Undrained Strengths for Short-Term Static Loads	Reduced Undrained Strengths for Seismic Loads
Pond Deposits	Hydraulically Placed Ash	107	c = 0, φ = 10°	c = 0, φ = 8°
	Sensitive Silt/Clay	107	$S_u = 0.24\ \sigma'_v$	$S_u = 0.19\ \sigma'_v$
Dike Materials	Rockfill Buttress	128	c = 0, φ = 38°	c = 0, φ = 38°
	Compacted Ash	109	*For σ' < 17,693 psf:* c = 0, φ = 30° *For σ' ≥ 17,693 psf:* c = 1200 psf, φ = 27°	*For σ' < 5,539 psf:* c = 0, φ = 30° *For σ' ≥ 5,539 psf:* c = 960 psf, φ = 22°
	Ash Subgrade	110	*For σ' < 4,686 psf:* c = 0, φ = 30° *For σ' ≥ 4,686 psf:* c = 1000 psf, φ = 20°	*For σ' < 2,753 psf:* c = 0, φ = 30° *For σ' ≥ 2,753 psf:* c = 800 psf, φ = 16°

Table 5. Summary of Undrained Soil Strengths

Material Zone in Stability Analysis		Unit Weight (pcf)	Consolidated Undrained Strengths for Short-Term Static Loads	Reduced Undrained Strengths for Seismic Loads
	Raised Clay Dike	125	c = 0, φ = 23°	c = 0, φ = 19°
	Starter Clay Dike			
	Gravel to Clayey Gravel			
Native Alluvium	Lean Clay Foundation Soil	130	c = 0, φ = 24°	c = 0, φ = 20°
	Silty Sand to Sandy Silt	128	*For σ' < 2,741 psf:* c = 0, φ = 30° *For σ' ≥ 2,741 psf:* c = 1000 psf, φ = 12°	*For σ' < 1,995 psf:* c = 0, φ = 30° *For σ' ≥ 1,995 psf:* c = 800 psf, φ = 10°
	Fine Grained Sand			
	Silty Sand with Gravel			

6.1. Undrained Strengths for Static Loads

Undrained strength parameters (c and φ), appropriate for the analysis of rapidly applied static loads, are listed for each soil zone in the third column in Table 5. These are consolidated, undrained strength parameters, which can be used in a stability analysis to compute shearing resistance as a function of the normal consolidation (effective) stress. Cyclic loading in an earthquake will create additional pore pressures, such that lower strength parameters (see Sections 6.2 and 6.3) are appropriate in saturated soils subjected to undrained seismic conditions.

The static undrained strength parameters were estimated using available laboratory test data, typically consolidated undrained, triaxial compression tests on undisturbed soil samples. Where direct measurements were lacking, the undrained strengths were estimated based on data for similar soils.

The strength of the sensitive silt/clay layer was characterized by AECOM (2009) using direct simple shear tests. Assuming this soft material is normally consolidated, the ratio of undrained strength over vertical effective stress (S_u/σ'_v) is about 0.24.

At low stress levels, undrained soil strengths may be higher than the fully drained strengths. This can occur if the soil is dilative and generates suction pore pressures in a particular stress range. However, the additional shearing resistance due to negative pore pressures may not be sustainable in the field. Over time, water will be drawn toward areas with suction pore pressures, the beneficial effects of the higher effective stress will be lost, and the soil strength will reduce to the drained shearing resistance. To avoid unconservative predictions of stability, the undrained strength is thus taken as the lesser of the undrained or drained strength envelopes at a given normal stress (the composite, undrained strength envelope is then bi-linear).

In Dike C, the compacted ash, ash subgrade, and alluvial sand strata have undrained strength envelopes with cohesion intercepts. For these materials, the drained strengths (c' = 0 and φ' = 30° in each case) are used in the lower pressure range. The applicable ranges of stress for the drained and undrained parameters are noted for these materials in Table 5.

6.2. Undrained Strengths for Seismic Loads

The seismic stability analyses (Section 7 and Section 8) used the undrained strength parameters listed in the last column in Table 5. These parameters represent the undrained shearing resistance of the saturated soils during and immediately after the earthquake, considering the potential for pore pressure accumulation under dynamic load. Residual strengths for the liquefiable materials are discussed in Section 6.3.

Cyclic shearing generates pore water pressures in a saturated soil, leading to softening and reduced shearing resistance. However, soils that do not liquefy will retain most of their strength. Conventional practice assumes, conservatively, that an unliquefied soil will retain at least 80% of the static undrained strength in an earthquake (U.S. Bureau of Reclamation 1999). Hynes-Griffin and Franklin (1984), in their methodology for pseudostatic slope stability analyses (Section 8), recommend using 80% of the static undrained soil strengths. When bi-linear strength envelopes are used to avoid relying upon suction pressures for shearing resistance (Section 6.1), the drained strength parameters are not reduced.

In unsaturated soils, shear induced volumetric changes are accommodated by the compressibility of the pore air, such that cyclic shearing is not expected to generate significant pore water pressures. The full, static undrained strength is assumed to apply for unsaturated soils subjected to seismic loading, with no reduction for dynamic pore pressures. Hence, in the dike materials above the phreatic surface, the static undrained strengths (third column in Table 5) are used in the seismic stability analyses.

The rockfill buttress is comprised of coarse stone aggregate and stone rip rap. Given the very high permeability of this material, excess pore pressures will not accumulate in the buttress during an earthquake. The undrained strength (for both static and seismic loadings) can be computed using the fully drained strength parameters (c = 0, φ = 38°).

6.3. Residual Strengths of Liquefied Soils

The ash deposits in the stilling pond, ash subgrade beneath the raised dike, and the alluvial sands beneath the facility are expected to liquefy in a large magnitude earthquake. Residual, steady state strengths (S_r) were estimated (Table 6) for the post-earthquake conditions in these soils.

Estimates of S_r can be obtained from a variety of empirical correlations. Typically, residual strength (or the ratio of residual strength over vertical effective stress) is correlated to in situ penetration resistance, based on back analysis of liquefaction case histories. The "hybrid" model recently developed by Kramer and Wang (in press) was used in this study:

$$\overline{\ln(S_r)} = -8.444 + 0.109(N_1)_{60} + 5.379(\sigma'_{vo})^{0.1}$$

Here, S_r = residual strength in atmospheres, $(N_1)_{60}$ = normalized and corrected SPT blowcount, and σ_{vo}' = initial vertical effective stress in atmospheres.

A representative value of $(N_1)_{60}$ was selected for the liquefied soil from a detailed review of the boring logs (Table 3). SPT blowcounts judged to be unrepresentative of the in situ conditions were discarded. For example, excessively high blowcounts that may have resulted from the SPT sampler striking a gravel or cobble were discarded. Drilling fluids were used to control potential heave in the boreholes, so low blowcounts (including "weight of hammer" at some locations) were retained. The remaining blowcounts, in terms of $(N_1)_{60}$, were then averaged to arrive at a representative value.

In the alluvial sands, the representative, average blowcount was $(N_1)_{60}$ = 5. In the ash subgrade, in the improved area beneath the raised dike, the average blowcount was $(N_1)_{60}$ = 17. Values of S_r were computed (see Table 6) at a grid of points throughout each of these two deposits, accounting for the variation in vertical effective stress. In the slope stability analyses, an interpolation scheme was then used to compute S_r at any location (the "spatial variation for cohesion" option in Slope/W was used).

Stantec did not have data from borings within the stilling pond, and no blowcount data for the hydraulically placed ash in the pond. These ash deposits will have a lower residual strength, compared to the ash in the raised dike subgrade. In the design for the closure of the adjacent ash pond and dredge cell, a residual strength ratio (S_r/σ'_v) of 0.06 was estimated for liquefied Kingston fly ash. A range of empirical correlations was used to obtain this estimate, which was found to be consistent with data from limited laboratory testing. This strength ratio is also consistent with the final runout slope of failed ash, measured after the 2008 liquefaction flow failure in the Kingston dredge cell. Hence, S_r/σ'_v = 0.06 was adopted for the ash deposits.

The sensitive silt/clay exhibits plasticity and may not liquefy in the design earthquake. However, rather than try to prove this thin layer does not liquefy, liquefaction was assumed and residual strengths were assigned. As long as the shearing resistance assigned to the sensitive silt/clay is not less than that in the overlying ash, the sensitive layer will not affect slope stability. That is, if the sensitive layer does not liquefy, deep failure surfaces will still pass through the liquefied ash just above the thin sensitive layer, and the computed factor of safety will be the same.

Table 6. Summary of Residual Strengths for Liquefied Soils

Material Zone in Stability Analysis	Residual Strength
Hydraulically Placed Ash	$S_r = 0.06\ \sigma'_v$
Sensitive Silt/Clay	
Ash Subgrade	Average $(N_1)_{60}$ = 17: $\overline{\ln(S_r)} = -8.444 + 0.109(17) + 5.379(\sigma'_{vo})^{0.1}$
Silty Sand to Sandy Silt	Average $(N_1)_{60}$ = 5: $\overline{\ln(S_r)} = -8.444 + 0.109(5) + 5.379(\sigma'_{vo})^{0.1}$
Fine Grained Sand	
Silty Sand with Gravel	

Note: Other materials are not expected to liquefy

7. Post-Earthquake Slope Stability

7.1. Method of Analysis

Analyses for slope stability were performed using the SLOPE/W module in GeoStudio 2012 (GEO-SLOPE International, Ltd., Calgary, Alberta, Canada). Spencer's method of analysis was used with the water levels presented in Section 3.2 and the strength parameters discussed in Section 6.

The evaluation included a search for critical slip surfaces, considering both circular and noncircular surfaces. Inward and outward failures of Dike C, involving mass displacements toward the stilling pond or toward the Emory River, were analyzed. Computed factors of safety (FS_{slope}) are reported for each case.

Static analyses of the post-earthquake conditions, with liquefied soils are presented in this section. Pseudostatic analyses of the conditions during seismic loading (without liquefaction) are presented in Section 8. Graphical output from the slope stability analyses are presented in Appendix F.

7.2. Liquefaction in the Alluvial Sands

In the first set of analyses, stability was evaluated assuming an earthquake liquefies the ash deposits in the stilling pond, the ash subgrade beneath the raised dike, and the various sublayers within the alluvial sands. Static, post-earthquake conditions were assumed. Residual strengths were assigned to all of the materials identified in Table 6, assuming each one will be liquefied. In the other saturated soils, the undrained shear strengths were reduced to account for elevated pore pressures generated by dynamic loading (Table 5).

The results, as summarized in Table 7, suggest that deep-seated, outward failures would result at both cross sections (Stations 119+69 and 132+37). A significant inward failure of the raised dike is also indicated for Station 132+37. Hence, earthquakes that are large enough to liquefy the alluvial sands will cause a failure in Dike C, with a likely release of ash from the stilling pond. The probability that this will occur is discussed in Section 9.

Table 7. Post-Earthquake Stability Assuming Liquefaction in the Ash Subgrade and Alluvial Sands

Liquefied Zones	Cross Section	Post-Earthquake Factor of Safety	
		Outward Failure	Inward Failure
Ash Deposits Ash Subgrade Alluvial Sands	119+69	0.6	1.2
	132+37	0.5	0.7

7.3. Liquefaction in the Ash Subgrade

Next, post-earthquake conditions were evaluated assuming liquefaction only in the ash subgrade and ash deposits. Residual strengths (Table 6) were assigned to the hydraulically placed ash, sensitive silt/clay, and the ash subgrade zones. In all of the other saturated soils, including the alluvial sand sublayers, the undrained shear strengths were reduced to account for pore pressures generated by dynamic loading (Table 5).

The results are summarized Table 8. Safety factors greater than one were computed in each case, with the exception of the inward failure at Station 132+37. A closer examination of this result (see graphical output in Appendix F) shows that FS_{slope} = 0.8 was computed for a relatively shallow failure on the inboard slope of the raised dike. Additional stability runs were completed to better understand the inward failure mechanism at Station 132+37.

A release from the stilling pond might occur if a shallow failure on the inboard slope retrogressed to take out the full width of the raised dike. For the current geometry, the supplemental analyses (Appendix F) show that a slip surface involving the full width of the crest has a factor of safety of about one. An even deeper slip surface, which exits the ground surface at the juncture between the rockfill buttress and the raised dike, has a factor of safety of 1.4. In reality, the failure would initiate in the inboard slope, with material sliding off into the pond. Material would accumulate at the toe of the slope, reducing the effective slope of the remnant dike. The progression of the failure would result in a more stable geometry by the time sliding retrogressed to engage the full width of the raised dike. Hence, it seems unlikely that liquefaction of the ash would result in a breach at Station 132+37.

The crest of the rockfill buttress on the starter dike is at elevation 754 feet, about 9 feet above the average top of the ash deposits in the stilling pond. Even if the raised dike is lost, most of the ash in the stilling pond will be retained by the starter dike and rockfill buttress. A small volume of suspended ash might be released with the 0.7 feet of pond water that would overtop the lower starter dike and rockfill buttress.

Stantec concludes that the release of substantial volumes of ash is unlikely if liquefaction is triggered in the ash subgrade and ash deposits, but not in the deeper sands. The failure modes associated with liquefaction only in the ash subgrade and ash deposits can therefore be dismissed. Note that this conclusion has little impact on the probabilities discussed in Section 9, as the limiting earthquakes causing liquefaction in the ash and sands (Table 4) are nearly the same.

Table 8. Post-Earthquake Stability Assuming Liquefaction in the Ash Subgrade

Liquefied Zones	Cross Section	Post-Earthquake Factor of Safety	
		Outward Failure	Inward Failure
Ash Deposits Ash Subgrade	119+69	1.8	1.3
	132+37	1.6	0.8*

** For the inward failure at Station 132+37:*

- *FS_{slope} = 0.8 for a shallow slip surface in the raised dike.*
- *FS_{slope} = 1.0 for a deeper slip surface that would involve the full crest width.*
- *FS_{slope} = 1.4 for an even deeper slip surface that would undermine the raised dike.*

8. Pseudostatic Slope Stability

8.1. Limiting Acceleration

The post-earthquake stability analyses show that Dike C will fail if the alluvial sands are liquefied. In an earthquake that is too weak to cause liquefaction, however, the inertial loads may be large enough to cause excessive dike deformations. This potential failure mode was checked using pseudostatic slope stability analyses for the maximum site accelerations that may occur without liquefaction.

The limiting earthquakes identified in Section 5.5 represent seismic events that are just strong enough to trigger soil liquefaction. Four peak accelerations in rock (PGA_{rock}), representing the limiting conditions for liquefaction, are listed in Table 4. For each seismic source, the pseudostatic analysis should focus on the smaller limiting acceleration; that is, the smaller of the two values of PGA_{rock} identified for liquefaction of the ash subgrade, or liquefaction of the ash subgrade and alluvial sands. For a New Madrid event, for example, the values in Table 4 are PGA_{rock} = 0.0193 g and 0.0203 g. The pseudostatic analysis should assume PGA_{rock} = 0.0193 g, because liquefaction is expected under the dikes at accelerations above this lower value. The results would not be meaningful where the dike foundations are liquefied. However, as discussed in Section 5.5, the differences between these numbers are not significant. The limiting earthquake and PGA_{rock} for liquefying the ash subgrade and alluvial sands is about the same for each seismic source.

From the values in Table 4, liquefaction of the ash and sand is expected for a PGA_{rock} of 0.02 g or greater in a New Madrid earthquake, or 0.08 g or greater in an event originating elsewhere. This difference is attributed to the longer duration of strong motions in the larger magnitude New Madrid events. The pseudostatic analysis treats the dynamic, seismic load as a single, horizontal inertial force that is independent of earthquake duration or magnitude. Here, the pseudostatic analysis is needed only for the larger triggering acceleration, for the New Madrid or all other seismic sources. This will be the maximum site acceleration, and maximum inertial load on the dikes, that could occur without triggering liquefaction. If Dike C will retain the stilling pond at this dynamic load, it will retain the pool at smaller accelerations.

Hence, the pseudostatic stability analyses were completed based on a limiting value of PGA_{rock} = 0.08 g. Refer to Section 8.2 regarding derivation of the horizontal pseudostatic coefficient (k_h) based on the limiting value of PGA_{rock}.

8.2. Method of Analysis

Dynamic slope stability, assuming no liquefaction, was evaluated using pseudostatic, limit equilibrium methods. The analyses were completed using the SLOPE/W module in GeoStudio 2012, and included a search for critical slip surfaces (circular and noncircular).

A constant, uniform, horizontal pseudostatic force was applied to all of the materials in the cross section to approximate the cyclic, inertial loads generated by earthquake shaking. The pseudostatic force, which was applied to the centroid of each slice in the limit equilibrium stability analysis, is computed as:

$$F_h = \frac{a_h W}{g} = k_h W$$

F_h is the applied inertial force, a_h is the horizontal acceleration, W is the weight of soil in each slice, and g is the acceleration due to gravity. The horizontal pseudostatic coefficient (k_h) is a dimensionless ratio, or fraction of gravity, representing the horizontal acceleration due to shaking.

The pseudostatic analyses were completed in accordance with the recommendations of Hynes-Griffin and Franklin (1984), based on their work for the US Army Corps of Engineers. They considered stability of embankment dams, performed Newmark deformation analyses, integrated over 350 ground motion time histories, used an amplification factor of three to represent peak accelerations at the base of the embankment, and assumed a displacement of one meter would be tolerable for an embankment dam. Key elements of this method include:

- The acceleration at the top of bedrock (PGA_{rock}) beneath the dam is used as the reference acceleration.
- The horizontal pseudostatic coefficient is set to one-half of the reference acceleration ($k_h = 0.5 \cdot PGA_{rock}$).
- Undrained soil strengths are reduced to 80% of the static undrained strength, to account for pore pressure buildup during the earthquake.
- If the computed pseudostatic $FS_{slope} \geq 1.0$, then the resulting displacements should be tolerable (less than about 1 m).

8.3. Pseudostatic Results

Pseudostatic slope stability analyses were completed for the two cross sections, at Stations 119+69 and 132+37, assuming $k_h = 0.5 \cdot PGA_{rock} = 0.04$. This represents the maximum dynamic load that would be expected without causing liquefaction. The reduced shear strength parameters in the last column of Table 5 were assigned, to account for pore pressure accumulation in the saturated soil zones.

The pseudostatic FS_{slope} results are summarized in Table 9 and graphical output from the analyses is provided in Appendix F. Safety factors greater than one were computed in each case, with the exception of the inward failure at Station 132+37. A similar condition was noted in the post-earthquake analyses discussed in Section 7.3.

At Station 132+37, a pseudostatic FS_{slope} = 0.7 was computed for a relatively shallow failure on the inboard slope of the raised dike. A slip surface involving the full width of the crest returned FS_{slope} = 0.9. If dynamic loads of this magnitude occurred, sliding would probably initiate on the inboard slope and progress across the width of the crest. The displaced material would accumulate on the inboard side and reduce the effective slope of the remnant dike. With the current geometry, a deeper slip surface through the full width of the raised dike has a factor of safety of 1.7; however, the progression of an inward failure would result in a more stable geometry by the time sliding engaged the full width of the raised dike.

Significant displacements could occur in the raised dike without releasing the stilling pond. The crest of the rockfill buttress on the starter dike is about 9 feet above the average top of the ash deposits in the stilling pond. Even if the raised dike is lost, most of the ash in the stilling pond will be retained by the starter dike and rockfill buttress. A small volume of suspended ash might be released with the 0.7 feet of pond water that would overtop the rockfill buttress.

For potential failures involving the starter dike, the pseudostatic analyses indicate safety factors of 1.4. The lower starter dike, which is critical to the retention of the stilling pond, should be stable if the underlying sand does not liquefy.

Stantec concludes that dynamic loading of the dike, at accelerations below the threshold for triggering liquefaction, is unlikely to cause the release of substantial volumes of ash. The failure mode associated with inertial loading of the dike slopes can therefore be dismissed.

Table 9. Pseudostatic Stability Results, Assuming no Liquefaction and k_h = 0.04

Pseudostatic k_h	Cross Section	Pseudostatic Factor of Safety (FS_{slope})	
		Outward Failure	Inward Failure
0.04	119+69	1.4	1.1
	132+37	1.4	0.7*

** For the inward failure at Station 132+37:*

- *FS_{slope} = 0.7 for a shallow slip surface in the raised dike.*
- *FS_{slope} = 0.9 for a deeper slip surface that would involve the full crest width.*
- *FS_{slope} = 1.7 for an even deeper slip surface that would undermine the raised dike.*

9. Probability of Seismic Failure

9.1. Poisson Model

The temporal distribution of earthquake hazards is usually quantified using a Poisson model, based on the assumption that earthquakes occur randomly in a region without regard to the time, size, or location of prior earthquake events (Kramer 1996). Using the Poisson distribution, the probability of experiencing "n" seismic events of a particular size during a given time interval is expressed as:

$$P[n] = \frac{(\lambda t)^n e^{-\lambda t}}{n!}$$

where λ is the mean annual rate of an event occurring and t is the time in years. The recurrence interval (return period) is the inverse of λ. The probability of exceedance (PE) is the probability of having one or more specific events in the time period t, or:

$$PE = P[n \geq 1] = 1 - P[n = 0]$$

$$PE \ = 1 - e^{-\lambda t}$$

For example, some dams are designed for a probabilistic earthquake having a 50-percent probability of exceedance (PE = 0.50) over t = 100 years. Using the Poisson model, this event has a mean annual rate of λ = 0.00693 events per year, or a return period of 1/λ = 144 years. The *annual* probability of exceedance is then 0.691%, computed using the above equation with λ = 0.00693 and t = 1 year.

The annual PE and λ are sometimes used interchangeably in describing earthquake hazards, although the two values are not mathematically equal. For return periods greater than 100 years, the annual PE and the mean annual rate differ by less than 0.00005.

9.2. Seismic Failure Modes

Seven potential earthquake failure modes, which would lead to a release of ash from the Kingston stilling pond, were identified in Section 2.1. Of these, four were dismissed and two were discounted through further analysis. The post-earthquake stability analyses indicate that failure is unlikely if the ash liquefies beneath the raised dike, as long as the alluvial sands do not liquefy. For earthquakes that do not cause liquefaction, the pseudostatic stability analyses show that the inertial loads are not strong enough to cause a breach.

The post-earthquake and pseudostatic analyses indicate instabilities in the raised dike at Station 132+37, as discussed in Sections 7.2, 7.3, and 8.3. However, the crest of the raised dike is 10.3 feet above the operating water surface and about 20 feet above the ash deposits in the stilling pond. Progressive failure of the raised dike in an earthquake is expected to stop before Dike C is breached. Even if the raised dike was lost, the ash deposits are, on average, 9 feet below the crest of the rockfill buttress on the starter dike. Hence, inward sliding of the raised dike at this location is not expected to result in the release of significant ash from the stilling pond.

The primary seismic failure mode for the Kingston stilling pond results from liquefaction of the alluvial sands beneath Dike C. The probability of a seismic failure is then equal to the probability of an earthquake event that would be just strong enough to cause liquefaction in the alluvial sands. An event of this strength, which would also liquefy the ash, would destabilize the perimeter dikes and result in the release of ash deposits from the stilling pond.

9.3. Annual Probability of Failure

Seismic performance was evaluated in terms of the limiting, weakest earthquake that would cause a failure. This is the lowest return period earthquake that would cause liquefaction of the alluvial sand; all stronger earthquakes (with longer return periods) were assumed to also cause failure. Hence, the probability of the limiting earthquake is the probability of exceedance for liquefaction and failure.

Return periods for a limiting earthquake were identified separately for the two source zones (New Madrid events and all other sources). The Poisson model relates the return period (recurrence interval) to the annual failure probability (probability of exceedance). These values are given in Table 4 and Table 10 for the two source zones.

The two earthquake sources collectively encompass all seismic hazards, so the total annual probability of liquefaction is equal to the sum of the probabilities for each of the two earthquake scenarios. The total annual failure probability = 0.102% + 0.067% = 0.169%, corresponding to a recurrence interval of 591 years (Table 10).

Table 10. Probability of Seismic Failure

Earthquake Source	Annual Probability of Exceedance	Return Period (years)
New Madrid Events	0.102%	984
All Other Sources	0.067%	1497
Total Hazard	0.169%	591

9.4. Probability over Remaining Service Life

In approximate terms, every year there is a 0.17% chance that an earthquake will occur that is strong enough to trigger liquefaction in the foundation soils and ash deposits beneath Dike C. Then, for $\lambda = 0.0017$ events/year, the Poisson model can be used to compute the probability of failure over any time period (t), as given in Table 11.

Assuming the Kingston stilling pond will operate in the current conditions for another four years (see Section 3.1), there is a 0.68% chance for an earthquake large enough to cause a failure to occur. This probability decreases over time, as the remaining service life approaches zero (Table 11).

Table 11. Probability of Seismic Failure Assuming an Annual Probability of 0.17%

Service Life (years)	Probability of Seismic Failure over Service Life
4	0.68%
3	0.51%
2	0.34%
1	0.17%
0	0.00%

10. References

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Appendix A

Site Plan

Notes:
1. Aerial imagery flown in October 2013 by Tuck Mapping Solutions, Inc. Current conditions differ from those shown.
2. Facility boundaries shown are approximate, and not all site features are labeled or shown.
3. Location of the stability sections are approximate.

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STANTEC CONSULTING SERVICES INC.
1409 N. Forbes Rd.
Lexington, Kentucky
40511-2050
859-422-3000

Stantec

TVA Kingston Fossil Plant

Stilling Pond
Probability of Seismic Failure
During Remaining Service Life

PROJECT NO.	175553016
DATE	JANUARY 2014
DRAWN BY	MMM
CHECKED BY	AFR
CHECKED BY	
SCALE	AS SHOWN
REVISED	
1.	
2.	
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SHEET

1 OF 1

Appendix B

Boring Logs

Project No.	175569042	Location	N 555204.87, E 2442894.11 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-18** Total Depth 71.5 ft
Location	Kingston, Tennessee	Surface Elevation	751.0 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/14/09 Completed 4/15/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	13.0 ft Date/Time 4/15/09
Logged By	Ben Halada	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
751.0'	0.0'	Top of Hole						
748.5'	2.5'	LEAN CLAY (Fill), red brown, moist, soft to medium stiff	SPT-1	0.0 - 1.5	1.1	4-4-4	23	Boring advanced using 3 1/4 " Hollow Stem Augers
			SPT-2	1.5 - 3.0	1.2	9-10-22	18	
735.0'	16.0'	BOTTOM ASH 65% / FLY ASH 35% (Fill), black, moist to saturated, loose to medium dense	SPT-3	3.0 - 4.5	1.0	10-11-11	13	Piston sampler and sucker rods were utilized to obtain recovery during Shelby Tube sampling
			SPT-4	4.5 - 6.0	1.1	3-7-6	9	
			SPT-5	6.0 - 7.5	1.0	3-7-15	7	
			SPT-6	7.5 - 9.0	1.0	5-7-13	12	
			SPT-7	9.0 - 10.5	1.1	3-4-3	9	
			SPT-8	10.5 - 12.0	1.0	6-6-7	13	
			SPT-9	12.0 - 13.5	1.0	3-4-4	14	
			SPT-10	13.5 - 15.0	0.9	2-3-3	16	
			SPT-11	15.0 - 16.5	0.9	4-3-1	26	
727.0'	24.0'	SAND, light brown, saturated, very loose, fine grained, trace silt	SPT-12	16.5 - 18.0	1.2	1-WOH-WOH	18	Water added at 18.0 ft to keep augers clear
			SPT-13	18.0 - 19.5	0.2	1-WOH-WOH	18	
			SPT-14	19.5 - 21.0	0.9	1-WOH-1	17	
			SPT-15	21.0 - 22.5	1.0	1-WOH-WOH	17	
			SPT-16	22.5 - 24.0	1.1	2-1-1	16	
723.5'	27.5'	SILTY CLAY, light brown, saturated, very soft, some fine grained sand, some silt	SPT-17	24.0 - 25.5	0.3	2-WOH-1	23	
			ST-1	25.5 - 27.5	2.0		--	
719.0'	32.0'	SAND, light brown, saturated, loose, fine to medium grained, trace silt	SPT-18	27.5 - 29.0	1.5	2-3-3	18	
			SPT-19	29.0 - 30.5	1.4	2-5-4	22	
			SPT-20	30.5 - 32.0	1.1	4-5-4	19	
717.0'	34.0'	SAND, brown, saturated, loose, fine grained, some silt, some clay	SPT-21	32.0 - 33.5	1.2	4-4-3	20	
		SAND, light gray to gray, saturated, very loose, fine grained, some silt	SPT-22	33.5 - 35.0	1.3	WOH-WOH-WOH	19	
			SPT-23	35.0 - 36.5	1.0	WOH-WOH-WOH	19	

FNSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FNSM.GDT 7/16/09

Project No.	175569042	Location	N 555204.87, E 2442894.11 (NAD27)		
Project Name	Kingston Ash Pond	Boring No.	STN-18	Total Depth	71.5 ft

Lithology: Elevation	Lithology: Depth	Description	Overburden: Sample # / Rock Core: RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SAND, light gray to gray, saturated, very loose, fine grained, some silt *(Continued)*	SPT-24	36.5 - 38.0	1.5	WOH-1-1	18	
			SPT-25	38.0 - 39.5	1.0	1-2-2	18	
			SPT-26	39.5 - 41.0	1.1	2-3-1	18	
			SPT-27	41.0 - 42.5	0.7	1-3-1	18	
707.0'	44.0'		SPT-28	42.5 - 44.0	0.8	2-3-4	21	
		SAND, light gray to gray, moist, dense to very dense, fine grained, some fine to medium gravel	SPT-29	44.0 - 45.5	1.1	4-12-16	12	
			SPT-30	45.5 - 47.0	0.9	33-32-31	12	SPT-30: sandstone in tip of spoon
702.5'	48.5'		SPT-31	47.0 - 48.5	1.1	25-27-30	12	
			SPT-32	48.5 - 49.0	0.5	50-10/0.0	8	
700.5'	50.5'	Shale, (Augered)						Began Core
		Shale, dark gray, very fine to fine grained, very soft, very thin bedded, with very thin to thin limestone layers, 30° to 45° bedding angle	0%	6.0	0.7	12	56.5	
			0%	5.0	1.3	26	61.5	
			0%	5.0	0.0	0	66.5	
679.5'	71.5'		8%	5.0	1.4	28	71.5	Boring backfilled with bentonite cement grout from 0.0 ft to 71.5 ft

Bottom of Hole

Top of Rock = 48.5'
Elevation (702.5')

Project No.	175569042	Location	N 555204.87, E 2442894.11 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-18** Total Depth 71.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks

WOH = Weight of Hammer
WOR = Weight of Rods

Split Samples: SPT-2, 11 and 22

Slope Indicator (60 ft of pipe) installed with a concrete pad and flushmount cover

Stantec

SUBSURFACE LOG

Project No.	175569042	Location	N 555204.68, E 2442842.94 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-19** Total Depth 65.0 ft
Location	Kingston, Tennessee	Surface Elevation	765.6 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/1/09 Completed 4/1/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	23.0 ft Date/Time 4/1/09
Logged By	Ben Halada	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
765.6'	0.0'	Top of Hole						
765.1'	0.5'	GRAVEL (Fill)						
764.1'	1.5'	BOTTOM ASH (Fill), black, moist, loose	SPT-1	0.5 - 2.0	1.1	5-7-10	20	Boring advanced using 3 1/4 " Hollow Stem Augers
		LEAN CLAY (Fill), red brown, moist, medium stiff, some chert	SPT-2	2.0 - 3.5	1.1	5-5-5	7	
			SPT-3	3.5 - 5.0	1.4	5-6-8	25	All ST samples recovered using a fixed head piston sampler
			ST-1	5.0 - 7.0	2.0		--	
			SPT-4	7.0 - 8.5	1.0	6-9-11	25	
			SPT-5	8.5 - 10.0	0.3	4-4-7	18	
			SPT-6	10.0 - 11.5	1.0	4-3-4	29	
			SPT-7	11.5 - 13.0	1.1	2-4-4	28	
			ST-2	13.0 - 15.0	1.5		--	
			SPT-8	15.0 - 16.5	0.2	4-6-4	24	
			SPT-9	16.5 - 18.0	0.0	10-15-16	--	
747.1'	18.5'	GRAVEL (Fill), gray, moist, dense	SPT-10	18.0 - 19.5	1.3	11-18-20	12	
746.6'	19.0'	Bottom Ash 65% / Fly Ash 35% (Fill), black, saturated, medium dense	SPT-11	19.5 - 21.0	1.1	6-10-13	12	
743.6'	22.0'	BOTTOM ASH (Fill), black, saturated, very loose to loose	SPT-12	21.0 - 22.5	1.0	9-10-14	13	Water added at 22.0 ft to keep augers clear
			SPT-13	22.5 - 24.0	1.2	6-6-5	22	
			SPT-14	24.0 - 25.5	1.1	3-5-6	19	
739.1'	26.5'	SAND, light brown, saturated, very loose to loose, fine grained	SPT-15	25.5 - 27.0	1.1	4-3-2	24	
			SPT-16	27.0 - 28.5	0.8	3-2-4	25	
			SPT-17	28.5 - 30.0	1.0	4-5-5	21	
			SPT-18	30.0 - 31.5	1.1	3-3-1	22	
			SPT-19	31.5 - 33.0	1.2	3-2-3	23	
731.6'	34.0'		SPT-20	33.0 - 34.5	1.1	WOR-WOR-WOR	17	
730.6'	35.0'	SAND, light brown, saturated, very loose, fine grained, trace silty clay	SPT-21	34.5 - 36.0	1.0	WOR-WOH-1	20	

FMSM_LEGACY 17146117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

Project No.	175569042	Location	N 555204.68, E 2442842.94 (NAD27)		
Project Name	Kingston Ash Pond	Boring No.	**STN-19**	Total Depth	65.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
728.1'	37.5'	SAND, light brown, saturated, very loose, fine grained, clayey sand *(Continued)*		SPT-22	36.0 - 37.5	1.2	WOH-WOH-WOH	18	
				SPT-23	37.5 - 39.0	1.5	WOH-WOH-WOH	23	
724.6'	41.0'	SILTY CLAY, light red brown, saturated, very soft, trace fine grained sand		ST-3	39.0 - 41.0	2.0		--	ST-3: sand in bottom to tube
722.6'	43.0'	SAND, light brown, saturated, very loose, fine grained		SPT-24	41.0 - 42.5	1.2	WOR-4-5	19	
				SPT-25	42.5 - 44.0	1.1	2-4-5	17	
716.6'	49.0'	SAND, light brown, saturated, loose, fine grained, clayey silt		SPT-26	44.0 - 45.5	1.0	1-2-3	19	
				SPT-27	45.5 - 47.0	1.3	1-2-2	18	
				SPT-28	47.0 - 48.5	1.2	2-4-4	19	
714.6'	51.0'	SAND, light brown, saturated, loose, fine grained, trace silt		SPT-29	48.5 - 50.0	1.2	6-9-3	20	
				SPT-30	50.0 - 51.5	1.3	1-2-2	19	
710.6'	55.0'	SAND, light brown, saturated, loose, fine grained		SPT-31	51.5 - 53.0	1.0	2-3-5	20	
				SPT-32	53.0 - 54.5	0.2	WOH-WOH-WOH	22	
707.6'	58.0'	SAND, light brown, saturated, loose, fine grained, trace silt		SPT-33	54.5 - 56.0	1.0	WOH-WOH-WOH	21	
				SPT-34	56.0 - 57.5	1.0	WOR-1-1	21	SPT-35: sandstone in tip of spoon
701.1'	64.5'	SAND, dark gray, saturated, dense, fine to coarse grained, some fine to coarse gravel		SPT-35	57.5 - 59.0	1.2	4-4-34	23	SPT-36: shale in tip of spoon
				SPT-36	59.0 - 60.5	1.2	6-35-50	18	
				SPT-37	60.5 - 62.0	1.1	13-24-29	14	Boring backfilled with bentonite cement grout from 0.0 ft to 65.0 ft
				SPT-38	62.0 - 63.5	1.1	19-22-24	16	
700.6'	65.0'	Shale, (Augered)		SPT-39	63.5 - 64.9	0.9	14-28-50/0.4	11	
		Auger Refusal / Bottom of Hole							

WOH = Weight of Hammer
WOR = Weight of Rods

FMSM_LEGACY 171468117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 555020.22, E 2442857.46 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-23** Total Depth 62.0 ft
Location	Kingston, Tennessee	Surface Elevation	764.7 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	5/11/09 Completed 5/12/09
Supervisor	Ben Halada Driller Sam Wilks	Depth to Water	8.0 ft Date/Time 5/11/09
Logged By	Briggs Evans	Automatic Hammer ☐ Safety Hammer ☒ Other ☐	

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
764.7'	0.0'	Top of Hole							
764.5'	0.2'	GRAVEL (Fill), light gray, dry, road material		SPT-1	0.0 - 1.5	0.5	19-17-10	14	
763.2'	1.5'	BOTTOM ASH (Fill), gray black, dry, dense		SPT-2	1.5 - 3.0	0.9	9-7-7	27	
		LEAN CLAY (Fill), red brown, dry, stiff, with chert		SPT-3	3.0 - 4.5	0.9	7-7-7	26	
				SPT-4	4.5 - 6.0	0.4	4-4-5	24	
				SPT-5	6.0 - 7.5	1.0	6-6-4	26	
				SPT-6	7.5 - 9.0	0.3	8-8-8	22	
				SPT-7	9.0 - 10.5	0.7	7-7-7	28	
				SPT-8	10.5 - 12.0	0.7	6-6-10	25	
				SPT-9	12.0 - 13.5	0.4	3-4-9	19	
				SPT-10	13.5 - 15.0	0.9	7-7-8	28	
				SPT-11	15.0 - 16.5	1.0	3-8-8	22	
				SPT-12	16.5 - 18.0	1.3	8-8-9	25	
				SPT-13	18.0 - 19.5	1.0	8-8-9	28	
				SPT-14	19.5 - 21.0	0.2	5-5-4	16	
				SPT-15	21.0 - 22.5	1.0	6-6-6	27	
741.7'	23.0'	BOTTOM ASH (Fill), black gray, saturated, dense, with fly ash		SPT-16	22.5 - 24.0	1.5	8-13-13	25	
739.7'	25.0'	SAND (Fill), brown gray, saturated, dense, fine grained, well rounded, well graded, with trace silt		SPT-17	24.0 - 25.5	0.9	13-11-13	17	
				SPT-18	25.5 - 27.0	1.5	14-16-14	18	
737.2'	27.5'	BOTTOM ASH (Fill), black, saturated, medium dense, fine to coarse grained		SPT-19	27.0 - 28.5	1.5	9-9-6	20	
				SPT-20	28.5 - 30.0	1.5	2-4-4	24	
734.7'	30.0'			SPT-21	30.0 - 31.5	0.2	1-1-1	20	
733.2'	31.5'	SAND, gray brown, saturated, very loose, fine grained, with fly ash, silty		SPT-22	31.5 - 33.0	1.0	1-WOH-WOH	17	
		SAND, light brown, saturated, very loose, fine grained, well rounded, well graded, with trace silt		SPT-23	33.0 - 34.5	1.0	1-1-1	17	
728.7'	36.0'			SPT-24	34.5 - 36.0	1.5	2-2-2	18	

FMSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 555020.22, E 2442857.46 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-23** Total Depth 62.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SAND, brown, saturated, very loose, fine grained, well rounded, well graded, with trace silt and gravelly *(Continued)*		SPT-25	36.0 - 37.5	1.5	1-1-1	17	
				SPT-26	37.5 - 39.0	1.5	WOR-WOR-WOR	20	
724.2'	40.5'			SPT-27	39.0 - 40.5	1.5	3-2-2	23	
		SILTY CLAY, brown gray, saturated, soft, mottled		SPT-28	40.5 - 42.0	1.5	WOR-WOR-2	26	
				SPT-29	42.0 - 43.5	1.0	3-3-4	25	
719.7'	45.0'			ST-1	43.5 - 45.5	2.0		--	
		SILTY SAND, brown gray, saturated, very loose, fine grained, well rounded		SPT-30	45.5 - 47.0	1.0	WOH-WOH-5	16	
716.2'	48.5'			SPT-31	47.0 - 48.5	1.0	WOR-WOR-WOR	20	
		SANDY SILT, gray, saturated, very soft		SPT-32	48.5 - 50.0	1.5	WOH-WOH-WOH	21	
713.2'	51.5'			SPT-33	50.0 - 51.5	1.5	WOR-WOR-WOR	22	
		SAND, gray, saturated, very loose to loose, fine grained, well rounded, well graded, with, trace silt		SPT-34	51.5 - 53.0	1.0	WOR-WOR-WOR	22	
				SPT-35	53.0 - 54.5	1.0	2-2-2	21	
				SPT-36	54.5 - 56.0	1.0	3-1-WOH	20	
				SPT-37	56.0 - 57.5	1.5	1-2-5	22	
				SPT-38	57.5 - 59.0	1.1	WOH-4-5	20	
				SPT-39	59.0 - 60.5	1.0	6-2-3	24	
703.7'	61.0'			SPT-40	60.5 - 61.9	1.4	12-25-50/0.4	--	
703.2'	61.5'	Sandstone, (augered)							
702.7'	62.0'	Shale, (augered)							
		Auger Refusal / Bottom of Hole							

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SUBSURFACE LOG

Project No.	175569042	Location	N 554803.45, E 2442843.16 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	STN-24 Total Depth 64.2 ft
Location	Kingston, Tennessee	Surface Elevation	765.1 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	5/7/09 Completed 5/11/09
Supervisor	Ben Halada Driller Sam Wilks	Depth to Water	18.0 ft Date/Time 5/7/09
Logged By	Briggs Evans	Automatic Hammer ☐ Safety Hammer ☒ Other ☐	

Lithology Elevation	Lithology Depth	Description	Sample # / RQD	Depth / Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
765.1'	0.0'	Top of Hole						
764.4'	0.8'	CRUSHED STONE (Fill)	SPT-1	0.0 - 1.5	1.8	14-12-7	9	Boring advanced using 3 1/4" hollow stem augers
		LEAN CLAY (Fill), red, dry to moist, soft to very stiff, some chert, trace gravel	SPT-2	1.5 - 3.0	0.8	9-8-4	20	
			SPT-3	3.0 - 4.5	0.5	9-9-10	21	
			SPT-4	4.5 - 6.0	1.0	5-6-7	28	
			SPT-5	6.0 - 7.5	1.4	15-15-15	22	
			SPT-6	7.5 - 9.0	1.1	6-5-4	28	
			SPT-7	9.0 - 10.5	0.8	8-9-11	23	
			SPT-8	10.5 - 12.0	0.8	5-7-9	24	
			SPT-9	12.0 - 13.5	1.5	11-11-9	26	
			SPT-10	13.5 - 15.0	1.0	3-4-6	24	
			SPT-11	15.0 - 16.5	1.3	7-9-10	30	
747.7'	17.4'		SPT-12	16.5 - 18.0	1.0	7-9-11	25	
		BOTTOM ASH (Fill), dark gray, wet to saturated, loose to dense, with fly ash	SPT-13	18.0 - 19.5	1.2	16-10-4	25	Wet at 18 ft bgs
			SPT-14	19.5 - 21.0	1.2	22-26-21	26	
			SPT-15	21.0 - 22.5	0.0	WOR-WOR-2	--	Begin adding water to control blowback
			SPT-16	22.5 - 24.0	0.5	3-3-3	24	
			SPT-17	24.0 - 25.5	1.0	6-7-9	21	
738.1'	27.0'		SPT-18	25.5 - 27.0	1.2	8-8-11	21	
736.7'	28.4'	GRAVELLY BOTTOM ASH (Fill), dark gray, saturated, medium dense	SPT-19	27.0 - 28.5	1.5	10-12-14	13	
		SAND, brown, wet, loose to very loose, fine to medium grained, some silt	SPT-20	28.5 - 30.0	1.0	4-4-7	20	
			SPT-21	30.0 - 31.5	0.5	1-1-2	19	
			SPT-22	31.5 - 33.0	1.0	4-4-6	22	
730.6'	34.5'		SPT-23	33.0 - 34.5	1.3	1-WOH-WOH	17	
729.1'	36.0'	SANDY SILT, brown, saturated, very soft, with fine grained sand	SPT-24	34.5 - 36.0	1.5	WOH-WOH-WOH	20	

FMSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

Project No.	175569042	Location	N 554803.45, E 2442843.16 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-24** Total Depth 64.2 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SILTY SAND, tan, wet to saturated, very loose to loose, fine to medium grained, well graded, little silt, homogeneous *(Continued)*		SPT-25	36.0 - 37.5	1.5	1-WOH-WOH	12	
				SPT-26	37.5 - 39.0	1.5	WOR-WOR-WOR	19	
				SPT-27	39.0 - 40.5	1.5	WOR-3-2	17	
				SPT-28	40.5 - 42.0	1.0	WOH-WOH-WOH	18	
				SPT-29	42.0 - 43.5	1.3	5-5-9	18	
				SPT-30	43.5 - 45.0	1.5	5-4-2	19	
				SPT-31	45.0 - 46.5	1.5	5-6-6	20	
				SPT-32	46.5 - 48.0	1.0	4-5-5	18	
				SPT-33	48.0 - 49.5	1.5	WOH-WOH-2	20	
				SPT-34	49.5 - 51.0	1.2	WOR-WOR-WOR	18	
				SPT-35	51.0 - 52.5	1.5	2-1-1	19	
				SPT-36	52.5 - 54.0	1.0	WOR-WOR-WOR	17	
				SPT-37	54.0 - 55.5	1.5	WOR-WOR-WOR	17	
				SPT-38	55.5 - 57.0	1.5	WOR-WOR-WOR	20	
				SPT-39	57.0 - 58.5	1.5	WOR-WOR-WOR	21	
				SPT-40	58.5 - 60.0	1.5	WOR-9-10	25	
				SPT-41	60.0 - 61.5	1.5	14-14-10	21	
				SPT-42	61.5 - 63.0	1.5	3-3-4	20	
701.6'	63.5'			SPT-43	63.0 - 63.7	0.7	7-50/0.2	19	
700.9'	64.2'	Sandstone, (Augered)							

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rod

FMSM_LEGACY 171468117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

SUBSURFACE LOG

Project No.	175569042	Location	N 554624.86, E 2442889.00 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-26** Total Depth 57.3 ft
Location	Kingston, Tennessee	Surface Elevation	750.0 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	3/23/09 Completed 3/23/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	6.0 ft Date/Time 3/23/09
Logged By	Ben Halada	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
750.0'	0.0'	Top of Hole						
748.0'	2.0'	LEAN CLAY (Fill), red brown to brown, moist, soft	SPT-1	0.0 - 1.5	1.2	2-3-4	24	Boring advanced using 3 1/4 " Hollow Stem Augers
743.0'	7.0'	Bottom Ash 60% / Fly Ash 40% (Fill), dark gray, saturated, dense to very dense	SPT-2	1.5 - 3.0	1.3	45-15-20	16	
			SPT-3	3.0 - 4.5	1.2	30-31-20	19	
			SPT-4	4.5 - 6.0	1.1	10-12-10	21	
			SPT-5	6.0 - 7.5	1.0	10-9-6	18	
730.0'	20.0'	LEAN CLAY (Fill), light brown to red brown, saturated, soft to medium stiff, some silt	SPT-6	7.5 - 9.0	0.8	3-3-4	22	
			ST-1	9.0 - 11.0	1.0		--	
			SPT-7	11.0 - 12.5	1.1	3-3-4	18	
			SPT-8	12.5 - 14.0	1.0	4-5-6	20	
			SPT-9	14.0 - 15.5	1.3	3-4-6	20	
			SPT-10	15.5 - 17.0	0.2	WOH-WOH-WOH	19	
			SPT-11	17.0 - 18.5	1.3	WOH-WOH-WOH	21	
			SPT-12	18.5 - 20.0	1.1	WOH-WOH-WOH	21	
727.0'	23.0'	LEAN CLAY with Silt, dark gray, saturated, very soft	ST-2	20.0 - 22.0	2.0		--	
716.0'	34.0'	SILTY SAND with Clay, brown, saturated, very soft, some fine grained sand	SPT-13	22.0 - 23.5	1.4	WOH-WOH-WOH	24	
			SPT-14	23.5 - 25.0	0.2	WOR-WOH-WOH	23	
			SPT-15	25.0 - 26.5	1.4	WOR-WOH-1	23	
			SPT-16	26.5 - 28.0	1.1	1-1-1	22	
			SPT-17	28.0 - 29.5	1.4	WOH-WOH-2	22	
			SPT-18	29.5 - 31.0	1.1	WOH-WOH-WOH	24	
			SPT-19	31.0 - 32.5	1.3	WOH-2-2	25	
			SPT-20	32.5 - 34.0	1.0	WOH-1-2	25	
		SAND, gray, saturated, very loose, some silt	SPT-21	34.0 - 35.5	1.2	WOH-WOH-WOH	18	
			SPT-22	35.5 - 37.0	1.2	WOH-	19	

FMSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

Project No.	175569042	Location	N 554624.86, E 2442889.00 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-26** Total Depth 57.3 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SAND, gray, saturated, very loose, some silt *(Continued)*		SPT-23	37.0 - 38.5	1.3	WOH-WOH WOH-1-1	20	
				SPT-24	38.5 - 40.0	1.1	WOH-WOH-1	19	
				SPT-25	40.0 - 41.5	1.1	WOR-WOH-WOH	20	
				SPT-26	41.5 - 43.0	1.1	WOR-WOH-1	21	
706.0'	44.0'			SPT-27	43.0 - 44.5	1.3	2-2-6	21	
		SAND, light gray, saturated, very loose to loose, fine grained, trace fine to medium grained gravel		SPT-28	44.5 - 46.0	1.4	3-2-3	27	
				SPT-29	46.0 - 47.5	1.0	3-4-5	26	
701.0'	49.0'			SPT-30	47.5 - 49.0	1.4	3-3-4	33	SPT-30: wood fragments in sample
		SAND, light gray, saturated, loose to medium dense, fine to coarse grained, some fine to medium gravel		SPT-31	49.0 - 50.5	1.1	3-4-4	19	
				SPT-32	50.5 - 52.0	1.5	5-6-7	23	
				SPT-33	52.0 - 53.5	1.1	6-12-8	15	SPT-34: shale in spoon
696.0'	54.0'			SPT-34	53.5 - 55.0	1.1	14-15-15	12	Boring backfilled with bentonite cement grout from 0.0 ft to 57.3 ft
		Shale, (Augered)		SPT-35	55.0 - 55.9	0.9	23-50/0.4	12	
692.7'	57.3'								

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

Stantec

SUBSURFACE LOG

Project No.	175569042	Location	N 554601.77, E 2442850.67 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	STN-27 Total Depth 67.5 ft
Location	Kingston, Tennessee	Surface Elevation	765.1 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	3/30/09 Completed 3/30/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	22.0 ft Date/Time 3/30/09
Logged By	Ben Halada	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology Elevation	Lithology Depth	Description	Sample # (Overburden) / RQD (Rock Core)	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
765.1'	0.0'	Top of Hole						
764.6'	0.5'	GRAVEL (Fill), gray, moist, loose	SPT-1	0.0 - 1.5	1.3	10-7-9	13	Boring advanced using 3 1/4 " Hollow Stem Augers
		LEAN CLAY (Fill), red brown, moist, medium stiff to stiff, some chert	SPT-2	1.5 - 3.0	1.1	6-7-12	22	
			SPT-3	3.0 - 4.5	1.1	13-11-17	24	All ST samples recovered using a fixed head piston sampler
			ST-1	4.5 - 6.5	1.5		--	
			SPT-4	6.5 - 8.0	1.3	4-5-7	23	
			SPT-5	8.0 - 9.5	1.3	10-10-12	28	
			SPT-6	9.5 - 11.0	1.3	3-5-5	27	
			SPT-7	11.0 - 12.5	0.9	7-6-8	25	
			ST-2	12.5 - 14.5	1.5		--	
			SPT-8	14.5 - 16.0	1.2	2-5-5	29	
			SPT-9	16.0 - 17.5	1.3	6-7-9	23	
			SPT-10	17.5 - 19.0	1.0	1-2-3	29	
			ST-3	19.0 - 21.0	1.3		--	
743.1'	22.0'		SPT-11	21.0 - 22.5	1.1	2-4-7	25	
		Bottom Ash 60% / Fly Ash 40% (Fill), dark gray, saturated, loose	SPT-12	22.5 - 24.0	1.3	4-3-6	21	
			SPT-13	24.0 - 25.5	1.1	7-5-9	16	
			SPT-14	25.5 - 27.0	1.1	4-6-9	21	
737.1'	28.0'		SPT-15	27.0 - 28.5	1.1	7-9-9	20	
735.6'	29.5'	SAND (Fill), brown, saturated, loose, fine to medium grained	SPT-16	28.5 - 30.0	1.3	5-4-2	25	
733.1'	32.0'	SILT with clay (Fill), dark gray, saturated, soft, some fine grained sand	ST-4	30.0 - 32.0	1.0		--	ST-4: sand in bottom of tube
		Bottom Ash 70% / Fly Ash 30% (Fill), dark gray, saturated, very loose	SPT-17	32.0 - 33.5	1.2	WOH-2-3	20	
730.6'	34.5'		SPT-18	33.5 - 35.0	1.1	3-3-2	19	
730.1'	35.0'	SAND, brown, saturated, very loose, fine grained	SPT-19	35.0 - 36.5	1.4	1-1-1	25	

FMSM_LEGACY 17146817 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

Project No. 175569042 Location N 554601.77, E 2442850.67 (NAD27)

Project Name Kingston Ash Pond Boring No. **STN-27** Total Depth 67.5 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 gray, saturated, very soft to soft, trace clay *(Continued)*		SPT-20	36.5 - 38.0	1.2	WOH-1-1	27	
				SPT-21	38.0 - 39.5	1.1	WOR-WOR-WOR	25	
				SPT-22	39.5 - 41.0	1.4	WOH-WOH-WOH	25	
				SPT-23	41.0 - 42.5	1.0	WOH-1-1	20	
721.1'	44.0'			SPT-24	42.5 - 44.0	1.3	WOH-1-WOH	22	ST-5: sand in tube
		SAND, light brown, saturated, very loose to loose, fine grained		ST-5	44.0 - 46.0	1.3		--	Water added at 45.0 ft to keep sand out of augers
718.1'	47.0'			SPT-25	46.0 - 47.5	1.3	1-1-WOH	20	
		SILT, gray, saturated, very soft, some fine grained sand		SPT-26	47.5 - 49.0	1.3	WOH-WOH-1	20	
				SPT-27	49.0 - 50.5	1.0	WOH-WOH-WOH	21	
				SPT-28	50.5 - 52.0	1.1	WOR-WOR-WOR	21	
				SPT-29	52.0 - 53.5	1.2	WOR-WOR-WOR	21	
				SPT-30	53.5 - 55.0	1.2	WOR-WOR-WOR	21	
				SPT-31	55.0 - 56.5	1.1	WOR-WOR-WOH	20	
				SPT-32	56.5 - 58.0	1.3	WOR-WOH-1	20	
706.1'	59.0'			SPT-33	58.0 - 59.5	1.1	WOR-WOR-WOR	25	
		SAND, light gray, saturated, loose, fine grained, some fine to coarse gravel		SPT-34	59.5 - 61.0	1.1	WOR-2-2	21	
				SPT-35	61.0 - 62.5	1.3	3-2-5	26	SPT-35, 36, 37: wood fragments
				SPT-36	62.5 - 64.0	1.1	WOR-2-5	38	
700.1'	65.0'			SPT-37	64.0 - 65.5	1.0	WOH-6-26	25	Boring backfilled with bentonite cement grout from 0.0 ft to 67.5 ft
				SPT-38	65.5 - 66.2	0.6	80-20/0.2	--	
697.6'	67.5'	Shale, (Augered)							
		Auger Refusal / Bottom of Hole							

WOH = Weight of Hammer
WOR = Weight of Rods

SUBSURFACE LOG

Project No.	175569042	Location	N 554601.77, E 2442850.67 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-27** Total Depth 67.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		Boring located 8 ft toward center of dike from river side of dike							

Project No.	175569042	Location	N 554406.25, E 2442841.10 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-28** Total Depth 64.6 ft
Location	Kingston, Tennessee	Surface Elevation	764.8 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	5/5/09 Completed 5/7/09
Supervisor	Ben Halada Driller Sam Wilks	Depth to Water	20.5 ft Date/Time 5/6/09
Logged By	Briggs Evans	Automatic Hammer ☐	Safety Hammer ☒ Other ☐

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
764.8'	0.0'	Top of Hole						
~~764.3'~~	~~0.5'~~	CRUSHED STONE (Fill)	SPT-1	0.0 - 1.5	1.0	25-12-10	19	Boring advanced using 3 1/4" hollow stem augers
		LEAN CLAY (Fill), red brown, dry to moist, soft to very stiff, some chert, trace gravel, medium plasticity	SPT-3	3.0 - 4.5	0.8	8-8-8	22	
			SPT-4	4.5 - 6.0	0.5	18-7-7	20	
			SPT-5	6.0 - 7.5	0.3	9-8-9	25	
			SPT-6	7.5 - 9.0	1.3	5-5-6	25	
			SPT-7	9.0 - 10.5	1.2	8-8-9	25	
			SPT-8	10.5 - 12.0	1.0	9-14-13	25	
			SPT-9	12.0 - 13.5	0.0	3-5-5	24	
			SPT-10	13.5 - 15.0	0.5	3-5-5	--	
			SPT-11	15.0 - 16.5	1.0	8-7-8	28	
747.1'	17.7'		SPT-12	16.5 - 18.0	1.5	5-16-30	27	
		BOTTOM ASH (Fill), dark gray to gray, moist to saturated, loose to very dense, with fly ash	SPT-13	18.0 - 19.0	0.8	35-50/0.4	17	
			SPT-14	19.5 - 21.0	1.2	26-18-18	23	Wet at 20.5 ft
			SPT-15	21.0 - 22.5	1.0	6-8-4	20	Begin adding water to control blow-back
741.3'	23.5'		SPT-16	22.5 - 24.0	1.5	7-6-4	22	
		FLY ASH (Fill), gray to light gray, wet to saturated, loose to medium dense, some bottom ash, some silt	SPT-17	24.0 - 25.5	1.3	15-19-20	24	
			SPT-18	25.5 - 27.0	1.0	9-12-12	24	
			SPT-19	27.0 - 28.5	1.5	7-9-12	32	
			SPT-20	28.5 - 30.0	1.5	8-8-7	30	
			SPT-21	30.0 - 31.5	1.5	17-15-15	27	Very soft, saturated layer 30.3 to 31.0
731.8'	33.0'		SPT-22	31.5 - 33.0	1.5	3-3-3	25	
		LEAN CLAY, brown, wet to saturated, soft to very soft, with fine to medium grained sand, mottled	SPT-23	33.0 - 34.5	1.5	2-3-4	28	
			SPT-24	34.5 - 36.0	1.5	2-4-3	28	Saturated layer with

FMSM_LEGACY 17146811? KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 554406.25, E 2442841.10 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-28**
		Total Depth	64.6 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		LEAN CLAY, brown, wet to saturated, soft to very soft, with fine to medium grained sand, mottled *(Continued)*		SPT-25	36.0 - 37.5	1.5	1-1-1	26	bottom ash and fly ash
				ST-1	37.5 - 39.5	2.0		--	
				SPT-26	39.5 - 41.0	1.5	3-2-3	26	
				SPT-27	41.0 - 42.5	1.5	3-2-3	26	
				SPT-28	42.5 - 44.0	1.5	2-1-1	31	
				SPT-29	44.0 - 45.5	1.5	3-3-3	26	
				ST-2	45.5 - 47.5	2.0		--	
716.5'	48.3'			SPT-30	47.5 - 49.0	1.5	3-2-2	25	
		SILTY SAND, gray to brown, wet to saturated, loose to very loose, fine to medium grained, well graded, some silt, some		SPT-31	49.0 - 50.5	0.5	2-1-1	19	
				SPT-32	50.5 - 52.0	1.5	WOR-WOR-WOR	25	
711.3'	53.5'			SPT-33	52.0 - 53.5	1.5	WOR-WOR-WOR	20	Wood fragments at 53.5
		CLAYEY SAND, brown, saturated, very loose to loose, fine to medium grained		SPT-34	53.5 - 55.0	0.5	1-WOH-WOH	19	
				SPT-35	55.0 - 56.5	1.5	WOH-WOH-WOH	23	
706.8'	58.0'			SPT-36	56.5 - 58.0	1.5	3-2-3	22	Wood 57 to 57.2
		SAND, gray, saturated, loose, fine grained, trace silt		SPT-37	58.0 - 59.5	1.2	4-4-6	27	Wood 59 to 59.2
				SPT-38	59.5 - 61.0	1.5	4-6-7	27	Wood 60.5 to 61.0
				SPT-39	61.0 - 62.5	1.5	3-4-6	52	Boring backfilled with bentonite grout from 0.0 ft to 64.6 ft
				SPT-40	62.5 - 64.0	1.5	2-3-4	25	
700.5'	64.3'			SPT-41	64.0 - 64.3	0.3	50/0.3	25	
700.2'	64.6'	Shale (Augered)							

Auger Refusal / Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

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SUBSURFACE LOG

Project No.	175569042	Location	N 554155.15, E 2442854.72 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	STN-29 Total Depth 67.7 ft
Location	Kingston, Tennessee	Surface Elevation	764.7 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	5/4/09 Completed 5/12/09
Supervisor	Ben Halada Driller Sam Wilks	Depth to Water	27.0 ft Date/Time 5/5/09
Logged By	Briggs Evans	Automatic Hammer ☐ Safety Hammer ☒ Other ☐	

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
764.7'	0.0'	Top of Hole							
		CRUSHED STONE (Fill)		SPT-1	0.0 - 1.5	0.8	15-19-22	5	Boring advanced using 3 1/4" hollow stem augers
761.7'	3.0'			SPT-2	1.5 - 3.0	0.8	22-25-12	12	Perched water at the gravel - clay interface
		LEAN CLAY (Fill), red brown, dry to moist, soft to very stiff, some chert, trace gravel, medium plasticity		SPT-3	3.0 - 4.5	1.0	12-9-5	22	
				ST-1	4.5 - 6.5	1.2		--	
				SPT-4	6.5 - 8.0	1.0	12-12-15	26	
				SPT-5	8.0 - 9.5	1.5	7-9-10	22	
				SPT-6	9.5 - 11.0	1.5	11-12-14	23	
				ST-2	11.0 - 13.0	1.0		--	
				SPT-7	13.0 - 14.5	1.3	5-8-9	30	
				SPT-8	14.5 - 16.0	1.3	5-7-8	24	
				SPT-9	16.0 - 17.5	1.2	9-12-13	27	
				ST-3	17.5 - 19.5	1.2		--	
				SPT-10	19.5 - 21.0	1.2	1-3-4	29	Water at 20 ft
				SPT-11	21.0 - 22.5	1.0	1-3-4	28	
741.7'	23.0'			SPT-12	22.5 - 24.0	1.3	2-3-1	27	
		BOTTOM ASH (Fill), dark gray, wet to saturated, loose to medium dense, with fly ash		ST-4	24.0 - 26.0	1.0		--	
				SPT-13	26.0 - 27.5	1.5	20-20-21	20	Begin adding water to control blowback
				SPT-14	27.5 - 29.0	1.5	8-7-8	33	Coal fragments at 27.5 ft
				SPT-15	29.0 - 30.5	1.5	10-10-11	25	
				SPT-16	30.5 - 32.0	1.0	12-14-16	35	
				SPT-17	32.0 - 33.5	1.5	7-9-10	34	
729.9'	34.8'			SPT-18	33.5 - 35.0	1.5	1-1-3	32	
				SPT-19	35.0 - 36.5	0.9	2-2-3	24	

FMSM_LEGACY 17146117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

Project No.	175569042	Location	N 554155.15, E 2442854.72 (NAD27)		
Project Name	Kingston Ash Pond	Boring No.	**STN-29**	Total Depth	67.7 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SANDY SILT, brown, wet to saturated, soft to very soft, with fly ash, with bottom ash *(Continued)*		SPT-20	36.5 - 38.0	1.0	1-3-4	21	
725.7'	39.0'			SPT-21	38.0 - 39.5	1.0	WOH-1-2	22	
		SILT, dark gray, moist, very soft, with fine grained sand, some wood		SPT-22	39.5 - 41.0	1.0	3-3-3	25	
				SPT-23	41.0 - 42.5	1.5	WOR-WOR-WOR	26	
				SPT-24	42.5 - 44.0	1.2	WOH-WOH-WOH	26	
				ST-5	44.0 - 46.0	1.5		--	
717.7'	47.0'			SPT-25	46.0 - 47.5	0.5	WOR-WOR-WOR	24	
		LEAN CLAY, brown to gray, moist, very soft, with manganese, mottled		SPT-26	47.5 - 49.0	1.5	10-9-7	21	
				SPT-27	49.0 - 50.5	1.5	7-9-11	22	
				SPT-28	50.5 - 52.0	1.0	7-6-6	27	
				ST-6	52.0 - 54.0	1.0		--	
				SPT-29	.54.0 - 55.5	1.3	3-3-4	24	
				SPT-30	55.5 - 57.0	1.5	WOR-WOR-WOR	25	
				SPT-31	57.0 - 58.5	1.5	WOR-2-3	26	
				SPT-32	58.5 - 60.0	1.5	WOR-3-4	32	
702.9'	61.8'			ST-7	60.0 - 62.0	2.0		--	
		SAND, gray, wet, loose to medium dense, fine to medium grained, well graded, some silt, some wood		SPT-33	62.0 - 63.5	1.3	7-7-7	54	Wood 63.1 to 63.4 ft
				SPT-34	63.5 - 65.0	1.4	9-9-7	26	Boring backfilled with bentonite grout from 0.0 ft to 67.7 ft
				SPT-35	65.0 - 66.5	1.0	11-12-14	18	
697.2'	67.5'			SPT-36	66.5 - 67.7	1.2	10-14-50/0.2	18	
697.0'	67.7'	Shale, (augered)							
		Auger Refusal / Bottom of Hole							

WOH = Weight of Hammer
WOR = Weight of Rods

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SUBSURFACE LOG

Project No.	175569042	Location	N 553954.94, E 2442758.22 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-31** Total Depth 54.0 ft
Location	Kingston, Tennessee	Surface Elevation	749.5 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	3/24/09 Completed 3/25/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	8.0 ft Date/Time 3/25/09
Logged By	Ben Halada	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
749.5'	0.0'	Top of Hole							
		Overburden (Fill), consisted of gravel, clay, sand and ash		SPT-1	0.0 - 1.5	1.1	5-12-16	18	Boring advanced using 3 1/4 " Hollow Stem Augers
746.5'	3.0'			SPT-2	1.5 - 3.0	1.3	15-10-23	15	
~~746.0'~~	~~3.5'~~	Overburden (Fill), Auger advancement difficult - possible concrete slab		SPT-3	3.5 - 5.0	0.8	11-12-6	8	
		GRAVEL (Fill), gray, moist, medium dense		SPT-4	5.0 - 6.5	0.0	5-3-4	--	
				SPT-5	6.5 - 8.0	0.1	6-17-14	2	
				SPT-6	8.0 - 9.5	0.1	6-3-3	18	
739.5'	10.0'			SPT-7	9.5 - 11.0	0.5	3-1-4	39	
		FAT CLAY (Fill), light brown and red brown, moist, very soft, some fine to coarse gravel		SPT-8	11.0 - 12.5	1.3	2-1-3	43	
				ST-1	12.5 - 14.5	1.3		--	
				SPT-9	14.5 - 16.0	0.3	1-1-3	22	
				SPT-10	16.0 - 17.5	0.8	1-2-2	39	
				SPT-11	17.5 - 19.0	1.1	1-2-3	31	
				SPT-12	19.0 - 20.5	1.4	1-1-2	38	
				ST-2	20.5 - 22.5	1.0		--	
				SPT-13	22.5 - 24.0	1.2	WOH-1-1	37	
724.5'	25.0'			SPT-14	24.0 - 25.5	1.5	1-1-2	29	
		SILT, gray and brown, saturated, very soft, some clay, some fine grained sand		SPT-15	25.5 - 27.0	1.3	WOR-WOH-1	25	
				SPT-16	27.0 - 28.5	1.3	WOH-WOH-WOH	23	
				SPT-17	28.5 - 30.0	1.1	WOH-WOH-WOH	28	
				SPT-18	30.0 - 31.5	1.3	WOH-WOH-WOH	26	
717.5'	32.0'			SPT-19	31.5 - 33.0	1.1	1-2-4	23	
		LEAN CLAY, light brown, saturated, soft to medium stiff, some fine grained sand		ST-3	33.0 - 35.0	2.0		--	
				SPT-20	35.0 - 36.5	1.3	2-2-7	22	

FMSM_LEGACY 171468117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

Project No.	175569042	Location	N 553954.94, E 2442758.22 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-31** Total Depth 54.0 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		LEAN CLAY, light brown, saturated, soft to medium stiff, some fine grained sand *(Continued)*		SPT-21	36.5 - 38.0	1.2	3-3-5	23	
				ST-4	38.0 - 40.0	2.0		--	
				SPT-22	40.0 - 41.5	1.3	4-4-4	25	
707.0'	42.5'			SPT-23	41.5 - 43.0	1.2	1-1-3	29	
		SILT, dark gray, saturated, soft, some clay		SPT-24	43.0 - 44.5	1.3	WOH-WOH-WOH	27	
				SPT-25	44.5 - 46.0	1.1	1-3-2	28	
				SPT-26	46.0 - 47.5	1.2	4-3-3	33	
				SPT-27	47.5 - 49.0	1.1	3-3-4	38	
				SPT-28	49.0 - 50.5	1.3	2-2-2	36	SPT-29: sand/gravel in tip of spoon
				SPT-29	50.5 - 52.0	1.0	WOH-2-2	31	Boring backfilled with bentonite cement grout from 0.0 ft to 54.0 ft
697.0'	52.5'								
~~696.5'~~	~~53.0'~~	SAND, light brown, saturated, dense, medium to coarse grained, some fine to medium gravel		SPT-30	52.0 - 53.2	1.1	5-13-50	16	
695.5'	54.0'	Shale, (Augered)							

Auger Refusal / Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

FMSM_LEGACY 171468117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

SUBSURFACE LOG

Stantec

Project No.	175569042	Location	N 553994.90, E 2442746.44 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	STN-32 Total Depth 69.0 ft
Location	Kingston, Tennessee	Surface Elevation	764.8 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/1/09 Completed 4/1/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	20.0 ft Date/Time 4/1/09
Logged By	Ben Halada	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
764.8'	0.0'	Top of Hole							
763.3'	1.5'	GRAVEL (Fill), gray, moist, dense		SPT-1	0.0 - 1.5	1.2	18-24-30	4	Boring advanced using 3 1/4 " Hollow Stem Augers
		LEAN CLAY (Fill), red brown, moist, soft to medium stiff, chert		SPT-2	1.5 - 3.0	1.0	3-5-7	23	
				SPT-3	3.0 - 4.5	1.2	8-10-10	27	All ST samples recovered using a fixed head piston sampler
				ST-1	4.5 - 6.5	1.5		--	
				SPT-4	6.5 - 8.0	0.1	3-4-3	18	
				SPT-5	8.0 - 9.5	1.2	4-6-8	21	
				SPT-6	9.5 - 11.0	1.1	4-6-7	25	
				SPT-7	11.0 - 12.5	1.3	9-10-12	29	
				SPT-8	12.5 - 14.0	1.0	8-10-11	31	
				ST-2	14.0 - 16.0	1.5		--	
746.8'	18.0'			SPT-9	16.0 - 17.5	1.2	7-7-6	34	
		FAT CLAY (Fill), dark red brown, moist, soft, some clay		SPT-10	17.5 - 19.0	1.2	4-3-5	24	
				SPT-11	19.0 - 20.5	1.0	2-2-2	29	SPT-12: ash in tip of spoon
742.3'	22.5'			SPT-12	20.5 - 22.0	1.1	2-1-2	29	
		Bottom Ash 55% / Fly Ash 45% (Fill), black, saturated, very loose to loose		SPT-13	22.0 - 23.5	0.8	8-13-10	14	
				SPT-14	23.5 - 25.0	0.8	6-4-4	21	
737.8'	27.0'			SPT-15	25.0 - 26.5	0.8	3-2-2	24	SPT-16: gravel in tip of spoon
		FAT CLAY (Fill), brown, saturated, very soft to soft		SPT-16	26.5 - 28.0	1.0	2-5-4	30	
				SPT-17	28.0 - 29.5	0.2	WOH-WOH-2	28	
				SPT-18	29.5 - 31.0	0.1	5-5-5	18	SPT-19: rock and wood in tip of spoon
				SPT-19	31.0 - 32.5	0.1	5-4-3	24	
				SPT-20	32.5 - 34.0	0.2	5-3-4	44	
				SPT-21	34.0 - 35.5	0.0	4-1-2	--	
				SPT-22	35.5 - 37.0	0.0	3-1-1	--	

FMSM_LEGACY 17146117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 553994.90, E 2442746.44 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-32** Total Depth 69.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		FAT CLAY (Fill), brown, saturated, very soft to soft *(Continued)*		SPT-23	37.0 - 38.5	0.2	2-1-1	38	
				SPT-24	38.5 - 40.0	1.0	WOR-WOR-1	34	
723.8'	41.0'			SPT-25	40.0 - 41.5	1.0	1-2-1	38	
721.8'	43.0'	SILT, dark gray, saturated, very soft, trace clay, trace fine grained sand		SPT-26	41.5 - 43.0	1.5	WOR-2-2	25	
		SILT, light brown, saturated, very soft, some clay		SPT-27	43.0 - 44.5	1.2	WOR-WOR-WOR	27	
				SPT-28	44.5 - 46.0	1.2	WOH-WOH-WOH	30	
717.3'	47.5'			SPT-29	46.0 - 47.5	1.1	2-2-2	25	
		LEAN CLAY, gray, saturated, very soft to medium stiff, trace fine grained sand, trace silt		SPT-30	47.5 - 49.0	1.3	2-1-1	25	
				ST-3	49.0 - 51.0	2.0		--	
				SPT-31	51.0 - 52.5	1.2	1-2-2	20	
				SPT-32	52.5 - 54.0	1.3	5-4-5	22	
				SPT-33	54.0 - 55.5	1.2	7-7-8	23	
708.8'	56.0'			SPT-34	55.5 - 57.0	1.2	4-4-5	26	
		SILT, gray, saturated, very soft to soft, some clay		SPT-35	57.0 - 58.5	1.1	WOR-1-1	26	
				SPT-36	58.5 - 60.0	1.5	WOH-WOH-WOH	29	
703.3'	61.5'			SPT-37	60.0 - 61.5	1.2	2-2-2	29	
		SILT, dark gray, saturated, soft, trace clay, some fine grained sand		SPT-38	61.5 - 63.0	1.1	4-2-1	33	Sand lenses at 61.5 ft to bottom. Very thin, < 0.05 ft
				SPT-39	63.0 - 64.5	1.2	4-4-4	43	
				SPT-40	64.5 - 66.0	1.5	2-2-3	34	
				SPT-41	66.0 - 67.5	1.1	4-5-6	40	Boring backfilled with bentonite cement grout from 0.0 ft to 69.0 ft
696.8'	68.0'			SPT-42	67.5 - 68.5	1.0	30-50/0.5	18	
696.3'	68.5'	SAND, dark gray, saturated, medium dense, fine to coarse grained, some fine to medium gravel							
695.8'	69.0'	Shale, (Augered)							
		Auger Refusal / Bottom of Hole							

WOH = Weight of Hammer

FMSH_LEGACY 17468117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 553994.90, E 2442746.44 (NAD27)		
Project Name	Kingston Ash Pond	Boring No.	**STN-32**	Total Depth	69.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks

WOR = Weight of Rods

FMSM_LEGACY 17468117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

SUBSURFACE LOG

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Project No.	175569042	Location	N 553853.66, E 2442184.35 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-34** Total Depth 76.0 ft
Location	Kingston, Tennessee	Surface Elevation	764.7 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	5/20/09 Completed 5/21/09
Supervisor	Ben Halada Driller Steve Bradford	Depth to Water	21.0 ft Date/Time 5/20/09
Logged By	Brad Smiley	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
764.7'	0.0'	Top of Hole						
		FAT CLAY (Fill), red brown, moist, medium stiff, some chert	SPT-1	0.0 - 1.5	0.8	2-2-2	24	Boring advanced using 4 1/4 " Hollow Stem Augers
			SPT-2	1.5 - 3.0	0.8	2-3-4	27	
			SPT-3	3.0 - 4.5	0.9	3-4-4	27	
			SPT-4	4.5 - 6.0	0.9	2-2-2	32	
			SPT-5	6.0 - 7.5	1.0	2-4-5	27	
			SPT-6	7.5 - 9.0	1.2	5-4-6	29	
			SPT-7	9.0 - 10.5	1.1	5-6-5	27	
			SPT-8	10.5 - 12.0	1.4	4-6-6	27	
			SPT-9	12.0 - 13.5	1.5	6-10-10	30	
			SPT-10	13.5 - 15.0	1.3	7-8-8	25	
			SPT-11	15.0 - 16.5	1.3	3-5-4	29	
			SPT-12	16.5 - 18.0	1.2	4-5-4	33	
745.2'	19.5'		SPT-13	18.0 - 19.3	0.7	5-10-50/0.3	3	
		BOTTOM ASH (Fill), black, saturated, medium dense	SPT-14	19.5 - 21.0	0.9	3-5-2	21	Water added at 20.0 ft to keep sand out of augers
			SPT-15	21.0 - 22.5	0.8	3-7-7	19	
			SPT-16	22.5 - 24.0	0.9	7-8-8	13	
739.2'	25.5'		SPT-17	24.0 - 25.5	1.3	4-4-4	21	
737.7'	27.0'	FLY ASH (Fill), black, saturated, loose	SPT-18	25.5 - 27.0	0.9	3-3-3	21	
		SAND (Fill), dark gray, moist, medium dense, fine to medium grained, some silty clay	SPT-19	27.0 - 28.5	0.4	3-8-19	7	
			SPT-20	28.5 - 30.0	0.5	3-7-5	24	
732.7'	32.0'		ST-1	30.0 - 32.0	0.0		--	
		BOTTOM ASH (Fill), dark gray, saturated, medium dense to dense	SPT-21	32.0 - 33.5	1.2	31-16-6	12	
			SPT-22	33.5 - 35.0	1.0	7-16-10	17	
			SPT-23	35.0 - 36.5	0.4	13-16-11	11	

FMSM_LEGACY 17146811? KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 553853.66, E 2442184.35 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-34** Total Depth 76.0 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
725.2'	39.5'	BOTTOM ASH (Fill), dark gray, saturated, medium dense to dense *(Continued)*		SPT-24	36.5 - 38.0	0.9	13-10-11	14	
				SPT-25	38.0 - 39.5	0.9	4-6-5	19	
719.2'	45.5'	LEAN CLAY, gray to brown, moist, soft, some clay, trace fine grained sand		SPT-26	39.5 - 41.0	0.7	4-2-2	22	
				SPT-27	41.0 - 42.5	0.0	2-2-4	--	
				SPT-28	42.5 - 44.0	0.7	2-4-4	22	
				SPT-29	44.0 - 45.5	1.5	4-6-7	25	
714.7'	50.0'	SAND, light brown, saturated, loose to medium dense, fine grained, some clay		SPT-30	45.5 - 47.0	0.4	1-2-4	30	
				SPT-31	47.0 - 48.5	1.4	6-6-6	24	
				SPT-32	48.5 - 50.0	1.1	4-6-6	26	
701.2'	63.5'	SAND, gray to dark gray, saturated, loose to medium dense, medium to coarse grained, some clay		SPT-33	50.0 - 51.5	1.5	WOR-WOR-WOR	19	
				SPT-34	51.5 - 53.0	0.8	1-1-3	22	
				SPT-35	53.0 - 54.5	1.3	2-3-3	19	
				SPT-36	54.5 - 56.0	0.9	2-2-2	21	
				SPT-37	56.0 - 57.5	1.2	3-3-7	20	
				SPT-38	57.5 - 59.0	1.4	3-3-3	21	
				SPT-39	59.0 - 60.5	1.2	4-3-4	24	
				SPT-40	60.5 - 62.0	1.3	4-5-11	25	
				SPT-41	62.0 - 63.5	1.2	7-7-8	21	
699.7'	65.0'	SAND, dark gray, saturated, dense, medium grained, some coarse gravel		SPT-42	63.5 - 65.0	1.3	7-19-31	21	
				SPT-43	65.0 - 66.2	1.1	17-42-41/0.2	--	
688.7'	76.0'	Shale (Augered)							Boring backfilled with bentonite cement grout from 0.0 ft to 76.0 ft
		Auger Refusal / Bottom of Hole							

FMSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

Project No.	175569042	Location	N 553853.66, E 2442184.35 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-34** Total Depth 76.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks

WOH = Weight of Hammer
WOR = Weight of Rods

Slope Indicator (79 ft of pipe) installed with a concrete pad and protective cover

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SUBSURFACE LOG

Project No.	175569042	Location	N 553776.74, E 2442198.78 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-36** Total Depth 44.0 ft
Location	Kingston, Tennessee	Surface Elevation	751.9 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	3/24/09 Completed 3/24/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	5.0 ft Date/Time 3/24/09
Logged By	Ben Halada	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Lithology Depth	Description	Sample # / RQD	Depth / Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
751.9'	0.0'	Top of Hole						
750.9'	1.0'	LEAN CLAY (Fill), red brown, moist, stiff	SPT-1	0.0 - 1.5	1.3	5-7-18	20	Boring advanced using 3 1/4 " Hollow Stem Augers
750.7'	1.2'	BOTTOM ASH (Fill), dark gray, moist, medium dense	SPT-2	1.5 - 3.0	1.3	22-14-12	11	
		LEAN CLAY (Fill), light brown to gray, moist, medium stiff to stiff, some coarse gravel	SPT-3	3.0 - 4.5	1.0	9-10-12	15	
			SPT-4	4.5 - 6.0	0.4	3-4-4	17	
			SPT-5	6.0 - 7.5	0.5	10-7-8	15	
			SPT-6	7.5 - 9.0	0.0	6-6-12	--	
742.4'	9.5'		SPT-7	9.0 - 10.5	1.3	12-8-15	10	SPT-7: gravel in tip of spoon
741.9'	10.0'	GRAVEL (Fill), gray, moist, medium dense	SPT-8	10.5 - 12.0	1.0	8-28-17	12	
		LEAN CLAY (Fill), light brown, moist, medium stiff, some shale	SPT-9	12.0 - 13.5	0.0	12-8-8	--	
738.4'	13.5'	GRAVEL (Fill), gray, moist, medium dense, boulders	SPT-10	13.5 - 15.0	0.0	21-35-10	--	
			SPT-11	15.0 - 16.5	0.6	2-2-3	10	
			SPT-12	16.5 - 18.0	0.8	5-3-2	22	
733.9'	18.0'	SILTY CLAY, dark gray, saturated, very soft to soft	SPT-13	18.0 - 19.5	1.1	3-2-1	27	
			SPT-14	19.5 - 21.0	1.3	1-1-1	24	
730.4'	21.5'	LEAN CLAY, light brown, moist, soft to medium stiff, some fine grained sand	SPT-15	21.0 - 22.5	1.2	1-2-2	25	
			ST-1	22.5 - 24.5	2.0		--	
			SPT-16	24.5 - 26.0	1.5	3-5-6	24	
			SPT-17	26.0 - 27.5	1.5	4-6-7	19	
			SPT-18	27.5 - 29.0	1.1	4-6-8	21	
721.4'	30.5'		ST-2	29.0 - 31.0	2.0		--	ST-2: sand in bottom of tube
		SAND, brown, saturated, very loose, fine to medium grained	SPT-19	31.0 - 32.5	1.3	1-1-2	23	
718.9'	33.0'	SAND, brown, saturated, loose to medium dense, fine to medium grained, some fine to coarse gravel	SPT-20	32.5 - 34.0	1.3	3-13-21	15	
			SPT-21	34.0 - 35.5	1.3	13-28-28	11	
			SPT-22	35.5 - 37.0	0.5	8-7-5	20	

FMSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

Project No.	175569042	Location	N 553776.74, E 2442198.78 (NAD27)		
Project Name	Kingston Ash Pond	Boring No.	**STN-36**	Total Depth	44.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
				SPT-23	37.0 - 38.5	1.1	7-8-11	14	
712.4'	39.5'			SPT-24	38.5 - 40.0	1.4	7-13-13	32	
		Shale, (Augered)		SPT-25	40.0 - 41.5	1.3	6-29-31	17	Boring backfilled with bentonite cement grout from 0.0 ft to 44.0 ft
707.9'	44.0'			SPT-26	41.5 - 43.0	0.8	27-31-36	18	

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

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SUBSURFACE LOG

Project No.	175569042	Location	N 553799.90, E 2442184.40 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-37** Total Depth 54.2 ft
Location	Kingston, Tennessee	Surface Elevation	763.8 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	3/25/09 Completed 3/26/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	8.5 ft Date/Time 3/26/09
Logged By	Ben Halada	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Lithology Depth	Description	Sample # / RQD	Depth / Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
763.8'	0.0'	Top of Hole						
762.8'	1.0'	GRAVEL (Fill), gray, moist, dense	SPT-1	0.0 - 1.5	1.0	15-6-7	5	Boring advanced using 3 1/4 " Hollow Stem Augers
		LEAN CLAY (Fill), red brown, moist, soft to stiff, some chert, some ash	SPT-2	1.5 - 3.0	1.3	6-7-9	23	
			SPT-3	3.0 - 4.5	1.3	11-11-11	24	
			SPT-4	4.5 - 6.0	1.1	8-4-5	22	
			SPT-5	6.0 - 7.5	0.9	8-6-10	28	
754.8'	9.0'		SPT-6	7.5 - 9.0	1.1	5-7-9	22	
		FAT CLAY (Fill), red brown, moist, soft to stiff, some chert	SPT-7	9.0 - 10.5	1.0	4-6-6	27	
			SPT-8	10.5 - 12.0	1.1	2-2-3	33	
			SPT-9	12.0 - 13.5	1.3	4-5-7	27	
			ST-1	13.5 - 15.5	2.0		--	
			SPT-10	15.5 - 17.0	1.2	3-3-3	24	
			SPT-11	17.0 - 18.5	1.1	1-3-7	28	
			SPT-12	18.5 - 20.0	1.0	2-3-3	23	
			ST-2	20.0 - 22.0	1.7		--	
			SPT-13	22.0 - 23.5	1.3	2-2-3	22	
738.8'	25.0'		SPT-14	23.5 - 25.0	1.0	3-3-4	20	
		CLAYEY GRAVEL (Fill), gray, moist, medium dense, some shale	SPT-15	25.0 - 26.5	0.2	9-11-12	16	
735.8'	28.0'		SPT-16	26.5 - 28.0	0.2	4-10-11	19	
		LEAN CLAY, light brown, saturated, very soft to soft	SPT-17	28.0 - 29.5	0.3	4-2-1	25	
			SPT-18	29.5 - 31.0	1.3	1-1-2	26	
			SPT-19	31.0 - 32.5	1.2	1-3-5	23	
729.3'	34.5'		ST-3	32.5 - 34.5	1.0		--	
			SPT-20	34.5 - 36.0	1.2	WOH-2-3	21	

FMSM_LEGACY 17108117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

Project No.	175569042	Location	N 553799.90, E 2442184.40 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-37** Total Depth 54.2 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SAND, light brown, saturated, loose to medium dense, fine to medium grained, some silty clay *(Continued)*		SPT-21	36.0 - 37.5	1.1	2-3-4	21	
				SPT-22	37.5 - 39.0	1.1	6-8-8	22	
				SPT-23	39.0 - 40.5	1.3	5-4-4	18	
				SPT-24	40.5 - 42.0	1.0	WOH-3-4	24	
				SPT-25	42.0 - 43.5	1.4	5-15-18	22	
				SPT-26	43.5 - 45.0	1.1	10-14-18	20	Water added at 44.0 ft to keep sand out of augers
717.3'	46.5'			SPT-27	45.0 - 46.5	1.0	1-5-15	17	
		Shale, (Augered)		SPT-28	46.5 - 48.0	1.1	5-20-20	16	
				SPT-29	48.0 - 49.5	1.1	10-30-33	14	
				SPT-30	49.5 - 51.0	1.1	17-34-32	21	
				SPT-31	51.0 - 52.0	1.0	37-50/0.5	16	Boring backfilled with bentonite cement grout from 0.0 ft to 54.2 ft
709.6'	54.2'								

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

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SUBSURFACE LOG

Project No.	175569042	Location	N 553730.83, E 2441988.70 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-38** Total Depth 51.3 ft
Location	Kingston, Tennessee	Surface Elevation	764.1 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	5/21/09 Completed 5/22/09
Supervisor	Ben Halada Driller Steve Bradford	Depth to Water	30.0 ft Date/Time 5/21/09
Logged By	Brad Smiley	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
764.1'	0.0'	Top of Hole						
763.4'	0.7'	GRAVEL (Fill)	SPT-1	0.0 - 1.5	1.2	8-6-6	15	Boring advanced using 4 1/4 " Hollow Stem Augers
		LEAN CLAY (Fill), red brown, moist, medium stiff, some chert	SPT-2	1.5 - 3.0	1.4	6-8-12	20	
			SPT-3	3.0 - 4.5	1.2	12-12-10	18	
			SPT-4	4.5 - 6.0	0.5	6-4-5	30	
			SPT-5	6.0 - 7.5	1.0	6-7-9	23	
			SPT-6	7.5 - 9.0	1.0	9-10-11	22	
			SPT-7	9.0 - 10.5	0.9	9-11-11	26	
			SPT-8	10.5 - 12.0	0.9	3-3-9	21	
			SPT-9	12.0 - 13.5	0.0	9-10-13	--	
			SPT-10	13.5 - 15.0	0.1	13-16-14	26	
			SPT-11	15.0 - 16.5	1.2	2-3-3	31	
			SPT-12	16.5 - 18.0	1.1	3-4-4	23	
			SPT-13	18.0 - 19.5	1.5	3-4-4	33	
			SPT-14	19.5 - 21.0	1.5	2-3-4	32	
			SPT-15	21.0 - 22.5	1.5	3-4-5	35	
			SPT-16	22.5 - 24.0	1.5	4-5-6	28	
			SPT-17	24.0 - 25.5	0.9	3-4-3	26	
			SPT-18	25.5 - 27.0	0.8	1-1-4	24	
735.6'	28.5'		SPT-19	27.0 - 28.5	1.4	2-3-4	23	
		FAT CLAY, light brown, moist, medium stiff, some fly ash	SPT-20	28.5 - 30.0	1.1	3-4-4	26	
			SPT-21	30.0 - 31.5	1.5	4-5-7	26	Water added at 30.0 ft to keep sand out of augers
731.1'	33.0'		SPT-22	31.5 - 33.0	1.5	6-7-9	25	
		SILTY SAND, light brown, saturated, loose to medium dense, fine to medium grained, some clay	SPT-23	33.0 - 34.5	1.5	7-9-7	20	
			SPT-24	34.5 - 36.0	1.2	1-2-4	20	

FMSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 553730.83, E 2441988.70 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-38** Total Depth 51.3 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SILTY SAND, light brown, saturated, loose to medium dense, fine to medium grained, some clay *(Continued)*		SPT-25	36.0 - 37.5	1.3	4-5-4	23	
				SPT-26	37.5 - 39.0	1.5	1-1-2	21	
				SPT-27	39.0 - 40.5	1.2	4-6-4	22	
				SPT-28	40.5 - 42.0	0.9	WOH-WOH-1	23	
				SPT-29	42.0 - 43.5	1.0	WOR-2-4	22	
				SPT-30	43.5 - 45.0	1.0	WOR-2-4	23	
717.6'	46.5'			SPT-31	45.0 - 46.5	1.2	3-5-5	20	
		SAND, light gray, saturated, dense, fine to medium grained, trace gravel		SPT-32	46.5 - 48.0	1.2	5-7-11	20	Boring backfilled with bentonite cement grout from 0.0 ft to 51.3 ft
715.1'	49.0'			SPT-33	48.0 - 49.5	1.0	21-22-12	18	
		Shale (Augered)		SPT-34	49.5 - 51.0	1.3	8-9-8	--	
712.8'	51.3'			SPT-35	51.0 - 51.3	0.3	50/0.3	--	

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

FMSM_LEGACY 17148117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

Stantec

SUBSURFACE LOG

Project No.	175569042	Location	N 553583.10, E 2441510.71 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-41** Total Depth 63.0 ft
Location	Kingston, Tennessee	Surface Elevation	752.7 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/21/09 Completed 4/21/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	15.0 ft Date/Time 4/21/09
Logged By	Ben Halada	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
752.7'	0.0'	Top of Hole						
		FAT CLAY (Fill), red brown, moist, soft	SPT-1	0.0 - 1.5	1.0	2-4-4	28	Boring advanced using 3 1/4 " Hollow Stem Augers
750.2'	2.5'		SPT-2	1.5 - 3.0	1.3	5-6-6	23	
749.7'	3.0'	BOTTOM ASH (Fill), black, moist, medium dense	SPT-3	3.0 - 4.5	1.3	11-12-7	19	Piston sampler and sucker rods were utilized to obtain recovery during Shelby Tube sampling
		FAT CLAY (Fill), red brown and brown, moist, stiff to very stiff, some gravel	SPT-4	4.5 - 6.0	0.2	6-6-11	15	SPT-4: gravel in spoon
			SPT-5	6.0 - 7.5	1.0	9-8-7	16	
743.7'	9.0'		SPT-6	7.5 - 9.0	1.3	17-34-26	13	
		LEAN CLAY (Fill), red brown and brown, moist, medium stiff, some gravel	SPT-7	9.0 - 10.5	1.1	4-5-5	19	
740.7'	12.0'		SPT-8	10.5 - 12.0	1.1	2-4-6	17	SPT-8: gravel in spoon
		FAT CLAY, brown, moist, soft, some fine grained sand	SPT-9	12.0 - 13.5	1.2	9-11-8	19	
			SPT-10	13.5 - 15.0	1.3	2-2-2	21	
735.7'	17.0'		ST-1	15.0 - 17.0	1.0		--	ST-1: sand in bottom of tube
		SAND, gray, saturated, very loose, fine to medium grained, some clay	SPT-11	17.0 - 18.5	1.0	1-1-1	18	Water added at 17.0 ft to keep augers clear
			SPT-12	18.5 - 20.0	1.3	WOH-WOH-1	19	
			SPT-13	20.0 - 21.5	1.0	WOH-WOH-WOH	23	
			SPT-14	21.5 - 23.0	1.5	WOH-1-1	21	
			SPT-15	23.0 - 24.5	1.3	WOH-1-2	20	
			SPT-16	24.5 - 26.0	1.4	WOH-1-1	18	
			SPT-17	26.0 - 27.5	1.3	WOH-1-1	23	
			SPT-18	27.5 - 29.0	1.4	WOH-1-1	20	
			SPT-19	29.0 - 30.5	1.5	1-WOH-1	19	
720.7'	32.0'		SPT-20	30.5 - 32.0	1.3	1-1-1	24	
		SAND, light gray, saturated, medium dense, medium grained	SPT-21	32.0 - 33.5	1.3	4-5-5	18	
			SPT-22	33.5 - 35.0	1.3	4-4-6	19	
			SPT-23	35.0 - 36.5	1.3	1-3-5	20	

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SUBSURFACE LOG

Project No.	175569042	Location	N 553583.10, E 2441510.71 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-41** Total Depth 63.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
714.7'	38.0'			SPT-24	36.5 - 38.0	0.0	4-5-9	23	SPT-24: shale in tip of spoon
		Shale, (Augered)		SPT-25	38.0 - 39.5	1.0	9-12-21	--	
				SPT-26	39.5 - 41.0	1.1	11-16-23	--	
709.7'	43.0'								Began Core
		Shale, dark gray, silty, very soft, very thin bedded, with very thin to thin limestone layers		0%	3.7	0.7	19	46.7	
				0%	6.3	0.8	13	53.0	
689.7'	63.0'			0%	10.0	2.0	20	63.0	Boring backfilled with bentonite cement grout from 0.0 ft to 63.0 ft

Bottom of Hole

Top of Rock = 38.0'
Elevation (714.7')

WOH = Weight of Hammer
WOR = Weight of Rods

Split Samples: SPT-2

FMSM_LEGACY 17146117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 553623.48, E 2441513.69 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-42** Total Depth 51.5 ft
Location	Kingston, Tennessee	Surface Elevation	764.7 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/16/09 Completed 4/17/09
Supervisor	Ben Phillips Driller Steve Bradford	Depth to Water	27.0 ft Date/Time 4/16/09
Logged By	Ben Phillips	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
764.7'	0.0'	Top of Hole						
763.4'	1.3'	GRAVEL (Fill), Gravel	SPT-1	0.0 - 1.5	1.1	3-5-7	20	Boring advanced using 3 1/4 " Hollow Stem Augers
		FAT CLAY (Fill), brown, moist, medium stiff to stiff, some silt	SPT-2	1.5 - 3.0	1.3	8-10-11	17	
			SPT-3	3.0 - 4.5	1.1	8-8-8	21	Piston sampler and sucker rods were utilized to obtain recovery during Shelby Tube sampling
			SPT-4	4.5 - 6.0	1.2	3-4-5	19	
			SPT-5	6.0 - 7.5	1.1	6-8-10	23	
			SPT-6	7.5 - 9.0	0.5	6-8-8	25	
			SPT-7	9.0 - 10.5	1.5	8-10-13	28	
			SPT-8	10.5 - 12.0	1.5	10-13-18	19	
			ST-1	12.0 - 14.0	1.6		--	
			SPT-9	14.0 - 15.5	1.5	3-4-4	28	
			SPT-10	15.5 - 17.0	1.5	3-5-5	29	
746.3'	18.4'		SPT-11	17.0 - 18.5	1.0	3-5-5	22	
		BOTTOM ASH (Fill), black, moist, medium dense	SPT-12	18.5 - 20.0	1.3	1-2-2	23	
			SPT-13	20.0 - 21.5	1.5	9-11-6	16	
742.7'	22.0'							
741.7'	23.0'	FLY ASH (Fill), black, wet, very loose	SPT-14	21.5 - 23.0	1.5	6-27-9	31	
		BOTTOM ASH (Fill), black, saturated, medium dense	SPT-15	23.0 - 24.5	1.5	5-7-7	24	
739.5'	25.2'		SPT-16	24.5 - 26.0	1.5	3-2-1	14	
738.2'	26.5'	FLY ASH (Fill), black, saturated, very loose	SPT-17	26.0 - 27.5	1.3	3-4-4	22	
		SAND with Clay, brown, wet, loose, some silt	SPT-18	27.5 - 29.0	1.5	3-3-3	23	
			SPT-19	29.0 - 30.5	1.4	2-4-2	19	
			SPT-20	30.5 - 32.0	1.3	3-4-4	20	
731.4'	33.3'		SPT-21	32.0 - 33.5	1.5	2-3-3	23	
		SAND, brown, wet, loose to very dense	SPT-22	33.5 - 35.0	1.5	3-4-5	23	
			SPT-23	35.0 - 36.5	1.5	5-6-6	23	

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SUBSURFACE LOG

Project No.	175569042	Location	N 553623.48, E 2441513.69 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-42** Total Depth 51.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SAND, brown, wet, loose to very dense *(Continued)*		SPT-24	36.5 - 38.0	1.5	3-4-4	21	
				SPT-25	38.0 - 39.5	1.5	4-3-2	23	
				SPT-26	39.5 - 41.0	1.5	2-4-6	22	
				SPT-27	41.0 - 42.5	1.5	4-5-5	22	
				SPT-28	42.5 - 44.0	1.5	9-3-2	22	
				SPT-29	44.0 - 45.5	1.5	4-5-5	20	
				SPT-30	45.5 - 47.0	1.5	3-4-4	22	
				SPT-31	47.0 - 48.5	1.5	14-22-27	22	Boring backfilled with bentonite cement grout from 0.0 ft to 51.5 ft
				SPT-32	48.5 - 50.0	1.5	20-32-45	21	
713.7'	51.0'			SPT-33	50.0 - 51.5	1.5	11-27-40	21	
713.2'	51.5'	Shale, (Augered)							
		Auger Refusal / Bottom of Hole							

FMSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 555020.69, E 2442907.23 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-62** Total Depth 49.0 ft
Location	Kingston, Tennessee	Surface Elevation	749.8 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/8/09 Completed 4/9/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	10.5 ft Date/Time 4/8/09
Logged By	Ben Halada	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
749.8'	0.0'	Top of Hole							
		FAT CLAY (Fill), red brown, moist, medium stiff, some chert		SPT-1	0.0 - 1.5	1.0	2-3-5	24	Boring advanced using 3 1/4 " Hollow Stem Augers
747.3'	2.5'			SPT-2	1.5 - 3.0	1.2	7-15-13	17	
746.8'	3.0'	GRAVEL (Fill), gray, moist, dense							
		BOTTOM ASH 60% / FLY ASH 40% (Fill), black, moist to saturated, loose to medium dense		SPT-3	3.0 - 4.5	1.5	4-5-6	19	Piston sampler and sucker rods were utilized to obtain recovery during Shelby Tube sampling
				SPT-4	4.5 - 6.0	1.3	7-14-15	14	
				SPT-5	6.0 - 7.5	1.0	9-8-6	8	
				SPT-6	7.5 - 9.0	1.0	5-8-6	8	
				SPT-7	9.0 - 10.5	1.1	4-5-5	13	
				SPT-8	10.5 - 12.0	1.1	3-4-4	15	
				SPT-9	12.0 - 13.5	0.8	4-3-3	12	
734.8'	15.0'			SPT-10	13.5 - 15.0	0.2	3-2-2	14	
		SAND, light brown, saturated, very loose, fine grained		SPT-11	15.0 - 16.5	1.5	3-1-1	20	
				SPT-12	16.5 - 18.0	1.3	WOH-WOH-WOH	20	
729.8'	20.0'			SPT-13	18.0 - 19.5	1.0	WOR-WOR-WOR	18	
		SAND, light brown, saturated, very loose, fine grained, some silt		SPT-14	19.5 - 21.0	1.0	WOR-1-1	20	
				SPT-15	21.0 - 22.5	1.1	WOR-WOR-1	21	
				SPT-16	22.5 - 24.0	1.1	WOH-WOH-WOH	23	
724.8'	25.0'			SPT-17	24.0 - 25.5	1.1	WOH-WOH-WOH	24	
		LEAN CLAY, light brown and gray, moist, very soft, some fine grained sand		SPT-18	25.5 - 27.0	1.1	WOH-1-1	23	
				SPT-19	27.0 - 28.5	1.2	WOH-1-2	25	
				ST-1	28.5 - 30.5	2.0		--	
				SPT-20	30.5 - 32.0	1.4	WOH-1-1	22	
716.8'	33.0'			SPT-21	32.0 - 33.5	1.1	4-3-2	25	
715.3'	34.5'	SAND, light brown and light gray, saturated, very loose, fine grained, some clay		SPT-22	33.5 - 35.0	1.3	WOH-WOH-WOH	26	
				SPT-23	35.0 - 36.5	1.1	WOH-WOH-WOH	24	Water added at 35.0 ft to keep augers clear

FMSM_LEGACY 17146B117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 555020.69, E 2442907.23 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-62** Total Depth 49.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SAND, light gray, saturated, very loose, fine grained, some silt *(Continued)*		SPT-24	36.5 - 38.0	1.1	WOH-WOH-WOH	20	
				SPT-25	38.0 - 39.5	1.3	WOH-WOH-1	20	
				SPT-26	39.5 - 41.0	1.3	2-2-2	21	
				SPT-27	41.0 - 42.5	1.3	WOH-1-1	21	
705.8'	44.0'			SPT-28	42.5 - 44.0	1.3	WOH-1-2	22	SPT-30: shale in tip of spoon
		SAND, gray, saturated, medium dense, fine grained, trace silt		SPT-29	44.0 - 45.5	1.1	7-9-15	19	
702.8'	47.0'			SPT-30	45.5 - 47.0	0.8	40-32-25	16	Boring backfilled with bentonite cement grout from 0.0 ft to 49.0 ft
				SPT-31	47.0 - 47.9	0.7	45-50/0.4	--	
700.8'	49.0'	Shale, (Augered)							

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

FMSM_LEGACY 17468117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 554822.75, E 2442910.57 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	STN-63 Total Depth 49.0 ft
Location	Kingston, Tennessee	Surface Elevation	750.0 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/2/09 Completed 4/2/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	10.0 ft Date/Time 4/2/09
Logged By	Ben Halada	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
750.0'	0.0'	Top of Hole						
748.0'	2.0'	LEAN CLAY (Fill), red brown, moist, medium stiff	SPT-1	0.0 - 1.5	1.1	1-4-9	17	Boring advanced using 3 1/4 " Hollow Stem Augers
743.0'	7.0'	BOTTOM ASH (Fill), black, moist, medium dense	SPT-2	1.5 - 3.0	1.3	8-16-14	18	
			SPT-3	3.0 - 4.5	1.3	10-21-14	13	All ST samples recovered using a fixed head piston sampler
			SPT-4	4.5 - 6.0	1.1	5-6-12	13	
			SPT-5	6.0 - 7.5	1.1	7-9-11	18	
734.0'	16.0'	LEAN CLAY (Fill), light brown, moist, soft to medium stiff, some	SPT-6	7.5 - 9.0	0.9	5-6-6	24	
			ST-1	9.0 - 11.0	1.2		--	
			SPT-7	11.0 - 12.5	0.7	1-1-2	24	
			SPT-8	12.5 - 14.0	0.7	1-2-2	24	
			ST-2	14.0 - 16.0	2.0		--	ST-2: sand in bottom to tube
728.0'	22.0'	SAND, gray, saturated, very loose, fine grained	SPT-9	16.0 - 17.5	0.4	WOR-WOR-WOR	30	
			SPT-10	17.5 - 19.0	1.0	WOR-WOH-1	25	
			SPT-11	19.0 - 20.5	1.3	WOR-WOR-WOR	21	
			SPT-12	20.5 - 22.0	0.0	WOH-WOH-WOH	--	
726.0'	24.0'	SILT, brown, saturated, very soft, some fine grained sand, trace clay	SPT-13	22.0 - 23.5	1.1	WOH-1-1	21	
725.0'	25.0'	SAND, light brown, saturated, very loose, fine grained	SPT-14	23.5 - 25.0	1.0	WOR-WOR-1	19	Water added at 23.5 ft to keep augers clear
719.5'	30.5'	SAND, light brown to brown, saturated, very loose, fine grained, some clay	SPT-15	25.0 - 26.5	1.3	1-1-1	23	
			SPT-16	26.5 - 28.0	1.2	WOH-1-1	20	
			SPT-17	28.0 - 29.5	1.1	WOR-WOR-WOR	24	
716.0'	34.0'	SILT, dark gray, saturated, very soft, trace clay	SPT-18	29.5 - 31.0	1.1	WOR-WOH-2	27	
			SPT-19	31.0 - 32.5	1.1	WOH-WOH-WOH	23	
			SPT-20	32.5 - 34.0	0.5	WOH-WOH-WOH	25	
714.0'	36.0'	SAND, brown, saturated, very loose, fine grained, some silt	SPT-21	34.0 - 35.5	1.0	WOH-WOH-2	27	
			SPT-22	35.5 - 37.0	1.4	WOH-	23	

FMSM_LEGACY 17146117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 554822.75, E 2442910.57 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-63** Total Depth 49.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SAND, light gray, saturated, very loose, fine grained, trace silt *(Continued)*		SPT-23	37.0 - 38.5	1.1	WOH-WOH WOH-WOH-WOH	22	
				SPT-24	38.5 - 40.0	1.1	WOR-WOR-WOR	19	
				SPT-25	40.0 - 41.5	1.4	WOR-WOH-1	22	
				SPT-26	41.5 - 43.0	1.1	WOR-WOH-2	25	
				SPT-27	43.0 - 44.5	1.1	1-3-7	32	SPT-28: sandstone in tip of spoon
				SPT-28	44.5 - 46.0	1.3	3-5-14	27	
702.5'	47.5'			SPT-29	46.0 - 47.5	1.1	10-24-28	18	SPT-29: shale in tip of spoon
701.0'	49.0'	Shale, (Augered)		SPT-30	47.5 - 48.9	0.9	20-44-36/0.4	--	Boring backfilled with bentonite cement grout from 0.0 ft to 49.0 ft

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

FMSM_LEGACY 17165117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 554411.29, E 2442911.08 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	STN-64 Total Depth 55.5 ft
Location	Kingston, Tennessee	Surface Elevation	749.4 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/3/09 Completed 4/6/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	8.0 ft Date/Time 4/6/09
Logged By	Ben Halada	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
749.4'	0.0'	Top of Hole							
		FAT CLAY (Fill), red brown, moist, soft to medium stiff, some gravel		SPT-1	0.0 - 1.5	0.7	2-2-3	24	Boring advanced using 3 1/4 " Hollow Stem Augers
746.4'	3.0'			SPT-2	1.5 - 3.0	1.1	3-5-5	23	
		FAT CLAY (Fill), light brown, moist, soft, some bottom ash		SPT-3	3.0 - 4.5	1.1	5-6-6	20	Slope indicator installed with a concrete pad and protective cover, 60.0 ft total (5.0 ft stickup)
743.4'	6.0'			SPT-4	4.5 - 6.0	1.0	5-3-4	21	
741.4'	8.0'	BOTTOM ASH (Fill), black, saturated, loose		SPT-5	6.0 - 7.5	1.2	8-6-5	17	
		LEAN CLAY (Fill), light brown, moist, soft to very soft, some fine grained sand		SPT-6	7.5 - 9.0	0.5	2-2-2	24	Piston sampler and sucker rods were utilized to obtain recovery during Shelby Tube sampling
				SPT-7	9.0 - 10.5	1.0	WOH-1-2	23	
				SPT-8	10.5 - 12.0	1.1	2-2-3	20	Piston sampler and sucker rods were utilized to obtain recovery during Shelby Tube sampling
				SPT-9	12.0 - 13.5	1.0	2-2-5	21	
				ST-1	13.5 - 15.5	1.5		--	
				SPT-10	15.5 - 17.0	0.4	WOH-WOH-WOH	23	
				SPT-11	17.0 - 18.5	1.2	WOH-WOH-WOH	25	
				SPT-12	18.5 - 20.0	1.1	WOH-WOH-WOH	27	
				ST-2	20.0 - 22.0	2.0		--	
726.4'	23.0'			SPT-13	22.0 - 23.5	1.1	WOH-1-1	33	
724.4'	25.0'	SILT, dark gray, saturated, very soft, trace clay		SPT-14	23.5 - 25.0	1.4	WOH-1-2	29	
		LEAN CLAY, gray and brown, saturated, very soft, some silt		SPT-15	25.0 - 26.5	1.1	WOH-WOH-WOH	26	
				SPT-16	26.5 - 28.0	1.1	WOH-1-2	27	
				SPT-17	28.0 - 29.5	1.4	1-2-3	27	
				ST-3	29.5 - 31.5	2.0		--	Water added to 30.0 ft to keep augers clear
				SPT-18	31.5 - 33.0	1.3	1-2-2	25	
				SPT-19	33.0 - 34.5	1.1	1-2-1	22	
714.4'	35.0'			SPT-20	34.5 - 36.0	1.0	WOH-WOH-WOH	21	
		SAND, gray, saturated, loose to very loose, fine grained, trace silt							

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7/16/09

Project No.	175569042	Location	N 554411.29, E 2442911.08 (NAD27)		
Project Name	Kingston Ash Pond	Boring No.	**STN-64**	Total Depth	55.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SAND, gray, saturated, loose to very loose, fine grained, trace silt *(Continued)*		SPT-21	36.0 - 37.5	1.1	WOH-WOH-WOH	20	
				SPT-22	37.5 - 39.0	1.2	WOR-WOR-WOR	22	
				SPT-23	39.0 - 40.5	1.1	2-1-2	19	
				SPT-24	40.5 - 42.0	1.1	WOH-WOH-WOH	20	
				SPT-25	42.0 - 43.5	1.1	2-1-1	22	
				SPT-26	43.5 - 45.0	1.2	2-2-3	28	SPT-26, 27: wood fragments in sample
702.9'	46.5'			SPT-27	45.0 - 46.5	1.4	5-6-6	22	
		Shale, (Augered)		SPT-28	46.5 - 46.8	0.3	50/0.3	--	SPT-28: wood fragments in sample, shale in tip of spoon
				SPT-29	50.0 - 50.5	0.5	50-10/0.0	--	
693.9'	55.5'								Boring backfilled with bentonite cement grout from 0.0 ft to 55.5 ft

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

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SUBSURFACE LOG

Project No.	175569042	Location	N 554147.51, E 2442915.09 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-65** Total Depth 50.0 ft
Location	Kingston, Tennessee	Surface Elevation	748.6 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/7/09 Completed 4/7/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	12.0 ft Date/Time 4/7/09
Logged By	Ben Halada	Automatic Hammer ☒	Safety Hammer ☐ Other ☐

Lithology Elevation	Lithology Depth	Description	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
748.6'	0.0'	Top of Hole						
747.1'	1.5'	GRAVEL (Fill), gray, moist, dense, with clay	SPT-1	0.0 - 1.5	0.2	5-4-7	10	Boring advanced using 3 1/4 " Hollow Stem Augers
		BOTTOM ASH 40% / FLY ASH 60% (Fill), black, saturated, loose	SPT-2	1.5 - 3.0	1.2	8-13-16	20	
			SPT-3	3.0 - 4.5	1.2	9-11-13	18	Piston sampler and sucker rods were utilized to obtain recovery during Shelby Tube sampling
			SPT-4	4.5 - 6.0	1.3	8-7-5	20	
			SPT-5	6.0 - 7.5	1.1	5-7-11	15	
740.1'	8.5'		SPT-6	7.5 - 9.0	1.1	4-6-11	21	
		LEAN CLAY (Fill), brown, moist, very soft to soft	SPT-7	9.0 - 10.5	0.3	3-5-4	19	
			SPT-8	10.5 - 12.0	1.0	5-4-3	20	
			SPT-9	12.0 - 13.5	1.0	4-3-3	19	
			ST-1	13.5 - 15.5	1.9		--	
			SPT-10	15.5 - 17.0	1.2	2-1-1	22	
			SPT-11	17.0 - 18.5	1.0	1-1-2	25	
			ST-2	18.5 - 20.5	1.8		--	
			SPT-12	20.5 - 22.0	1.3	WOH-1-1	25	
			SPT-13	22.0 - 23.5	1.3	WOH-WOH-2	26	SPT-13: wood fragments in sample
724.1'	24.5'		SPT-14	23.5 - 25.0	1.3	WOR-WOH-1	24	
722.1'	26.5'	SILT, gray, moist, very soft	SPT-15	25.0 - 26.5	1.2	WOH-WOH-2	27	
		SILT, brown, saturated, very soft, some clay	SPT-16	26.5 - 28.0	1.1	WOH-2-1	29	
719.1'	29.5'		SPT-17	28.0 - 29.5	1.1	WOH-WOH-WOH	26	SPT-17: wood fragments in sample
		LEAN CLAY, light brown to brown, moist, very soft	SPT-18	29.5 - 31.0	1.0	WOH-WOH-1	28	
			SPT-19	31.0 - 32.5	1.1	4-2-3	29	
			ST-3	32.5 - 34.5	2.0		--	
			SPT-20	34.5 - 36.0	1.0	WOH-WOH-WOH	29	

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SUBSURFACE LOG

Project No.	175569042	Location	N 554147.51, E 2442915.09 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-65** Total Depth 50.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		LEAN CLAY, light brown to brown, moist, very soft *(Continued)*		SPT-21	36.0 - 37.5	1.3	WOH-WOH-WOH	27	
				SPT-22	37.5 - 39.0	1.2	WOH-WOH-WOH	27	
				SPT-23	39.0 - 40.5	1.5	WOH-WOH-1	25	
				SPT-24	40.5 - 42.0	1.3	WOH-WOH-WOH	29	
				SPT-25	42.0 - 43.5	1.4	WOH-WOH-WOH	27	SPT-26: sand in tip of spoon
703.6'	45.0'			SPT-26	43.5 - 45.0	1.1	WOR-WOR-WOR	30	SPT-27: wood fragments in sample
		SAND, light gray, saturated, very loose to loose, fine to medium grained, some fine to medium gravel		SPT-27	45.0 - 46.5	1.1	WOR-2-4	52	SPT-28: wood fragments in sample; shale in tip of spoon
700.6'	48.0'			SPT-28	46.5 - 48.0	1.4	WOH-WOH-WOH	25	Boring backfilled with bentonite cement grout from 0.0 ft to 50.0 ft
				SPT-29	48.0 - 48.7	0.5	20-50/0.2	--	
698.6'	50.0'	Shale, (Augered)							

Auger Refusal /
Bottom of Hole

WOH = Weight of Hammer
WOR = Weight of Rods

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SUBSURFACE LOG

Project No.	175569042	Location	N 553888.83, E 2442564.24 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	STN-66 Total Depth 57.0 ft
Location	Kingston, Tennessee	Surface Elevation	750.9 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	4/8/09 Completed 4/8/09
Supervisor	Ben Halada Driller Kent Clements	Depth to Water	10.0 ft Date/Time 4/8/09
Logged By	Ben Halada	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
750.9'	0.0'	Top of Hole							
		FAT CLAY (Fill), red brown, moist, very soft to soft, some chert		SPT-1	0.0 - 1.5	1.0	5-3-3	15	Boring advanced using 3 1/4 " Hollow Stem Augers
				SPT-2	1.5 - 3.0	1.2	4-2-3	24	
				SPT-3	3.0 - 4.5	1.3	3-5-4	30	Piston sampler and sucker rods were utilized to obtain recovery during Shelby Tube sampling
				ST-1	4.5 - 6.5	1.0		--	
				SPT-4	6.5 - 8.0	1.0	6-4-4	28	
				SPT-5	8.0 - 9.5	1.3	2-3-4	31	
				SPT-6	9.5 - 11.0	1.0	2-3-3	32	
				SPT-7	11.0 - 12.5	1.2	5-5-5	28	
				SPT-8	12.5 - 14.0	1.1	1-2-1	28	
735.9'	15.0'			SPT-9	14.0 - 15.5	0.8	WOH-1-1	34	
		LEAN CLAY (Fill), brown, moist, soft, some gravel, some		SPT-10	15.5 - 17.0	0.5	2-2-4	15	
				SPT-11	17.0 - 18.5	0.8	2-3-4	17	
				SPT-12	18.5 - 20.0	0.5	2-3-12	20	SPT-12: shale in tip of spoon
729.9'	21.0'			SPT-13	20.0 - 21.5	0.5	2-2-2	26	
727.9'	23.0'	FAT CLAY, light brown, saturated, very soft		SPT-14	21.5 - 23.0	0.4	1-1-2	30	
		SILT, gray, saturated, very soft, some clay		SPT-15	23.0 - 24.5	1.1	WOH-WOH-WOH	31	
				SPT-16	24.5 - 26.0	1.2	WOH-WOH-1	27	
723.4'	27.5'			SPT-17	26.0 - 27.5	1.1	WOH-1-2	25	
		SAND, light brown, saturated, very loose, fine grained, some clayey silt		SPT-18	27.5 - 29.0	1.2	1-1-2	22	Water added at 28.0 ft to keep augers clear
				SPT-19	29.0 - 30.5	1.2	WOH-WOH-1	25	
				SPT-20	30.5 - 32.0	1.3	5-4-4	22	
				SPT-21	32.0 - 33.5	1.0	WOH-1-2	22	
715.9'	35.0'			ST-2	33.5 - 35.5	2.0		--	ST-2: sand in bottom to tube
		SAND, brown, saturated, very loose, fine grained, trace silt		SPT-22	35.5 - 37.0	1.5	WOH-1-1	21	

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7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 553888.83, E 2442564.24 (NAD27)		
Project Name	Kingston Ash Pond	Boring No.	**STN-66**	Total Depth	57.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SAND, brown, saturated, very loose, fine grained, trace silt *(Continued)*		SPT-23	37.0 - 38.5	1.4	WOR-WOH-1	20	
711.9'	39.0'								
		SAND, light gray to gray, saturated, very loose to loose, fine grained, trace silt		SPT-24	38.5 - 40.0	1.3	WOR-WOH-WOH	21	
				SPT-25	40.0 - 41.5	1.3	WOR-WOH-WOH	20	
				SPT-26	41.5 - 43.0	1.2	WOH-WOH-WOH	19	
				SPT-27	43.0 - 44.5	1.3	WOH-WOH-WOH	22	
				SPT-28	44.5 - 46.0	1.2	1-2-1	19	
				SPT-29	46.0 - 47.5	1.3	1-WOH-1	21	Wood fragments present in SPT-30, 31, 32 and 34
				SPT-30	47.5 - 49.0	1.0	2-1-1	29	
				SPT-31	49.0 - 50.5	1.4	2-3-3	45	SPT-31: silt lenses
				SPT-32	50.5 - 52.0	1.5	WOR-3-4	36	
				SPT-33	52.0 - 53.5	1.2	WOR-2-2	30	
				SPT-34	53.5 - 55.0	1.2	WOH-2-3	35	Boring backfilled with bentonite cement grout from 0.0 ft to 57.0 ft
695.9'	55.0'			SPT-35	55.0 - 55.5	0.4	50-10/0.0	--	
693.9'	57.0'	Sandstone, (Augered)							
		Auger Refusal / Bottom of Hole							

WOH = Weight of Hammer
WOR = Weight of Rods

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7/16/09

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SUBSURFACE LOG

Project No.	175569042	Location	N 553607.58, E 2441718.01 (NAD27)
Project Name	Kingston Ash Pond	Boring No.	**STN-69** Total Depth 59.5 ft
Location	Kingston, Tennessee	Surface Elevation	752.3 ft. (NGVD29)
Project Type	Geotechnical Exploration	Date Started	5/18/09 Completed 5/20/09
Supervisor	Ben Halada Driller Steve Bradford	Depth to Water	19.5 ft Date/Time 5/18/09
Logged By	Brad Smiley	Automatic Hammer ☒ Safety Hammer ☐ Other ☐	

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
752.3'	0.0'	Top of Hole						
		FAT CLAY with Gravel (Fill), red brown, moist, medium stiff, some gravel, trace	SPT-1	0.0 - 1.5	0.8	3-5-6	22	Boring advanced using 4 1/4 " Hollow Stem Augers
			SPT-2	1.5 - 3.0	1.0	5-6-4	23	
			SPT-3	3.0 - 4.5	1.2	4-8-6	29	
			SPT-4	4.5 - 6.0	1.2	3-3-5	21	
			SPT-5	6.0 - 7.4	0.8	4-50-46/0.4	18	
744.8'	7.5'		SPT-6	7.5 - 7.7	0.2	50/0.2	3	
		LEAN CLAY (Fill), light gray to dark gray, moist, stiff, some shale	SPT-7	9.0 - 10.5	1.3	23-16-16	8	
			SPT-8	10.5 - 12.0	1.1	10-16-8	10	
738.8'	13.5'		SPT-9	12.0 - 13.5	1.0	6-8-11	19	
		LEAN CLAY, red to brown, moist, medium stiff, some chert	SPT-10	13.5 - 15.0	0.4	5-6-5	17	
			SPT-11	15.0 - 16.5	1.2	1-2-3	22	
			SPT-12	16.5 - 18.0	1.5	2-3-4	21	
732.8'	19.5'		SPT-13	18.0 - 19.5	1.5	2-3-3	22	
		SAND, light brown to brown, saturated, loose to medium dense, fine to medium grained, some clay	SPT-14	19.5 - 21.0	1.2	1-2-2	21	
			SPT-15	21.0 - 22.5	1.2	1-1-1	22	
			SPT-16	22.5 - 24.0	1.5	1-1-2	20	
			SPT-17	24.0 - 25.5	1.0	1-1-3	16	Water added at 24.0 ft to keep sand out of augers
			SPT-18	25.5 - 27.0	0.8	1-1-2	24	
			SPT-19	27.0 - 28.5	1.3	WOR-1-2	17	
			SPT-20	28.5 - 30.0	1.0	1-1-1	23	
			SPT-21	30.0 - 31.5	0.9	1-1-1	18	
			SPT-22	31.5 - 33.0	1.2	4-5-5	20	
717.8'	34.5'		SPT-23	33.0 - 34.5	1.5	2-2-4	18	
			SPT-24	34.5 - 36.0	1.5	2-2-5	20	

FMSM_LEGACY 17168117 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

Project No.	175569042	Location	N 553607.58, E 2441718.01 (NAD27)		
Project Name	Kingston Ash Pond	Boring No.	**STN-69**	Total Depth	59.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SAND, brown, moist, medium dense to dense, fine to medium grained *(Continued)*		SPT-25	36.0 - 37.5	1.3	5-8-16	18	
				SPT-26	37.5 - 39.0	1.5	14-8-9	19	
				SPT-27	39.0 - 40.5	0.3	8-9-11	18	
				SPT-28	40.5 - 42.0	1.4	11-17-15	19	
				SPT-29	42.0 - 43.5	1.5	6-5-1	20	
707.3'	45.0'			SPT-30	43.5 - 45.0	1.3	2-2-10	36	
		Shale (Augered)		SPT-31	45.0 - 46.5	0.6	2-8-13	--	
				SPT-32	46.5 - 48.0	0.8	27-28-38	--	
				SPT-33	48.0 - 49.3	0.8	38-47-15/0.3	--	
692.8'	59.5'								Boring backfilled with bentonite cement grout from 0.0 ft to 59.5 ft
		Auger Refusal / Bottom of Hole							

WOH = Weight of Hammer
WOR = Weight of Rods

Slope Indicator (62.5 ft of pipe) installed with a concrete pad and protective cover

FMSM_LEGACY 17146817 KINGSTON ASH POND.GPJ FMSM.GDT 7/16/09

Appendix C

Seismic Hazards

TABLE 9

HAZARD RESULTS FOR THE KINGSTON FOSSIL PLANT

Seismic Sources	Return Period (years)[1]	Annual Probability of Exceedance	PGA[1] (g)	$S_a(0.2)$[2] (g)	$S_a(0.4)$ (g)	$S_a(1.0)$ (g)	$S_a(2.0)$ (g)	$S_a(4.0)$ (g)
New Madrid Seismic Zone	2,500	0.0004	0.0382	0.0717	0.0629	0.0375	0.0260	0.0134
	1,500	0.00067	0.0282	0.0545	0.0479	0.0261	0.0164	0.0086
	1,000	0.001	0.0209	0.0406	0.0351	0.0172	0.0114	0.0052
	500	0.002	0.0055	0.0123	0.0112	0.0045	0.0031	0.0012
	250	0.004	0	0	0	0	0	0
	100	0.01	0	0	0	0	0	0
All Other Seismic Sources	2,500	0.0004	0.1082	0.1399	0.0837	0.0368	0.0225	0.0102
	1,500	0.00067	0.0764	0.1023	0.0622	0.0272	0.0161	0.0070
	1,000	0.001	0.0578	0.0786	0.0490	0.0209	0.0124	0.0052
	500	0.002	0.0349	0.0500	0.0316	0.0132	0.0075	0.0031
	250	0.004	0.0202	0.0303	0.0188	0.0079	0.0042	0.0016
	100	0.01	0.0084	0.0135	0.0091	0.0035	0.0017	0.0006

Notes
1. Peak ground acceleration
2. $S_a(0.2)$ refers to the 5% damped spectral acceleration at a spectral period of 0.2 seconds (spectral frequency of 5 cycles/sec).

TABLE 32

HAZARD RESULTS FOR THE KINGSTON FOSSIL PLANT AT 1% DAMPING LEVEL

Seismic Sources	Return Period (years)[1]	Annual Probability of Exceedance	PGA[1] (g)	$S_a(0.2)$[2] (g)	$S_a(0.4)$ (g)	$S_a(1.0)$ (g)	$S_a(2.0)$ (g)	$S_a(4.0)$ (g)
New Madrid Seismic Zone	2,500	0.0004	0.0382	0.1169	0.0975	0.0553	0.0369	0.0185
	1,500	0.00067	0.0282	0.0889	0.0743	0.0385	0.0233	0.0118
	1,000	0.001	0.0209	0.0662	0.0544	0.0254	0.0162	0.0072
	500	0.002	0.0055	0.0201	0.0174	0.0066	0.0044	0.0016
	250	0.004	0	0	0	0	0	0
	100	0.01	0	0	0	0	0	0
All Other Seismic Sources	2,500	0.0004	0.1082	0.2282	0.1298	0.0538	0.0313	0.0136
	1,500	0.00067	0.0764	0.1669	0.0964	0.0398	0.0223	0.0093
	1,000	0.001	0.0578	0.1282	0.0760	0.0306	0.0172	0.0069
	500	0.002	0.0349	0.0816	0.0490	0.0193	0.0104	0.0041
	250	0.004	0.0202	0.0494	0.0291	0.0115	0.0058	0.0021
	100	0.01	0.0084	0.0220	0.0141	0.0051	0.0023	0.0008

Notes
1. Peak ground acceleration
2. $S_a(0.2)$ refers to the 1% damped spectral acceleration at a spectral period of 0.2 seconds (spectral frequency of 5 cycles/sec).

TABLE 33

HAZARD RESULTS FOR THE KINGSTON FOSSIL PLANT AT 3% DAMPING LEVEL

Seismic Sources	Return Period (years)[1]	Annual Probability of Exceedance	PGA[1] (g)	$S_a(0.2)$[2] (g)	$S_a(0.4)$ (g)	$S_a(1.0)$ (g)	$S_a(2.0)$ (g)	$S_a(4.0)$ (g)
New Madrid Seismic Zone	2,500	0.0004	0.0382	0.0851	0.0737	0.0434	0.0298	0.0152
	1,500	0.00067	0.0282	0.0647	0.0561	0.0302	0.0188	0.0098
	1,000	0.001	0.0209	0.0482	0.0411	0.0199	0.0131	0.0059
	500	0.002	0.0055	0.0146	0.0131	0.0052	0.0035	0.0014
	250	0.004	0	0	0	0	0	0
	100	0.01	0	0	0	0	0	0
All Other Seismic Sources	2,500	0.0004	0.1082	0.1660	0.0980	0.0424	0.0256	0.0115
	1,500	0.00067	0.0764	0.1214	0.0729	0.0314	0.0183	0.0079
	1,000	0.001	0.0578	0.0933	0.0574	0.0241	0.0141	0.0058
	500	0.002	0.0349	0.0593	0.0370	0.0152	0.0085	0.0035
	250	0.004	0.0202	0.0360	0.0220	0.0091	0.0048	0.0018
	100	0.01	0.0084	0.0160	0.0107	0.0040	0.0019	0.0007

Notes
1. Peak ground acceleration
2. $S_a(0.2)$ refers to the 3% damped spectral acceleration at a spectral period of 0.2 seconds (spectral frequency of 5 cycles/sec).

TABLE 34

HAZARD RESULTS FOR THE KINGSTON FOSSIL PLANT AT 7% DAMPING LEVEL

Seismic Sources	Return Period (years)[1]	Annual Probability of Exceedance	PGA[1] (g)	$S_a(0.2)$[2] (g)	$S_a(0.4)$ (g)	$S_a(1.0)$ (g)	$S_a(2.0)$ (g)	$S_a(4.0)$ (g)
New Madrid Seismic Zone	2,500	0.0004	0.0382	0.0636	0.0561	0.0337	0.0234	0.0121
	1,500	0.00067	0.0282	0.0483	0.0427	0.0234	0.0148	0.0078
	1,000	0.001	0.0209	0.0360	0.0313	0.0154	0.0103	0.0047
	500	0.002	0.0055	0.0109	0.0100	0.0040	0.0028	0.0011
	250	0.004	0	0	0	0	0	0
	100	0.01	0	0	0	0	0	0
All Other Seismic Sources	2,500	0.0004	0.1082	0.1241	0.0747	0.0331	0.0204	0.0093
	1,500	0.00067	0.0764	0.0907	0.0555	0.0245	0.0146	0.0064
	1,000	0.001	0.0578	0.0697	0.0437	0.0188	0.0113	0.0048
	500	0.002	0.0349	0.0444	0.0282	0.0119	0.0068	0.0028
	250	0.004	0.0202	0.0269	0.0168	0.0071	0.0038	0.0015
	100	0.01	0.0084	0.0120	0.0081	0.0032	0.0016	0.0006

Notes
1. Peak ground acceleration
2. $S_a(0.2)$ refers to the 7% damped spectral acceleration at a spectral period of 0.2 seconds (spectral frequency of 5 cycles/sec).

TABLE 35

HAZARD RESULTS FOR THE KINGSTON FOSSIL PLANT AT 10% DAMPING LEVEL

Seismic Sources	Return Period (years)[1]	Annual Probability of Exceedance	PGA[1] (g)	$S_a(0.2)$[2] (g)	$S_a(0.4)$ (g)	$S_a(1.0)$ (g)	$S_a(2.0)$ (g)	$S_a(4.0)$ (g)
New Madrid Seismic Zone	2,500	0.0004	0.0382	0.0557	0.0493	0.0297	0.0207	0.0107
	1,500	0.00067	0.0282	0.0424	0.0376	0.0207	0.0131	0.0069
	1,000	0.001	0.0209	0.0316	0.0275	0.0136	0.0091	0.0042
	500	0.002	0.0055	0.0096	0.0088	0.0036	0.0025	0.0010
	250	0.004	0	0	0	0	0	0
	100	0.01	0	0	0	0	0	0
All Other Seismic Sources	2,500	0.0004	0.1082	0.1087	0.0656	0.0293	0.0182	0.0083
	1,500	0.00067	0.0764	0.0795	0.0488	0.0217	0.0130	0.0057
	1,000	0.001	0.0578	0.0611	0.0384	0.0166	0.0100	0.0043
	500	0.002	0.0349	0.0389	0.0248	0.0105	0.0061	0.0025
	250	0.004	0.0202	0.0236	0.0147	0.0063	0.0034	0.0013
	100	0.01	0.0084	0.0105	0.0071	0.0028	0.0014	0.0005

Notes

1. Peak ground acceleration
2. $S_a(0.2)$ refers to the 10% damped spectral acceleration at a spectral period of 0.2 seconds (spectral frequency of 5 cycles/sec).

Appendix D

Ground Response

Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	119+69		Default value, user can modify
Seismic Zone:	All Other Zones		Calculated value
# of Layers	5		Calculated value, unoptimized
Total Thickness	25.3	feet	

Global Inputs:

PGA_{SOIL}	0.0724	
Groundwater Elevation (Z_{GW})	736.93	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γ_w	62.4	pcf
$G/G_{MAX,TOL}$	1.00%	
$G/G_{MAX,ACTUAL}$	0.90%	

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
510.0	0.1984	4.004	787.1

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Rock Fill	738.52	736.93	737.7	0.8	2.65	128	128	1	0
2	Rock Fill	736.93	726.59	731.8	6.8	2.65	128	128	1	0
3	Clay	726.59	721.69	724.1	14.4	2.7	130	130	1	0
4	Sand	721.69	718.91	720.3	18.2	2.65	128	128	1	0
5	Sand	718.91	713.22	716.1	22.5	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	119+69		Default value, user can modify
Seismic Zone:	New Madrid		Calculated value
# of Layers	5		Calculated value, unoptimized
Total Thickness	25.3	feet	

Global Inputs:

PGA_{SOIL}	0.039	
Groundwater Elevation (Z_{GW})	736.93	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γw	62.4	pcf
$G/G_{MAX,TOL}$	1.00%	
$G/G_{MAX,ACTUAL}$	0.90%	

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
532.5	0.1901	2.841	864.4

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Rock Fill	738.52	736.93	737.7	0.8	2.65	128	128	1	0
2	Rock Fill	736.93	726.59	731.8	6.8	2.65	128	128	1	0
3	Clay	726.59	721.69	724.1	14.4	2.7	130	130	1	0
4	Sand	721.69	718.91	720.3	18.2	2.65	128	128	1	0
5	Sand	718.91	713.22	716.1	22.5	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	119+69		Default value, user can modify
Seismic Zone:	All Other Zones		Calculated value
# of Layers	7		Calculated value, unoptimized
Total Thickness	43.86	feet	

Global Inputs:

PGA_{SOIL}	0.073	
Groundwater Elevation (Z_{GW})	746.36	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γ_w	62.4	pcf
$G/G_{MAX,TOL}$	1.00%	
$G/G_{MAX,ACTUAL}$	0.90%	

(19) Composite Shear Wave Velocity	(20) Natural Period	(22) Composite Damping Ratio	Interpolated Return Period
$\overline{V}_S$	T	$\overline{\xi}$ %	(years)
613.8	0.2858	4.135	1046.3

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Clay	758.95	746.36	752.7	6.3	2.7	130	130	1	0
2	Clay	746.36	743.52	744.9	14.0	2.7	130	130	1	0
3	Fly Ash	743.52	735.98	739.8	19.2	2.3	107	107	1	0
4	Fly Ash	735.98	735.02	735.5	23.5	2.3	107	107	1	0
5	Clay	735.02	729.42	732.2	26.7	2.7	130	130	1	0
6	Sand	729.42	721.54	725.5	33.5	2.65	128	128	1	0
7	Sand	721.54	715.09	718.3	40.6	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	119+69		Default value, user can modify
Seismic Zone:	New Madrid		Calculated value
# of Layers	7		Calculated value, unoptimized
Total Thickness	43.86	feet	

Global Inputs:

PGA_{SOIL}	0.039	
Groundwater Elevation (Z_{GW})	746.36	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γw	62.4	pcf
$G/G_{MAX,TOL}$	1.00%	
$G/G_{MAX,ACTUAL}$	0.90%	

(19) Composite Shear Wave Velocity $\bar{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\bar{\xi}$ %	Interpolated Return Period (years)
645.7	0.2717	2.794	872.8

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations Z_{TOP} (feet)	Elevations Z_{BOTTOM} (feet)	Elevations Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Clay	758.95	746.36	752.7	6.3	2.7	130	130	1	0
2	Clay	746.36	743.52	744.9	14.0	2.7	130	130	1	0
3	Fly Ash	743.52	735.98	739.8	19.2	2.3	107	107	1	0
4	Fly Ash	735.98	735.02	735.5	23.5	2.3	107	107	1	0
5	Clay	735.02	729.42	732.2	26.7	2.7	130	130	1	0
6	Sand	729.42	721.54	725.5	33.5	2.65	128	128	1	0
7	Sand	721.54	715.09	718.3	40.6	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	119+69		Default value, user can modify
Seismic Zone:	All Other Zones		Calculated value
# of Layers	8		Calculated value, unoptimized
Total Thickness	38.73	feet	

Global Inputs:

PGA_{SOIL}	0.073	
Groundwater Elevation (Z_{GW})	737.36	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γw	62.4	pcf
$G/G_{MAX,TOL}$	1.00%	
$G/G_{MAX,ACTUAL}$	0.90%	

(19) Composite Shear Wave Velocity	(20) Natural Period	(22) Composite Damping Ratio	Interpolated Return Period
$\overline{V}_S$	T	$\overline{\xi}$ %	(years)
677.1	0.2288	4.098	870.9

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations			Overburden	Specific Gravity	Moist Unit Weight	Saturated Unit Weight	Over-consolidation Ratio	Plasticity Index
		Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	(feet)	G_S	γ_{DRY} (pcf)	γ_{SAT} (pcf)	OCR	PI
1	Rock Fill	751.82	740.85	746.3	5.5	2.65	128	128	1	0
2	Clay	740.85	738.98	739.9	11.9	2.7	130	130	1	0
3	Clay	738.98	737.36	738.2	13.7	2.7	130	130	1	0
4	Clay	737.36	733.98	735.7	16.2	2.7	130	130	1	0
5	Fly Ash	733.98	733.01	733.5	18.3	2.3	107	107	1	0
6	Clay	733.01	721.59	727.3	24.5	2.7	130	130	1	0
7	Sand	721.59	718.97	720.3	31.5	2.65	128	128	1	0
8	Sand	718.97	713.09	716.0	35.8	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	119+69		Default value, user can modify
Seismic Zone:	New Madrid		Calculated value
# of Layers	8		Calculated value, unoptimized
Total Thickness	38.73	feet	

Global Inputs:

PGA_{SOIL}	0.039	
Groundwater Elevation (Z_{GW})	737.36	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γ_w	62.4	pcf
$G/G_{MAX,TOL}$	1.00%	
$G/G_{MAX,ACTUAL}$	0.90%	

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
708.1	0.2188	2.878	858.2

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Rock Fill	751.82	740.85	746.3	5.5	2.65	128	128	1	0
2	Clay	740.85	738.98	739.9	11.9	2.7	130	130	1	0
3	Clay	738.98	737.36	738.2	13.7	2.7	130	130	1	0
4	Clay	737.36	733.98	735.7	16.2	2.7	130	130	1	0
5	Fly Ash	733.98	733.01	733.5	18.3	2.3	107	107	1	0
6	Clay	733.01	721.59	727.3	24.5	2.7	130	130	1	0
7	Sand	721.59	718.97	720.3	31.5	2.65	128	128	1	0
8	Sand	718.97	713.09	716.0	35.8	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	132+37		Default value, user can modify
Seismic Zone:	All Other Zones		Calculated value
# of Layers	6		Calculated value, unoptimized
Total Thickness	55.06	feet	

Global Inputs:

PGA_{SOIL}	0.083	
Groundwater Elevation (Z_{GW})	755.13	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γ_w	62.4	pcf
$G/G_{MAX,TOL}$	0.20%	
$G/G_{MAX,ACTUAL}$	0.18%	

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
530.2	0.4154	6.239	> 2500

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Clay	755.13	743.06	749.1	6.0	2.7	130	130	1	0
2	Fly Ash	743.06	730.88	737.0	18.2	2.3	107	107	1	0
3	Sand	730.88	720.88	725.9	29.3	2.65	128	128	1	0
4	Sand	720.88	710.88	715.9	39.3	2.65	128	128	1	0
5	Sand	710.88	705.64	708.3	46.9	2.65	128	128	1	0
6	Sand	705.64	700.07	702.9	52.3	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	132+37		Default value, user can modify
Seismic Zone:	New Madrid		Calculated value
# of Layers	6		Calculated value, unoptimized
Total Thickness	55.06	feet	

Global Inputs:

PGA_{SOIL}	0.039	
Groundwater Elevation (Z_{GW})	755.13	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γw	62.4	pcf
$G/G_{MAX,TOL}$	0.20%	
$G/G_{MAX,ACTUAL}$	0.18%	

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

(19) Composite Shear Wave Velocity	(20) Natural Period	(22) Composite Damping Ratio	Interpolated Return Period
$\overline{V}_S$	T	$\overline{\xi}$ %	(years)
582.0	0.3784	3.638	983.4

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Clay	755.13	743.06	749.1	6.0	2.7	130	130	1	0
2	Fly Ash	743.06	730.88	737.0	18.2	2.3	107	107	1	0
3	Sand	730.88	720.88	725.9	29.3	2.65	128	128	1	0
4	Sand	720.88	710.88	715.9	39.3	2.65	128	128	1	0
5	Sand	710.88	705.64	708.3	46.9	2.65	128	128	1	0
6	Sand	705.64	700.07	702.9	52.3	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	132+37		Default value, user can modify
Seismic Zone:	All Other Zones		Calculated value
# of Layers	8		Calculated value, unoptimized
Total Thickness	53.01	feet	

Global Inputs:

PGA_{SOIL}	0.08	
Groundwater Elevation (Z_{GW})	745.06	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γw	62.4	pcf
$G/G_{MAX,TOL}$	1.00%	
$G/G_{MAX,ACTUAL}$	0.90%	

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
584.9	0.3625	5.102	1937.7

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Rock Fill	748.93	745.06	747.0	1.9	2.65	128	128	1	0
2	Fly Ash	745.06	743.16	744.1	4.8	2.3	111	111	1	0
3	Clay	743.16	731.52	737.3	11.6	2.7	130	130	1	0
4	Fly Ash	731.52	730.93	731.2	17.7	2.3	107	107	1	0
5	Sand	730.93	720.93	725.9	23.0	2.65	128	128	1	0
6	Sand	720.93	710.93	715.9	33.0	2.65	128	128	1	0
7	Sand	710.93	706.1	708.5	40.4	2.65	128	128	1	0
8	Sand	706.1	695.92	701.0	47.9	2.65	128	128	1	0
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10										
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12										
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16										
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22										
23										
24										
25										

Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	132+37		Default value, user can modify
Seismic Zone:	New Madrid		Calculated value
# of Layers	8		Calculated value, unoptimized
Total Thickness	53.01	feet	

Global Inputs:

PGA_{SOIL}	0.045	
Groundwater Elevation (Z_{GW})	745.06	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
Υw	62.4	pcf
$G/G_{MAX,TOL}$	1.00%	
$G/G_{MAX,ACTUAL}$	0.90%	

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
623.2	0.3403	3.522	1116.9

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight Υ_{DRY} (pcf)	Saturated Unit Weight Υ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Rock Fill	748.93	745.06	747.0	1.9	2.65	128	128	1	0
2	Fly Ash	745.06	743.16	744.1	4.8	2.3	111	111	1	0
3	Clay	743.16	731.52	737.3	11.6	2.7	130	130	1	0
4	Fly Ash	731.52	730.93	731.2	17.7	2.3	107	107	1	0
5	Sand	730.93	720.93	725.9	23.0	2.65	128	128	1	0
6	Sand	720.93	710.93	715.9	33.0	2.65	128	128	1	0
7	Sand	710.93	706.1	708.5	40.4	2.65	128	128	1	0
8	Sand	706.1	695.92	701.0	47.9	2.65	128	128	1	0
9										
10										
11										
12										
13										
14										
15										
16										
17										
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19										
20										
21										
22										
23										
24										
25										

Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	132+37		Default value, user can modify
Seismic Zone:	All Other Zones		Calculated value
# of Layers	7		Calculated value, unoptimized
Total Thickness	53.94	feet	

Global Inputs:

PGA_{SOIL}	0.08	
Groundwater Elevation (Z_{GW})	755.11	feet
Additional Vert. Stress	97.968	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γ_w	62.4	pcf
$G/G_{MAX,TOL}$	0.20%	
$G/G_{MAX,ACTUAL}$	0.18%	

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
514.9	0.4191	6.625	> 2500

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations Z_{TOP} (feet)	Elevations Z_{BOTTOM} (feet)	Elevations Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Fly Ash	753.54	752.15	752.8	0.7	2.3	107	107	1	0
2	Clay	752.15	743.1	747.6	5.9	2.7	130	130	1	0
3	Fly Ash	743.1	730.77	736.9	16.6	2.3	107	107	1	0
4	Sand	730.77	720.77	725.8	27.8	2.65	128	128	1	0
5	Sand	720.77	710.77	715.8	37.8	2.65	128	128	1	0
6	Sand	710.77	706.06	708.4	45.1	2.65	128	128	1	0
7	Sand	706.06	699.6	702.8	50.7	2.65	128	128	1	0
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23										
24										
25										

Seismic Risk Assessment

Plant:	Kingston Fossil Plant	
Facility:	Stilling Pond	
Section:	132+37	
Seismic Zone:	New Madrid	
# of Layers	7	
Total Thickness	53.94	feet

	User Input
	Drop-down selection
	Default value, user can modify
	Calculated value
	Calculated value, unoptimized

Global Inputs:

PGA_{SOIL}	0.045	
Groundwater Elevation (Z_{GW})	755.11	feet
Additional Vert. Stress	97.968	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
γ_w	62.4	pcf
$G/G_{MAX,TOL}$	0.20%	
$G/G_{MAX,ACTUAL}$	0.18%	

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
558.8	0.3861	4.272	1266.3

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Layer	Material	Elevations Z_{TOP} (feet)	Elevations Z_{BOTTOM} (feet)	Elevations Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight γ_{DRY} (pcf)	Saturated Unit Weight γ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Fly Ash	753.54	752.15	752.8	0.7	2.3	107	107	1	0
2	Clay	752.15	743.1	747.6	5.9	2.7	130	130	1	0
3	Fly Ash	743.1	730.77	736.9	16.6	2.3	107	107	1	0
4	Sand	730.77	720.77	725.8	27.8	2.65	128	128	1	0
5	Sand	720.77	710.77	715.8	37.8	2.65	128	128	1	0
6	Sand	710.77	706.06	708.4	45.1	2.65	128	128	1	0
7	Sand	706.06	699.6	702.8	50.7	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	132+37		Default value, user can modify
Seismic Zone:	All Other Zones		Calculated value
# of Layers	8		Calculated value, unoptimized
Total Thickness	53.88	feet	

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Global Inputs:

PGA_{SOIL}	0.073	
Groundwater Elevation (Z_{GW})	745.16	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
Yw	62.4	pcf
$G/G_{MAX,TOL}$	0.20%	
$G/G_{MAX,ACTUAL}$	0.18%	

(19) Composite Shear Wave Velocity $\overline{V}_S$	(20) Natural Period T	(22) Composite Damping Ratio $\overline{\xi}$ %	Interpolated Return Period (years)
597.1	0.3609	4.799	1568.9

Layer	Material	Elevations Z_{TOP} (feet)	Elevations Z_{BOTTOM} (feet)	Elevations Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight Υ_{DRY} (pcf)	Saturated Unit Weight Υ_{SAT} (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Rock Fill	750.08	745.16	747.6	2.5	2.65	128	128	1	0
2	Fly Ash	745.16	743.02	744.1	6.0	2.3	111	111	1	0
3	Clay	743.02	731.74	737.4	12.7	2.7	130	130	1	0
4	Fly Ash	731.74	730.95	731.3	18.7	2.3	107	107	1	0
5	Sand	730.95	720.95	726.0	24.1	2.65	128	128	1	0
6	Sand	720.95	710.95	716.0	34.1	2.65	128	128	1	0
7	Sand	710.95	706.07	708.5	41.6	2.65	128	128	1	0
8	Sand	706.07	696.2	701.1	48.9	2.65	128	128	1	0
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Seismic Risk Assessment

Plant:	Kingston Fossil Plant		User Input
Facility:	Stilling Pond		Drop-down selection
Section:	132+37		Default value, user can modify
Seismic Zone:	New Madrid		Calculated value
# of Layers	8		Calculated value, unoptimized
Total Thickness	53.88	feet	

Calculation Checks:

$G/G_{MAX,ACTUAL}$ Ratio OK

Global Inputs:

PGA_{SOIL}	0.039	
Groundwater Elevation (Z_{GW})	745.16	feet
Additional Vert. Stress	0	psf
Pa	2116.8	psf
k	0	
Ko	0.5	
g	32.2	ft/s2
Ɣw	62.4	pcf
$G/G_{MAX,TOL}$	0.20%	
$G/G_{MAX,ACTUAL}$	0.18%	

(19) Composite Shear Wave Velocity	(20) Natural Period	(22) Composite Damping Ratio	Interpolated Return Period
$\overline{V}_S$	T	$\overline{\xi}$ %	(years)
636.0	0.3389	3.244	940.3

Layer	Material	Elevations Z_{TOP} (feet)	Z_{BOTTOM} (feet)	Z_{MID} (feet)	Overburden (feet)	Specific Gravity G_S	Moist Unit Weight $Ɣ_{DRY}$ (pcf)	Saturated Unit Weight $Ɣ_{SAT}$ (pcf)	Over-consolidation Ratio OCR	Plasticity Index PI
1	Rock Fill	750.08	745.16	747.6	2.5	2.65	128	128	1	0
2	Fly Ash	745.16	743.02	744.1	6.0	2.3	111	111	1	0
3	Clay	743.02	731.74	737.4	12.7	2.7	130	130	1	0
4	Fly Ash	731.74	730.95	731.3	18.7	2.3	107	107	1	0
5	Sand	730.95	720.95	726.0	24.1	2.65	128	128	1	0
6	Sand	720.95	710.95	716.0	34.1	2.65	128	128	1	0
7	Sand	710.95	706.07	708.5	41.6	2.65	128	128	1	0
8	Sand	706.07	696.2	701.1	48.9	2.65	128	128	1	0
9										
10										
11										
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Appendix E

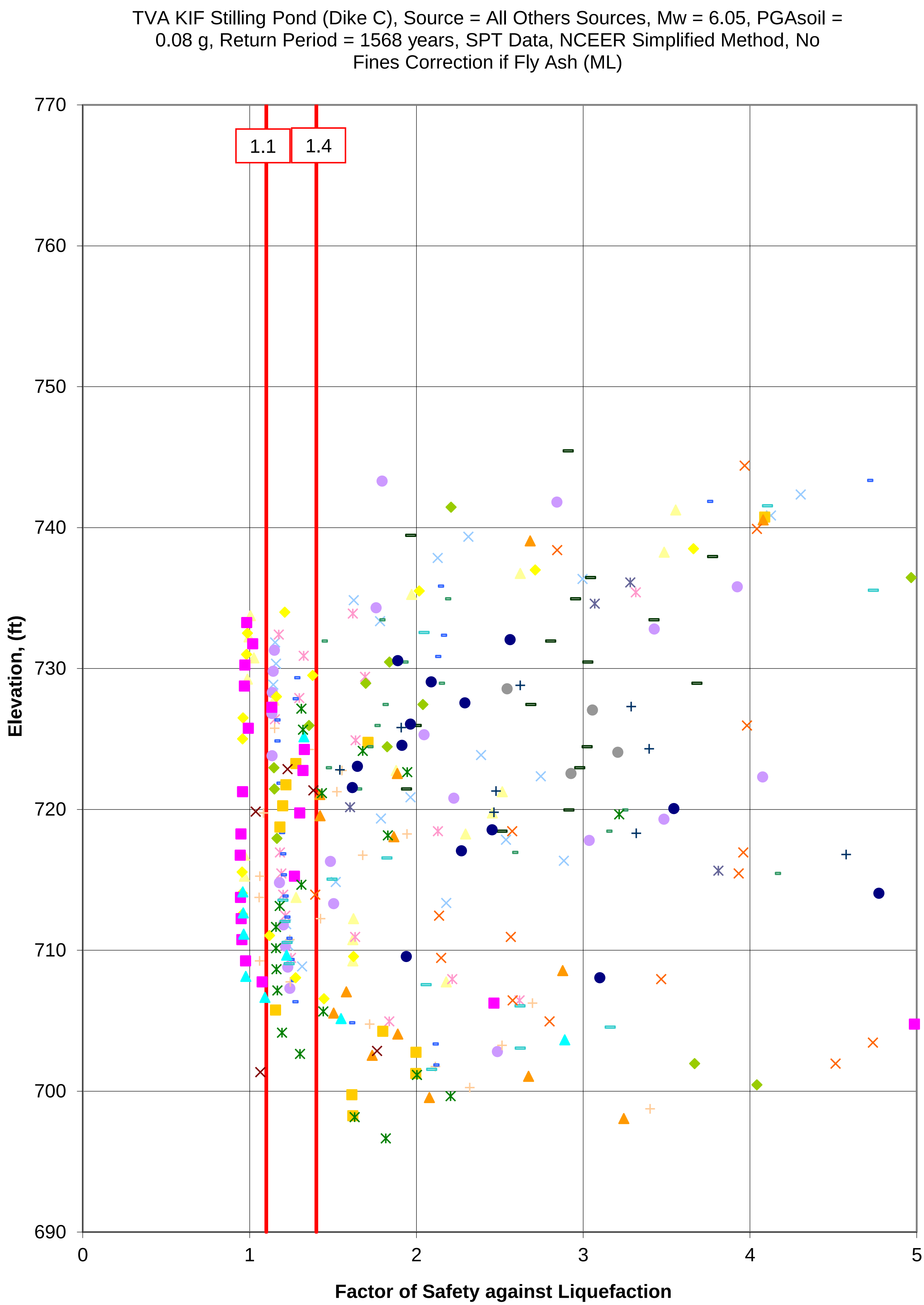
Liquefaction Analysis

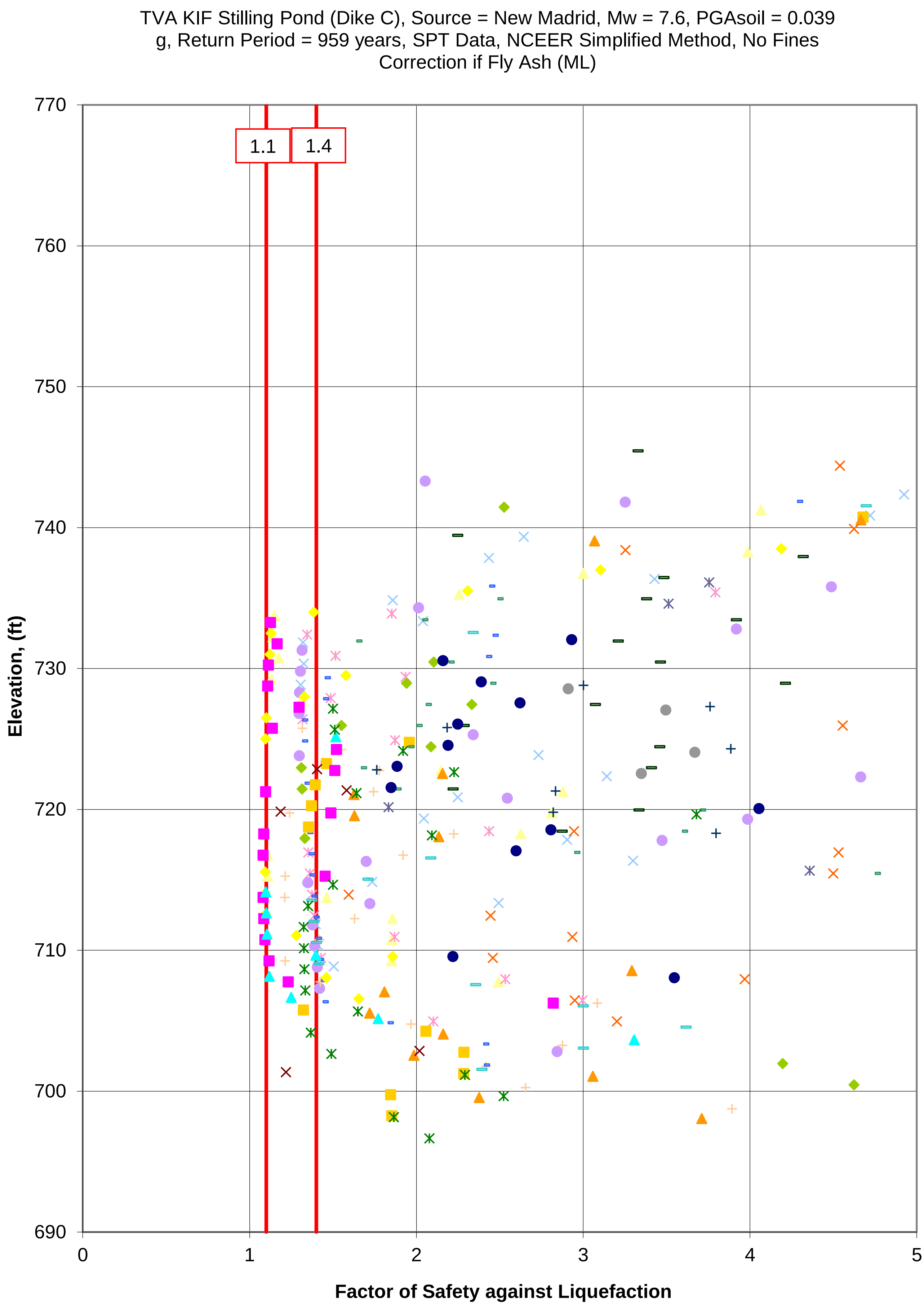
Liquefaction Potential – Limiting Earthquakes that Cause Liquefaction

Liquefiable Material	Source	Profile Location	Return Period (years)	PGA_{rock} [1] (g)	M_{rep} [1] (M)	a_{max} (g)	Amplification Ratio (a_{max}/PGA_{rock})
Ash Subgrade	New Madrid	119+69 (Outward)	864	0.0158	7.58	0.039	2.47
		132+37 (Inward)	983	0.0202	7.60	0.039	1.93
		132+37 (Outward)	1117	0.0227	7.62	0.045	1.98
	All Other Sources	119+69 (Outward)	787	0.0486	6.07	0.0724	1.49
		132+37 (Inward)	>2500	0.1082	6.04	0.083	0.77
		132+37 (Outward)	1938	0.0910	6.05	0.08	0.88
Ash Subgrade and Alluvial Sands	New Madrid	119+69 (Inward)	873	0.0161	7.58	0.039	2.42
		119+69 (Outward)	858	0.0156	7.58	0.039	2.50
		132+37 (Inward)	1266	0.0249	7.63	0.045	1.81
		132+37 (Outward)	940	0.0186	7.59	0.039	2.10
	All Other Sources	119+69 (Inward)	1046	0.0596	6.06	0.073	1.22
		119+69 (Outward)	871	0.0523	6.07	0.073	1.40
		132+37 (Inward)	>2500	0.1082	6.04	0.08	0.74
		132+37 (Outward)	1569	0.0788	6.05	0.073	0.93

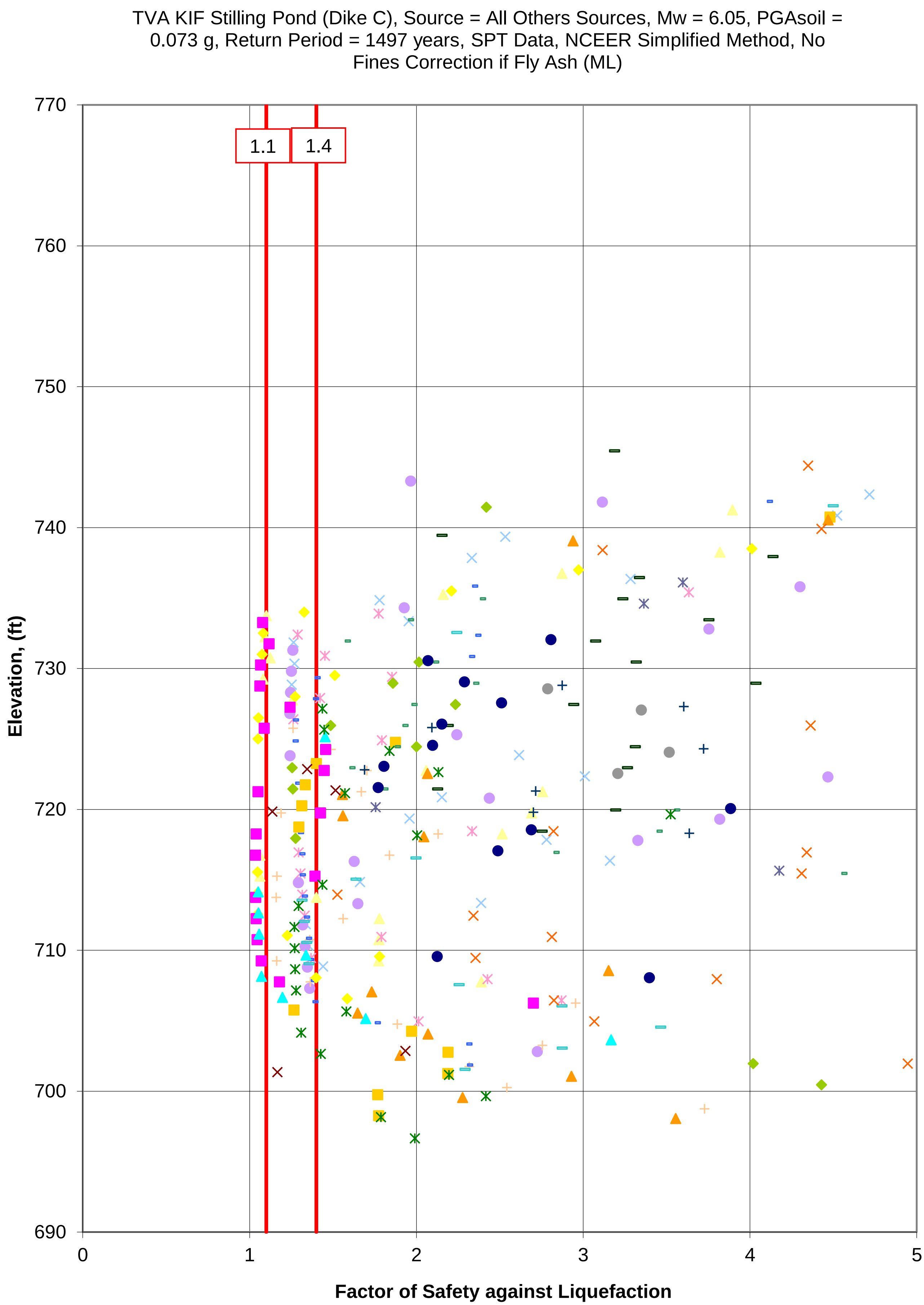
[1]For return periods greater than 2,500 years, the reported PGA_{rock} and M_{rep} values are representative of the 2,500 year event.

Liquefiable Material	Average Return Period (years)		Average Annual Probability of Exceedance		Total Annual Probability of Exceedance for Liquefaction	Probability of Exceedance for Liquefaction during Remaining Service Life
	All Other Sources	New Madrid	All Other Sources	New Madrid		
Ash Subgrade	1568	959	0.06%	0.10%	0.17%	0.84%
Ash Subgrade & Alluvial Sands	1497	984	0.07%	0.10%	0.17%	0.84%

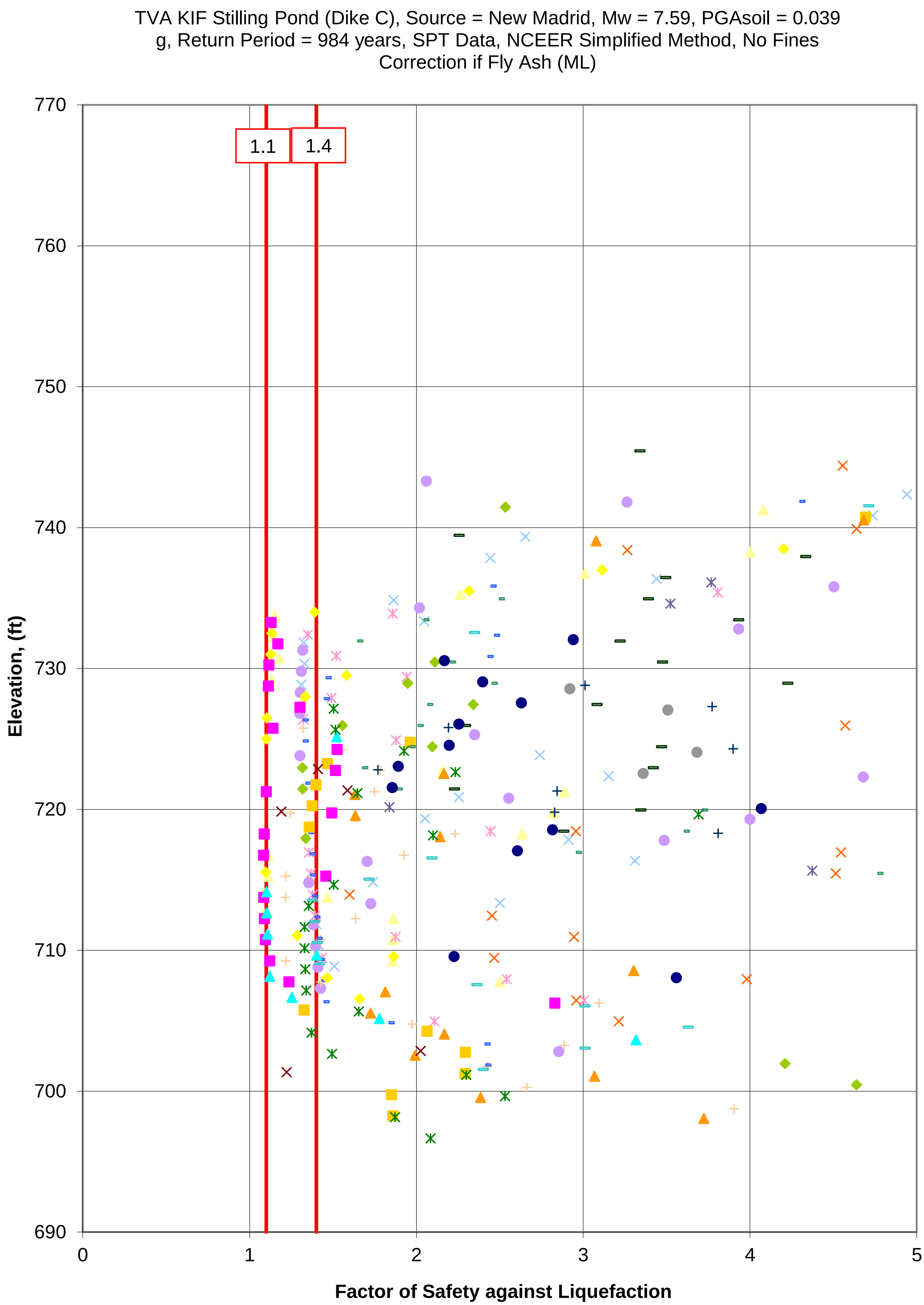

TVA KIF Stilling Pond (Dike C), Source = All Others Sources, Mw = 6.05, PGAsoil = 0.08 g, Return Period = 1568 years, SPT Data, NCEER Simplified Method, No Fines Correction if Fly Ash (ML)
1.1
1.4
Elevation, (ft)
770
760
750
740
730
720
710
700
690
0
1
2
3
4
5
Factor of Safety against Liquefaction



TVA KIF Stilling Pond (Dike C), Source = New Madrid, Mw = 7.6, PGAsoil = 0.039 g, Return Period = 959 years, SPT Data, NCEER Simplified Method, No Fines Correction if Fly Ash (ML)
1.1
1.4
Elevation, (ft)
770
760
750
740
730
720
710
700
690
0
1
2
3
4
5
Factor of Safety against Liquefaction



TVA KIF Stilling Pond (Dike C), Source = All Others Sources, Mw = 6.05, PGAsoil = 0.073 g, Return Period = 1497 years, SPT Data, NCEER Simplified Method, No Fines Correction if Fly Ash (ML)
1.1
1.4
Elevation, (ft)
770
760
750
740
730
720
710
700
690
0
1
2
3
4
5
Factor of Safety against Liquefaction



TVA KIF Stilling Pond (Dike C), Source = New Madrid, Mw = 7.59, PGAsoil = 0.039 g, Return Period = 984 years, SPT Data, NCEER Simplified Method, No Fines Correction if Fly Ash (ML)
1.1
1.4
Elevation, (ft)
770
760
750
740
730
720
710
700
690
0
1
2
3
4
5
Factor of Safety against Liquefaction

Appendix F

Stability Analysis

Station 119+69 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

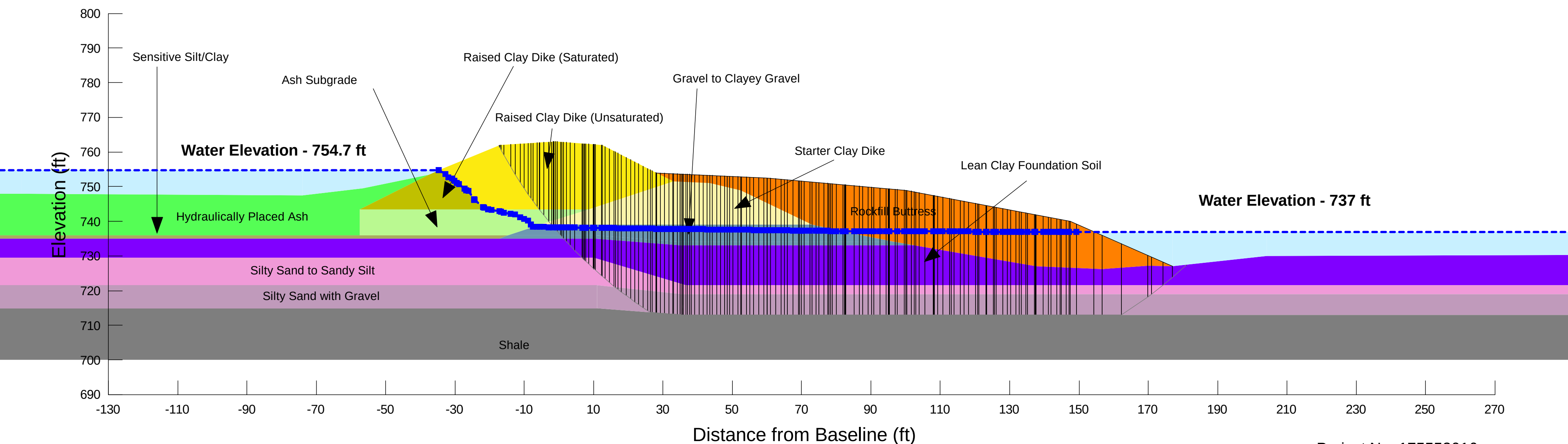
Operating Conditions - Post Earthquake

Liquefied Materials: Ash Subgrade and Alluvial Sands

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0 °
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0 °
Rockfill Buttress	128 pcf	0 psf	38 °
Ash Subgrade	110 pcf	Sr for N = 17	0 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Starter Clay Dike	125 pcf	0 psf	19 °
Gravel to Clayey Gravel	125 pcf	0 psf	19 °
Lean Clay Foundation Soil	130 pcf	0 psf	20 °
Silty Sand to Sandy Silt	128 pcf	Sr for N = 5	0 °
Silty Sand with Gravel	128 pcf	Sr for N = 5	0 °

Factor of Safety: 0.6



KIF_119+69 - Liq - all.gsz

Project No. 175553016

Station 119+69 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

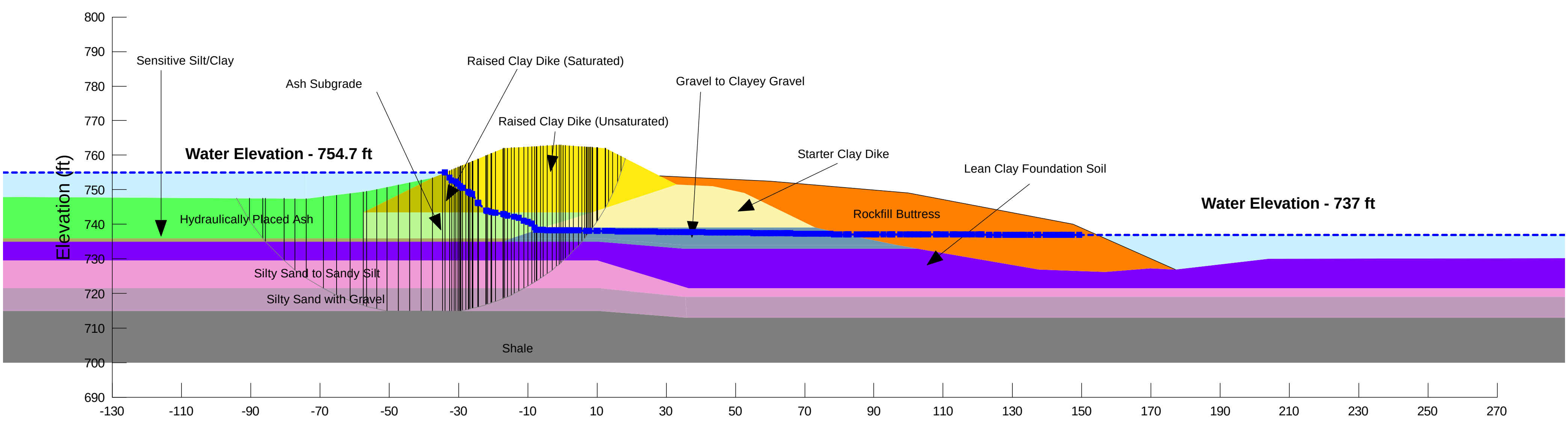
Operating Conditions - Post Earthquake

Liquefied Materials: Ash Subgrade and Alluvial Sands

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0 °
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0 °
Rockfill Buttress	128 pcf	0 psf	38 °
Ash Subgrade	110 pcf	Sr for N = 17	0 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Starter Clay Dike	125 pcf	0 psf	19 °
Gravel to Clayey Gravel	125 pcf	0 psf	19 °
Lean Clay Foundation Soil	130 pcf	0 psf	20 °
Silty Sand to Sandy Silt	128 pcf	Sr for N = 5	0 °
Silty Sand with Gravel	128 pcf	Sr for N = 5	0 °

Factor of Safety: 1.2



KIF_119+69 - Liq - all.gsz

Project No. 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

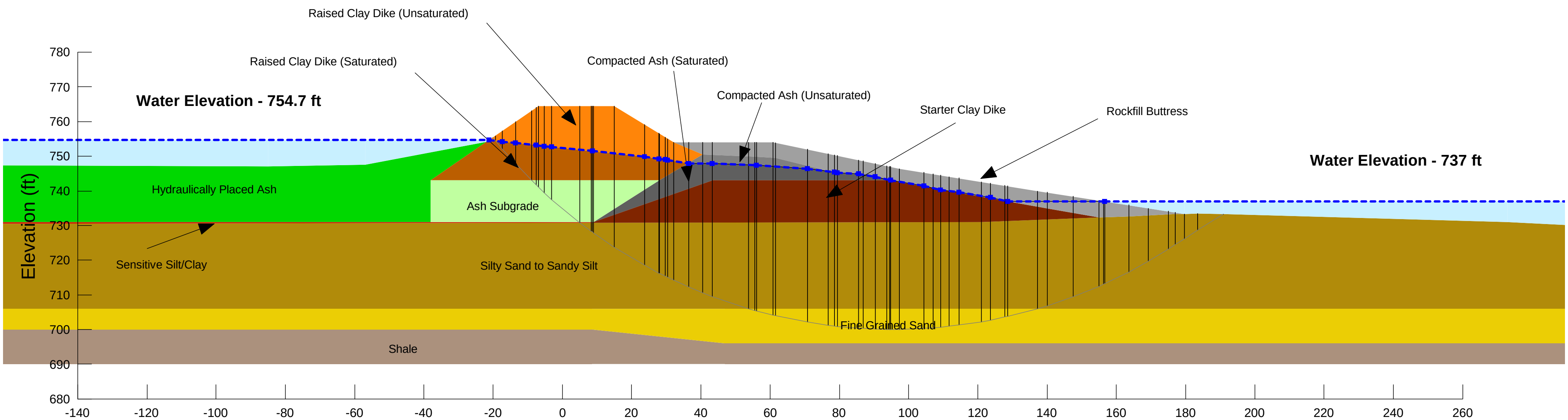
Operating Conditions - Post Earthquake

Liquefied Materials: Ash Subgrade and Alluvial Sands

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0°
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ϕ = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ϕ = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	Sr for N = 17	0°
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	Sr for N = 5	0°
Fine Grained Sand	128 pcf	Sr for N = 5	0°

Factor of Safety: 0.5



KIF_132+37 - Liq - all.gsz

Project No 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

Operating Conditions - Post Earthquake

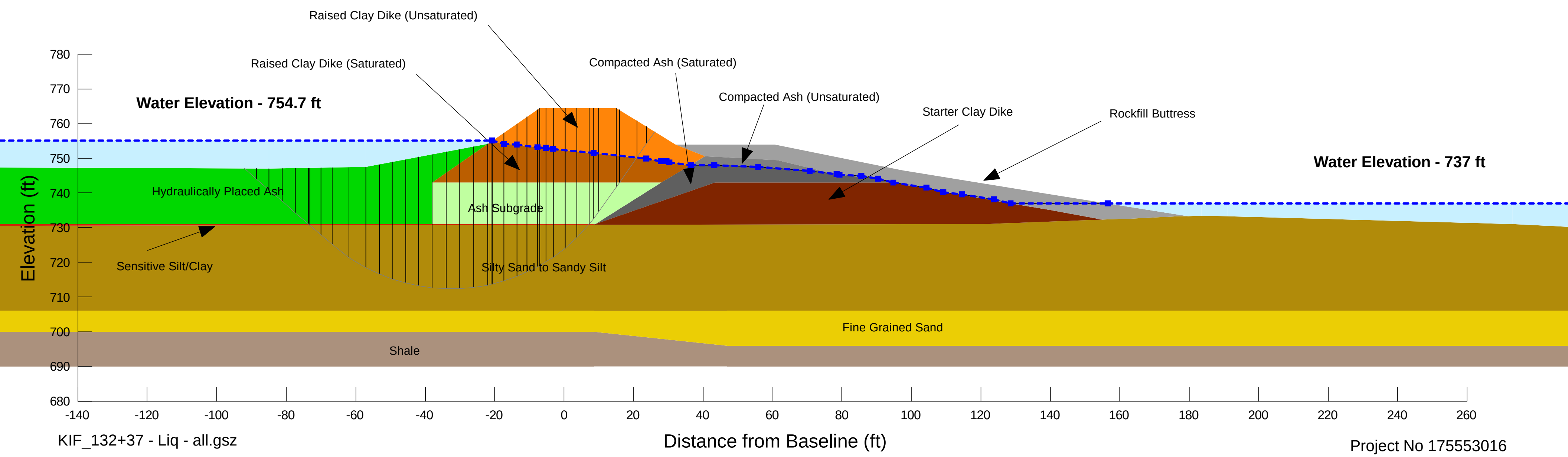
Stantec

Liquefied Materials: Ash Subgrade and Alluvial Sands

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 0.7

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0°
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ф = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ф = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	Sr for N = 17	0°
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	Sr for N = 5	0°
Fine Grained Sand	128 pcf	Sr for N = 5	0°



KIF_132+37 - Liq - all.gsz

Project No 175553016

Station 119+69 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

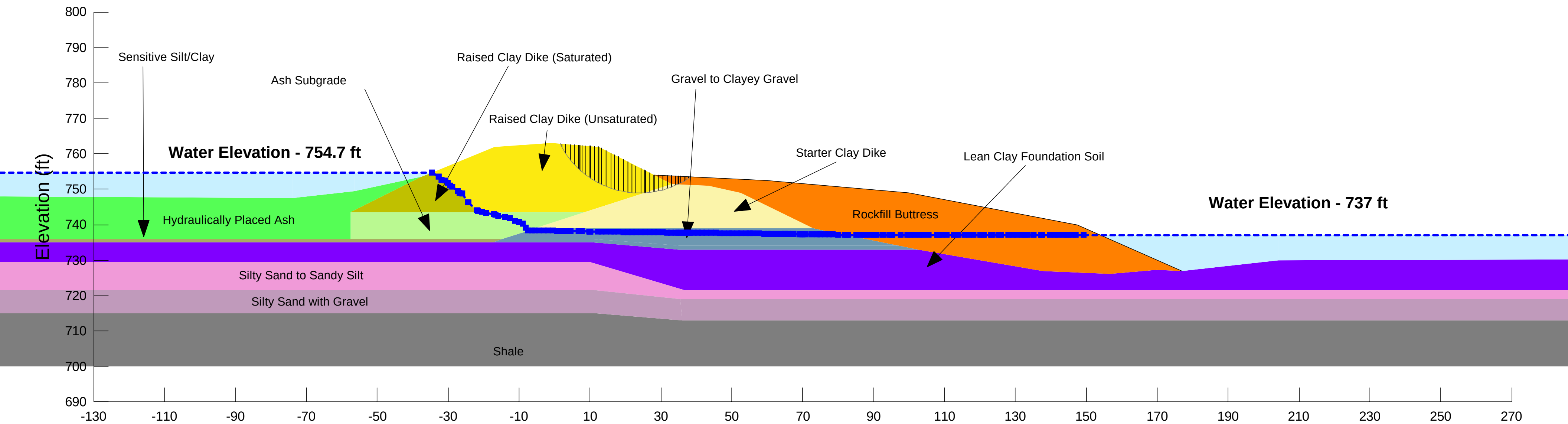
Operating Conditions - Post Earthquake

Liquefied Materials: Ash Subgrade

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.8

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0 °
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0 °
Rockfill Buttress	128 pcf	0 psf	38 °
Ash Subgrade	110 pcf	Sr for N = 17	0 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Starter Clay Dike	125 pcf	0 psf	19 °
Gravel to Clayey Gravel	125 pcf	0 psf	19 °
Lean Clay Foundation Soil	130 pcf	0 psf	20 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ɸ = 30˚ and c = 0 psf		
Silty Sand with Gravel	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ɸ = 30˚ and c = 0 psf		



KIF_119+69 - Liq - ash.gsz

Project No. 175553016

Station 119+69 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

Stantec

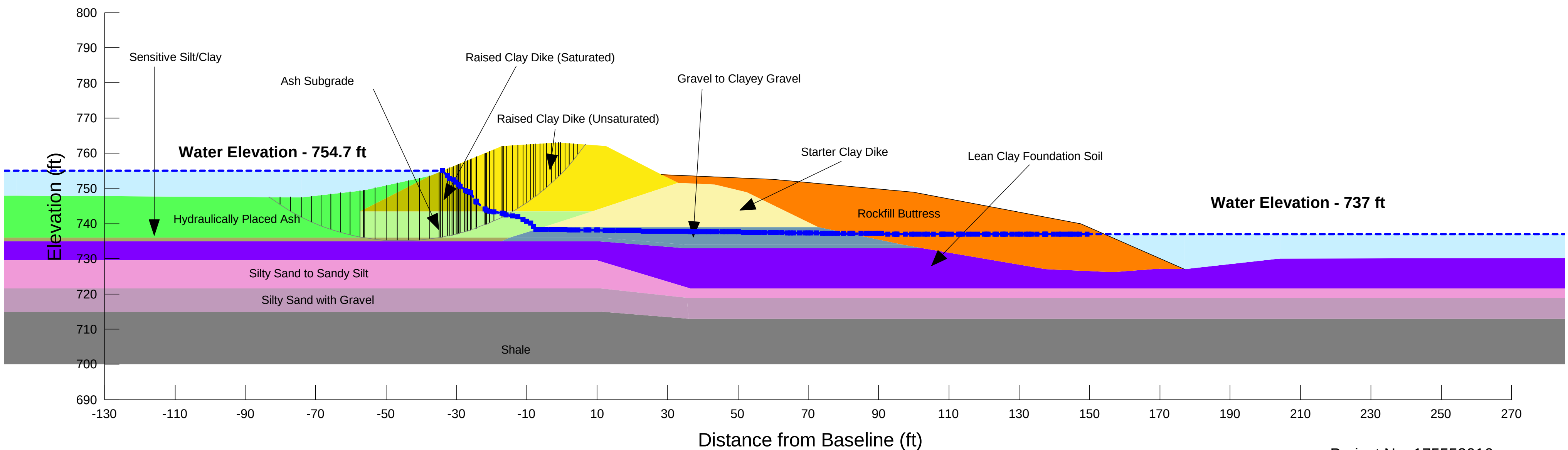
Operating Conditions - Post Earthquake

Liquefied Materials: Ash Subgrade

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.3

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0 °
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0 °
Rockfill Buttress	128 pcf	0 psf	38 °
Ash Subgrade	110 pcf	Sr for N = 17	0 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Starter Clay Dike	125 pcf	0 psf	19 °
Gravel to Clayey Gravel	125 pcf	0 psf	19 °
Lean Clay Foundation Soil	130 pcf	0 psf	20 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		
Silty Sand with Gravel	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		



KIF_119+69 - Liq - ash.gsz

Project No. 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

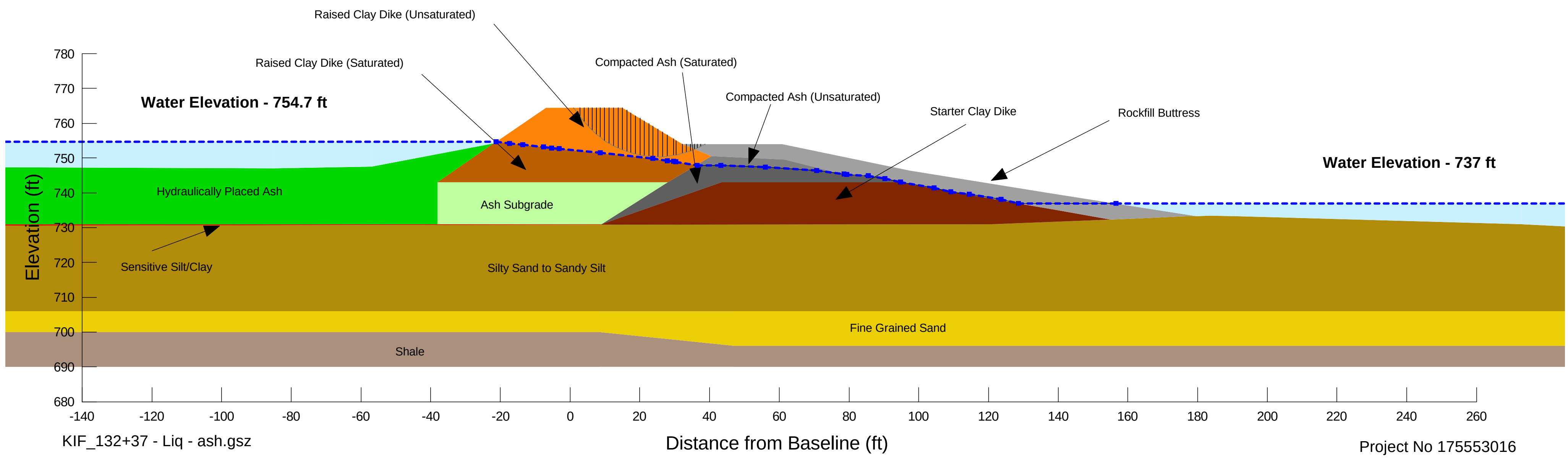
Operating Conditions - Post Earthquake

Liquefied Materials: Ash Subgrade

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.6

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0°
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ϕ = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ϕ = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	Sr for N = 17	0°
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		
Fine Grained Sand	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		



KIF_132+37 - Liq - ash.gsz

Project No 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

Operating Conditions - Post Earthquake

Liquefied Materials: Ash Subgrade

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0°
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ф = 30˚ and c = 0 psf		
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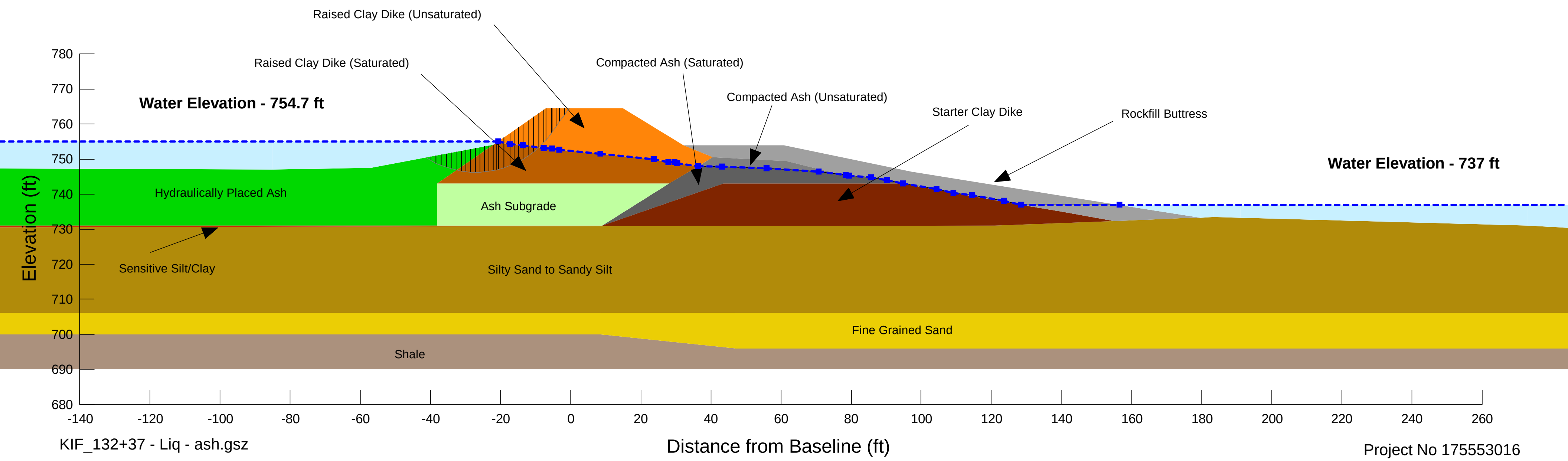
	For effective stress < 5,539 psf, use ф = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	Sr for N = 17	0°
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ф = 30˚ and c = 0 psf		
Fine Grained Sand	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ф = 30˚ and c = 0 psf		

Factor of Safety: 0.8

- Critical Failure



KIF_132+37 - Liq - ash.gsz

Project No 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

Operating Conditions - Post Earthquake

Stantec

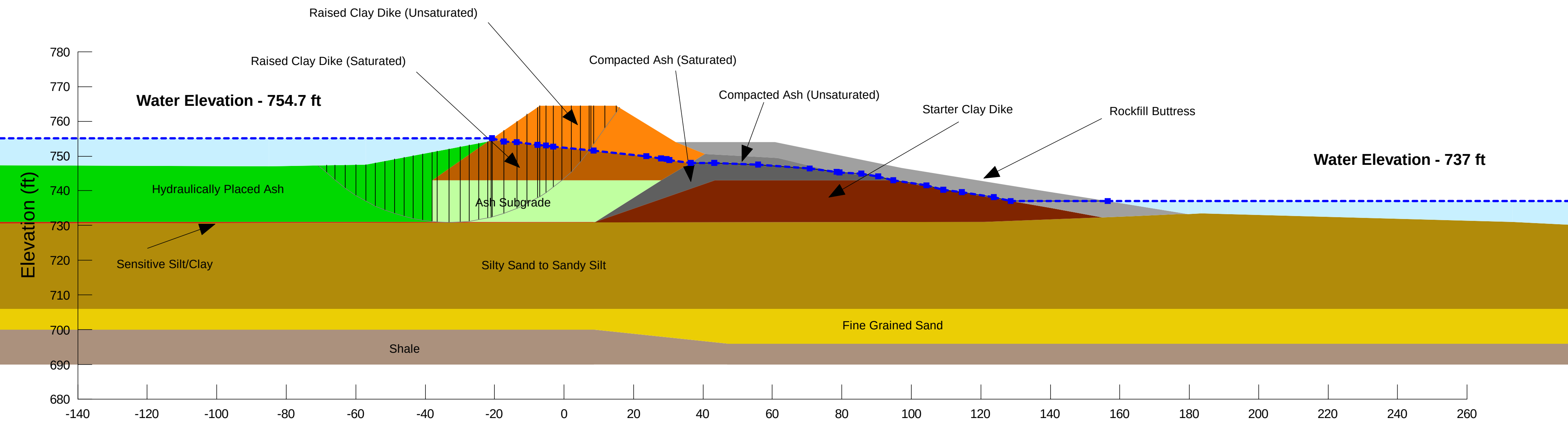
Liquefied Materials: Ash Subgrade

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0°
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ϕ = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ϕ = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	Sr for N = 17	0°
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		
Fine Grained Sand	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		

Factor of Safety: 1.0

- Failure through crest width



KIF_132+37 - Liq - ash.gsz

Distance from Baseline (ft)

Project No 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

Operating Conditions - Post Earthquake

Stantec

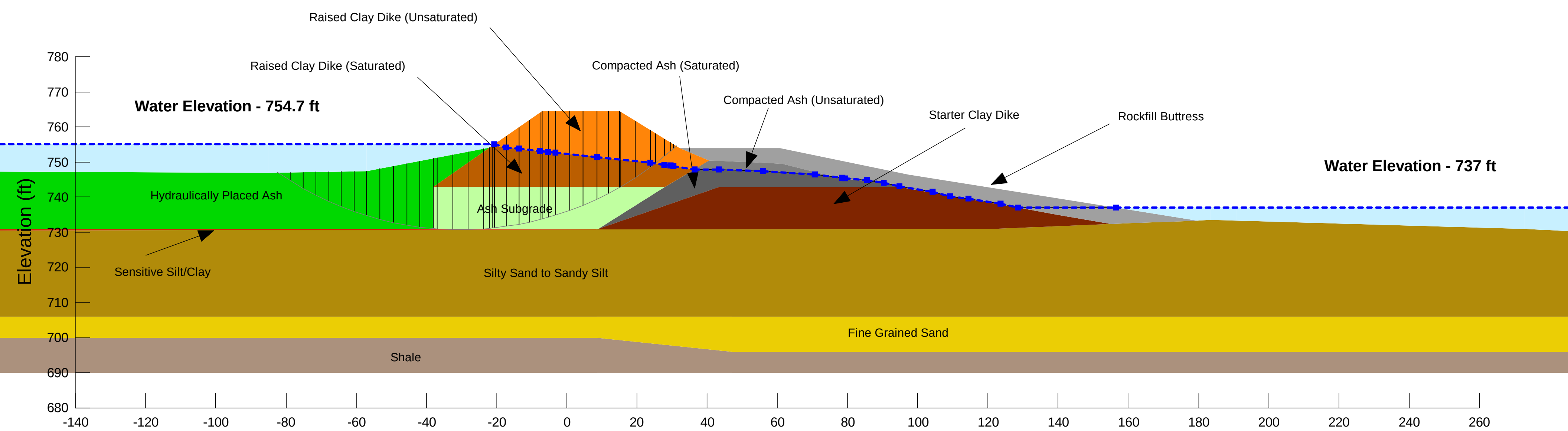
Liquefied Materials: Ash Subgrade

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	c/p = 0.06	0°
Sensitive Silt/Clay	107 pcf	c/p = 0.06	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ϕ = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ϕ = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	Sr for N = 17	0°
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		
Fine Grained Sand	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		

Factor of Safety: 1.4

- Failure through raised dike



KIF_132+37 - Liq - ash.gsz

Project No 175553016

Station 119+69 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

Stantec

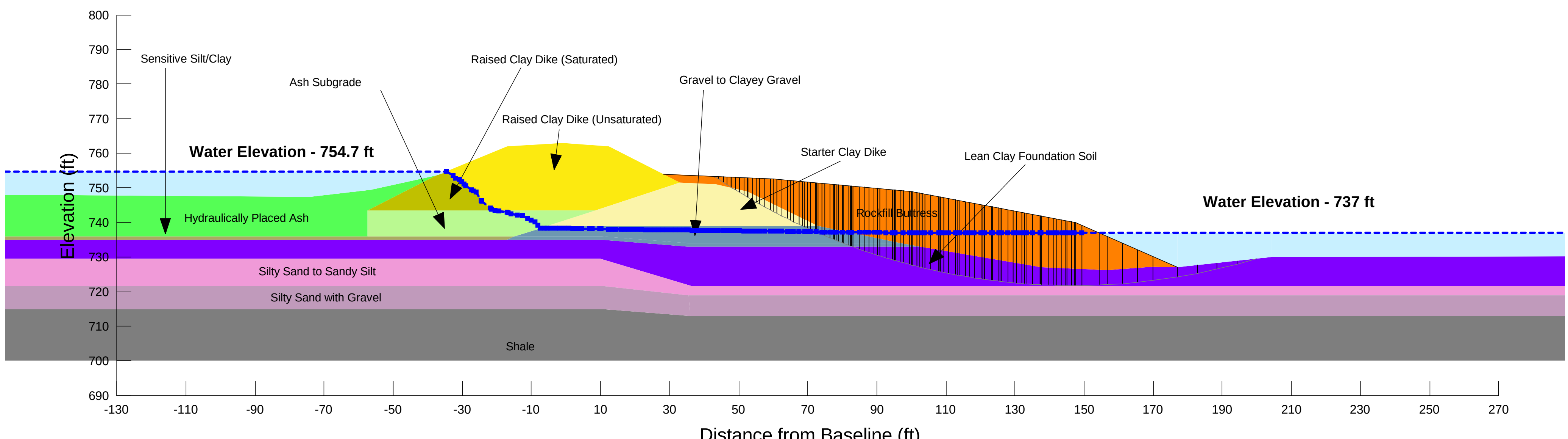
Operating Conditions - Pseudostatic Analysis

Kh = 0.04

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	0 psf	8 °
Sensitive Silt/Clay	107 pcf	c/p = 0.19	0°
Rockfill Buttress	128 pcf	0 psf	38 °
Ash Subgrade	110 pcf	800 psf	16 °
	For effective stress < 2,753 psf, use ϕ = 30˚ and c = 0 psf		
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Starter Clay Dike	125 pcf	0 psf	19 °
Gravel to Clayey Gravel	125 pcf	0 psf	19 °
Lean Clay Foundation Soil	130 pcf	0 psf	20 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		
Silty Sand with Gravel	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		

Factor of Safety: 1.4



KIF_119+69 - Eq.gsz

Project No. 175553016

Station 119+69 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

Stantec

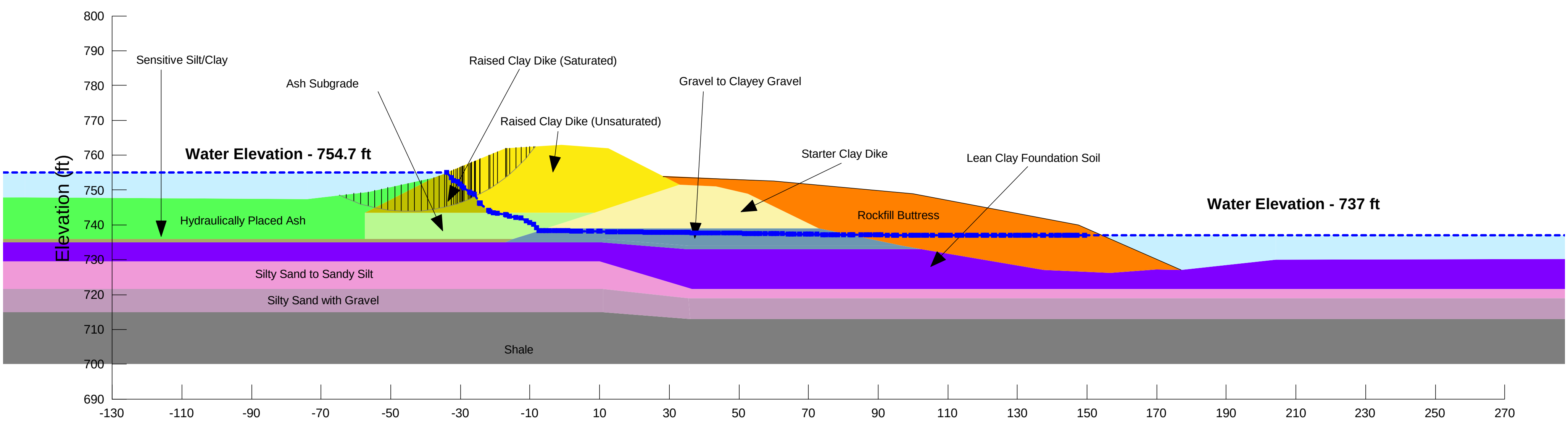
Operating Conditions - Pseudostatic Analysis

Kh = 0.04

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	0 psf	8 °
Sensitive Silt/Clay	107 pcf	c/p = 0.19	0°
Rockfill Buttress	128 pcf	0 psf	38 °
Ash Subgrade	110 pcf	800 psf	16 °
	For effective stress < 2,753 psf, use ф = 30˚ and c = 0 psf		
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Starter Clay Dike	125 pcf	0 psf	19 °
Gravel to Clayey Gravel	125 pcf	0 psf	19 °
Lean Clay Foundation Soil	130 pcf	0 psf	20 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ф = 30˚ and c = 0 psf		
Silty Sand with Gravel	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ф = 30˚ and c = 0 psf		

Factor of Safety: 1.1



KIF_119+69 - Eq.gsz

Project No. 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

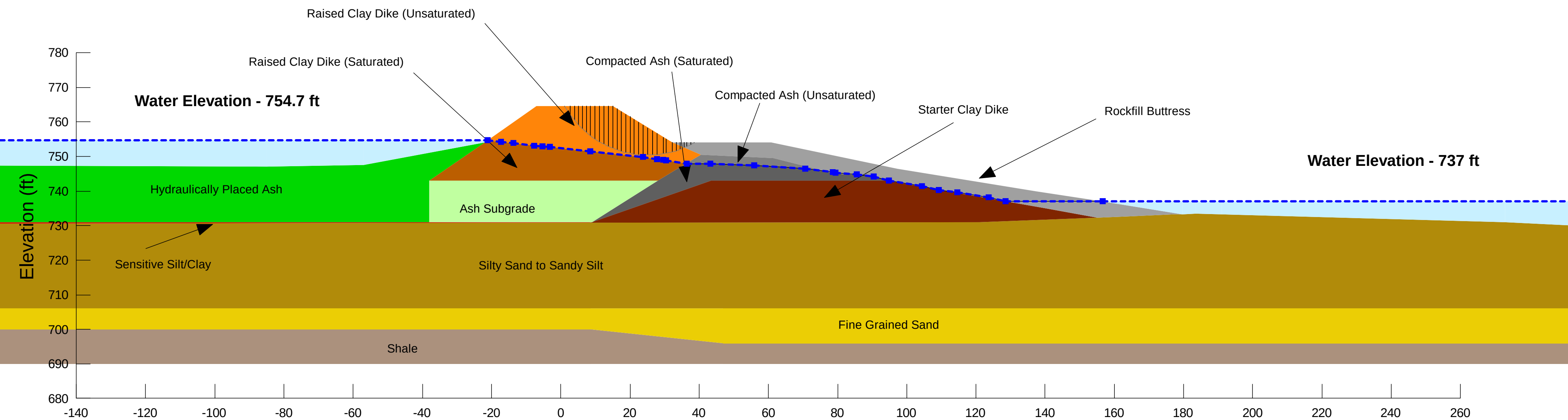
Operating Conditions - Pseudostatic Analysis

Kh = 0.04

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.4

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	0 psf	8°
Sensitive Silt/Clay	107 pcf	c/p = 0.19	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ɸ = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ɸ = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	800 psf	16 °
	For effective stress < 2,753 psf, use ɸ = 30˚ and c = 0 psf		
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ɸ = 30˚ and c = 0 psf		
Fine Grained Sand	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ɸ = 30˚ and c = 0 psf		



KIF_132+37 - Eq.gsz

Project No 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

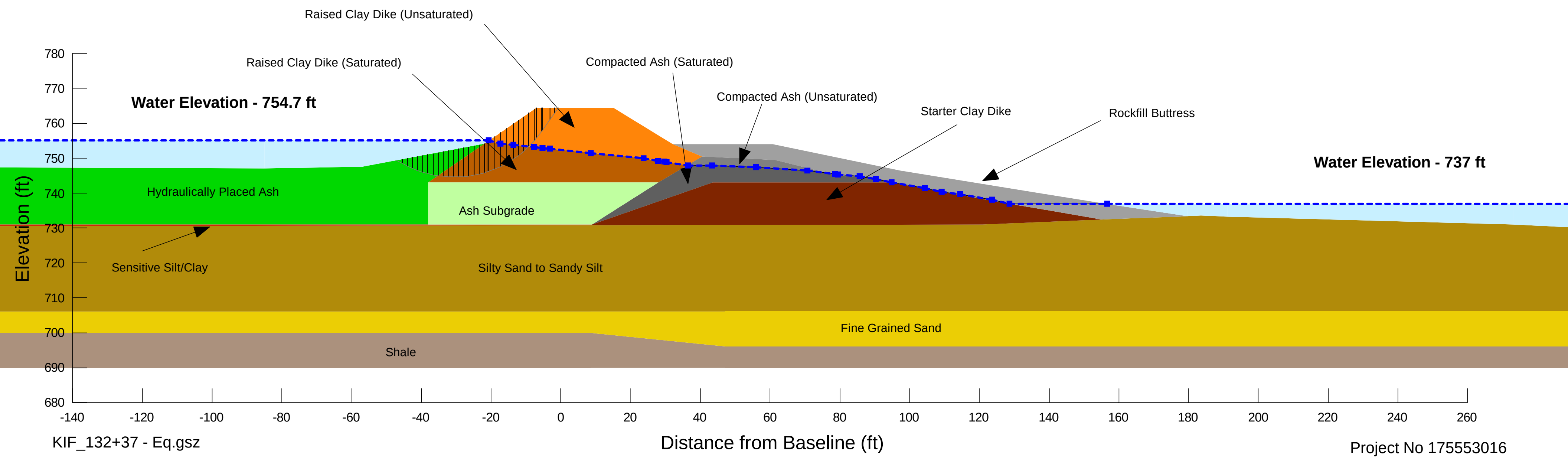
Operating Conditions - Pseudostatic Analysis

Kh = 0.04

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 0.7
- Critical Surface

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	0 psf	8°
Sensitive Silt/Clay	107 pcf	c/p = 0.19	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ϕ = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ϕ = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	800 psf	16 °
	For effective stress < 2,753 psf, use ϕ = 30˚ and c = 0 psf		
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		
Fine Grained Sand	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		



KIF_132+37 - Eq.gsz

Project No 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

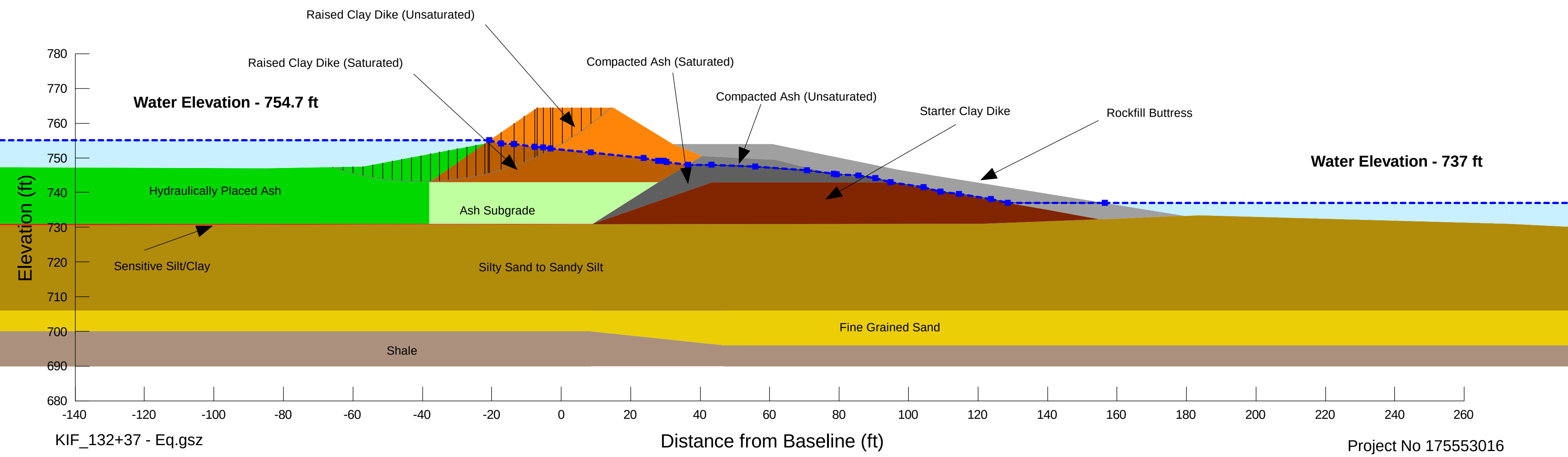
Operating Conditions - Pseudostatic Analysis

Kh = 0.04

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	0 psf	8°
Sensitive Silt/Clay	107 pcf	c/p = 0.19	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ɸ = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ɸ = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	800 psf	16 °
	For effective stress < 2,753 psf, use ɸ = 30˚ and c = 0 psf		
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ɸ = 30˚ and c = 0 psf		
Fine Grained Sand	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ɸ = 30˚ and c = 0 psf		

Factor of Safety: 0.9
- Failure through crest width



KIF_132+37 - Eq.gsz

Project No 175553016

Section 132+37 - Stilling Pond
Kingston Fossil Plant
Kingston, Tennessee

Operating Conditions - Pseudostatic Analysis

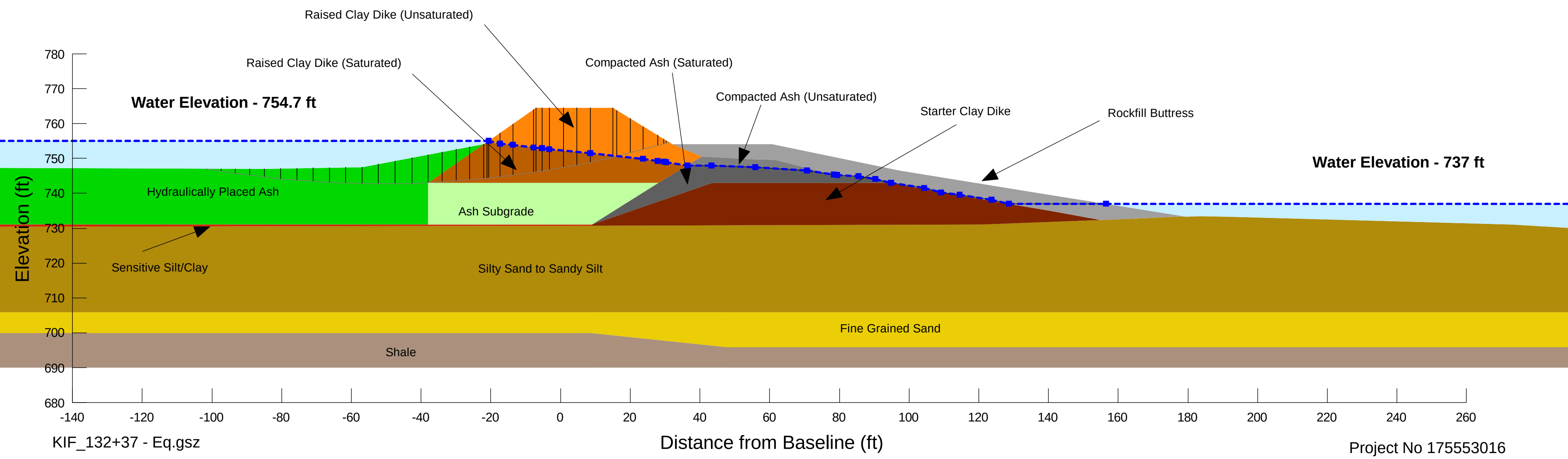
Kh = 0.04

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Material	Unit Weight	Cohesion	Friction Angle
Hydraulically Placed Ash	107 pcf	0 psf	8°
Sensitive Silt/Clay	107 pcf	c/p = 0.19	0°
Rockfill Buttress	128 pcf	0 psf	38°
Compacted Ash (Unsaturated)	109 pcf	1200 psf	27 °
	For effective stress < 17,693 psf, use ϕ = 30˚ and c = 0 psf		
Compacted Ash (Saturated)	109 pcf	960 psf	22 °
	For effective stress < 5,539 psf, use ϕ = 30˚ and c = 0 psf		
Ash Subgrade	110 pcf	800 psf	16 °
	For effective stress < 2,753 psf, use ϕ = 30˚ and c = 0 psf		
Raised Clay Dike (Unsaturated)	125 pcf	0 psf	23 °
Raised Clay Dike (Saturated)	125 pcf	0 psf	19 °
Starter Clay Dike	125 pcf	0 psf	19 °
Silty Sand to Sandy Silt	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		
Fine Grained Sand	128 pcf	800 psf	10 °
	For effective stress < 1,995 psf, use ϕ = 30˚ and c = 0 psf		

Factor of Safety: 1.7

- Failure through raised dike



KIF_132+37 - Eq.gsz

Project No 175553016

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
RESOURCE CONSERVATION
AND RECOVERY

JUN 16 2014

Brenda E. Brickhouse
Vice President, Environment
Tennessee Valley Authority
1101 Market Street, BR 4A
Chattanooga, Tennessee 37402

Re: Liquefaction Analysis of Stilling Pond, TVA Kingston Fossil Plant

Dear Ms. Brickhouse:

The United States Environmental Protection Agency (EPA) is in receipt of Tennessee Valley Authority's (TVA) letter, dated June 4, 2014, and accompanying seismic analyses, "Probability of Seismic Failure during Remaining Service Life: TVA Kingston Fossil Plant Stilling Pond; Harriman, Roane County, Tennessee," (Stantec Report) dated May 12, 2014, and prepared by Stantec Consulting Services Inc. (Stantec) on behalf of TVA.

The EPA conducted a coal combustion residuals (CCR) dam assessment at the TVA Kingston Fossil Plant (TVA Kingston) in Harriman, Tennessee, on October 21, 2011. The results of the assessment at TVA Kingston were published in a final report in April 2013. In the final report, the EPA indicated that the Main Ash Pond ("Ash Pond C") received a fair rating for continued safe and reliable operation. (As part of the assessment effort, in consultation with the Association of State Dam Safety Officials, EPA developed a standardized rating system, based on the systems used in several states. A discussion of the system may be found on our web site at http://www.epa.gov/waste/nonhaz/industrial/special/fossil/surveys2/index.htm.) In the final report, the EPA made a recommendation that TVA conduct formal liquefaction analysis for the Main Ash Pond based on concerns for soils of the Main Ash Pond dikes having susceptibility to liquefaction.

Following the site assessment, TVA formally closed portions of the Main Ash Pond. However, the south section of the Main Ash Pond, the Stilling Pond, remained operational. TVA conducted a formal liquefaction potential analysis of the Stilling Pond under seismic and post-earthquake conditions, dated May 12, 2014. The EPA received the Stantec Report on June 5, 2014.

The results presented in the Stantec Report indicate factors of safety for slope stability of the Stilling Pond embankments under post-earthquake liquefaction conditions do not always meet the minimum acceptable value of 1.0:

> Assuming liquefaction in the Ash Subgrade and Alluvial Sands of the embankment, cross section 119+69 has calculated factors of safety for downstream and upstream failure of 0.6 and 1.2, respectively. Assuming liquefaction in the Ash Subgrade and Alluvial Sands of the embankment,

cross section 132+37 has calculated factors of safety for downstream and upstream failure of 0.5 and 0.7, respectively. Assuming liquefaction in the Ash Subgrade of the embankment, cross section 119+69 has calculated factors of safety for downstream and upstream failure of 1.8 and 1.3, respectively. Assuming liquefaction in the Ash Subgrade of the embankment, cross section 132+37 has calculated factors of safety for downstream and upstream failure of 1.6 and 0.8, respectively.

The EPA, operating under an abundance of caution, finds that the results presented in the Stantec Report indicate there exists an unacceptable threat of release of CCR material to the environment from the failure of the embankment of the Stilling Pond at TVA Kingston. Given the history of the TVA Kingston facility and the history of the Main Ash Pond and its cells in particular, the EPA is requesting TVA take the following immediate action to increase the post-earthquake stability of the Stilling Pond embankments:

- TVA should lower the pool elevation of the Stilling Pond below the crest of the constructed ash dike (lower pond level 3 feet below the bench).

The EPA is requesting TVA respond to this letter within 5 days of receipt indicating what actions TVA will implement to increase the factors of safety of the Stilling Pond embankments to meet the minimum acceptable value of 1.0. The EPA is also requesting TVA to submit a schedule showing when the work to address the risks found at the TVA Kingston Stilling Pond will be completed.

You may assert a business confidentiality claim covering part or all of the information requested by EPA, in the manner described by 40 C.F.R. Part 2, Subpart B. Information covered by such a claim will be disclosed by the EPA only to the extent and only by means of the procedures set forth in 40 C.F.R. Part 2, Subpart B. If no such claim accompanies the information when the EPA receives it, the information may be made available to the public by the EPA without further notice to you. If you wish the EPA to treat any information or response as "confidential," you must so advise the EPA and follow the procedures described by 40 C.F.R. Part 2, Subpart B.

Please be aware that providing false, fictitious, or fraudulent statements of representation may subject you to criminal penalties under 18 U.S.C. § 1001.

If you are using overnight or hand delivery mail, please use the following address:

Mr. Stephen Hoffman
US Environmental Protection Agency
Two Potomac Yard
2733 South Crystal Drive
5th Floor, N-5237
Arlington, VA 22202-2733

You may also provide your response by e-mail to Hoffman.stephen@epa.gov.

While EPA is issuing this letter. EPA has discussed this matter with officials in the State of Tennessee and they have concurred on this approach. Consistent with our practice, we are sending a copy of the STANTEC report to them and will continue to work closely with them throughout this process.

Thank you and we look forward to your response

Sincerely,

Stephen Hoffman
Senior Environmental Scientist

cc Alan Farmer. Region IV

Bob Martineau
Commissioner. Tennessee Department of Environmental & Conservation

Shari Meghreblian
Deputy Commissioner, Tennessee Department of Environmental & Conservation

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 30 2014

OFFICE OF
RESOURCE CONSERVATION
AND RECOVERY

Ms. Brenda E. Brickhouse
Vice President, Environment
Tennessee Valley Authority
1101 Market Street, BR 4A
Chattanooga, Tennessee 37402

Dear Ms. Brickhouse:

Thank you for participating in the teleconference on September 11, 2014 with EPA and Tennessee DEC. The purpose of this letter is to document the agreement reached that TVA will initiate the studies that were agreed to by all parties during that teleconference.

All parties agreed that there is a need for additional study to clarify the nature and extent of potential deformation at the Stilling Pond, during and following the design seismic event. EPA is therefore requesting that TVA conduct a Fast Lagrangian Analysis of Continua 3-Dimensional (FLAC3D) study of the Stilling Pond Dike C and provide the results to EPA no later than April 13, 2015. The Agency would also appreciate written updates on the progress of this study every three months until completion.

You may assert a business confidentiality claim covering part or all of the information requested by EPA, in the manner described by 40 C.F.R. Part 2, Subpart B. Information covered by such a claim will be disclosed by the EPA only to the extent and only by means of the procedures set forth in 40 C.F.R. Part 2, Subpart B. In no such claim accompanies the information when the EPA receives it, the information may be made available to the public by the EPA without further notice to you. If you wish the EPA to treat any information or response as "confidential", you must so advise the EPA and follow the procedures described in 40 C.F.R. Part 2, Subpart B.

Please be aware that providing false, fictitious, or fraudulent statements of representation may subject you to criminal penalties under 18 U.S.C. 1001.

If you are using overnight or hand delivery mail, please use the following address:

Mr. Stephen Hoffman
U.S. Environmental protection Agency
Two Potomac Yd North
2733 South Crystal Drive
5th Floor, N-5237
Arlington, VA. 22202-2733

You may also provide your response by email to Hoffman.stephen@epa.gov.

Sincerely,

Stephen Hoffman

CC: Alan Farmer, USEPA Region IV
Bob Martineau, Commissioner, Tennessee Department of Environmental & Conservation

A72 141023 001
Env. Document Type: Solid Waste Correspondence

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402

Brenda E. Brickhouse
Vice President
Environment

October 22, 2014

Mr. Stephan Hoffman
U.S. Environmental Protection Agency (EPA)
Two Potomac Yard
2733 S. Crystal Drive
5th Floor, N-5838
Arlington, Virginia 22202-2733

Dear Mr. Hoffman:

TENNESSEE VALLEY AUTHORITY (TVA) – SEISMIC RISK ASSESSMENT – STILLING POND (POND C) – KINGSTON FOSSIL PLANT (KIF)

As detailed by the U.S. EPA final review and report of TVA's surface impoundments dated June 13, 2013, the KIF Stilling Pond (Pond C) received a *Fair* rating. This rating was given due to questions regarding potential for liquefaction of soils and materials at the management unit. TVA was directed to conduct additional seismic studies and responded with an Action Plan dated July 12, 2013. Consequently a seismic risk assessment for operating conditions of Pond C was conducted and a report from that study, which indicated a low probability for liquefaction of alluvial sands beneath the stilling pond and perimeter dike, was submitted to EPA on June 4, 2014. A letter response was received from EPA on June 16, 2014, which requested further action by TVA regarding Pond C.

In order to determine the appropriate next steps, discussions between EPA, the Tennessee Department of Environment and Conservation and TVA have been held over the past few months. As detailed in your letter dated September 30, 2014, consensus was reached by all parties that TVA will initiate additional assessments in order to clarify the nature and extent of potential deformation resulting from the design earthquake. To achieve this, TVA will conduct a Fast Langrangian Analysis of Continua (FLAC) analysis to define the potential for a 2-dimensional deformation (2D) of the Stilling Pond Dike. TVA will provide a written summary on the progress of this study in January 2015 and will report the results from the first phase of this study no later than April 13, 2015. If the results from the initial phase warrant, TVA will continue the FLAC study and will provide a written summary of the progress in July 2015 and a final report documenting the results of the study will be submitted in October 2015.

As previously reported, the requested seismic risk assessments are currently underway at Bull Run and Colbert Fossil Plants and TVA will forward reports for impoundments at those sites in the coming months. Moreover, TVA will continue to assess and improve the integrity of our coal combustion residual (CCR) impoundments and will address the appropriate closure of these facilities, including future structural stability. Ultimately the results of the seismic studies will be utilized in this regard.

We appreciate your attention in this matter. If you have questions or need additional information, please contact Sam Hixson at (423) 751-6705 or Amos Smith at (423) 751-7636 in Chattanooga, Tennessee, or by email at swhixson@tva.gov or alsmith@tva.gov.

Sincerely,

Brenda E. Brickhouse

cc: Mr. Patrick J. Flood, P.E.
Director, Division of Solid Waste Management
Tennessee Department of Environment and Conservation
William R. Snodgrass TN Tower
312 Rosa L. Parks Avenue, 14th Floor
Nashville, Tennessee 37243

ALS:SMF

cc: J. A. Birdwell, WT 6A-K
B. E. Brickhouse, BR 4A-C
J. L. Dodd, LP 1F-C
J. C. Kammeyer, LP 5D-C
B. D. Keeling, KFP 1A-KST
B. C. Portis, OMA 1A-WDC
A. L. Smith, BR 4A-C
M. S. Turnbow, LP 5G-C
EDMS, ENVrecords

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402

Wilbourne C. Markham, Jr
Director
Environmental Permitting and Compliance

February 3, 2015

Ms. Betsy Devlin, Director
U.S. Environmental Protection Agency (EPA)
Two Potomac yard
2733 S. Crystal Drive
5th Floor, N-5838
Arlington, Virginia 22202-2733

Dear Ms. Devlin:

TENNESSEE VALLEY AUTHORITY (TVA) – PROGRESS REPORT – POST EARTHQUAKE DEFORMATION ANALYSIS – STILLING POND (POND C) - KINGSTON FOSSIL PLANT (KIF)

As proposed in correspondence dated October 22, 2014, an additional assessment regarding the nature and extent of potential deformation of the Stilling Pond (Pond C) at KIF is being conducted. This potential deformation would result following liquefaction of underlying soil materials due to a large earthquake. To achieve this, a numerical analysis of the containment dike is being performed using the modeling software Fast Lagrangian Analysis of Continua in two dimensions (FLAC 2D). This letter provides an overview of work completed during the first reporting period in accordance with previously outlined commitments.

Initial steps for the FLAC model completed include selection and confirmation of the representative cross-section through Dike C to be analyzed by the numeric model. This was accomplished by thorough review of previous site studies at the site which included cross-sections which were defined and analyzed on the basis of topographic surveys, site explorations, along with historical project drawings. Subsurface profiles and post-earthquake residual strengths of potentially liquefied soils defined in previous studies were also reviewed. In addition to confirmation of the appropriate cross-section, site specific material properties required as input values into the FLAC model were selected. The material properties reviewed included; material density properties, soil stiffness properties, stress strength parameters and residual shear strength for liquefied soils.

The first phase of this study is scheduled to be complete by the end of April 2015. TVA will provide a written report of the first phase promptly following that date. TVA will continue to assess and improve the integrity of our coal combustion residual (CCR) impoundments and will address the appropriate closure of these facilities, including future structural stability. With the pre-publication draft of the CCR Rule released by EPA on December 19, 2014, TVA is currently evaluating the correct steps forward with regard to the Kingston Stilling Pond, as well as impoundments located at our other plant sites.

As agreed, the proposed deformation analysis are currently underway for the gypsum disposal facility at Bull Run and the Ash Pond 4 dike at Colbert Fossil Plants. TVA will forward updates for those studies in the coming weeks.

We appreciate your attention in this matter. If you have questions or need additional information, please contact Sam Hixson at (423) 751-6705 or Amos Smith at (423) 751-7636 in Chattanooga, or by email at swhixson@tva.gov or alsmith@tva.gov.

Sincerely,

Wilbourne C. Markham Jr.

Wilbourne C. Markham Jr.

cc: Mr. Patrick J. Flood, P.E.
Director, Division of Solid Waste Management
Tennessee Department of Environment
and Conservation
William R. Snodgrass TN Tower
312 Rosa L. Parks Avenue
Nashville, Tennessee 37243

ALS:SMF
cc: J. A. Birdwell, WT 6A-K
B. E. Brickhouse, BR 4A-C
J. L. Dodd, LP 1F-C
S. W. Hixson, BR 4A-C
J. C. Kammeyer, LP 5D-C
B. D. Keeling, KFP 1A-KST
B. C. Portis, OMA 1A-WDC
A. L. Smith, BR 4A-C
M. S. Turnbow, LP 5G-C
EDMS, ENVrecords

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402

Wilbourne C. Markham, Jr
Director
Environmental Permits & Compliance

May 1, 2015

Ms. Betsy Devlin, Director
U.S. Environmental Protection Agency (EPA)
Two Potomac yard
2733 S. Crystal Drive
5th Floor, N-5838
Arlington, Virginia 22202-2733

Dear Ms. Devlin:

TENNESSEE VALLEY AUTHORITY (TVA) – PROGRESS REPORT- SEISMIC RISK ASSESSMENT – BULL RUN FOSSIL PLANT (BRF) - COLBERT FOSSIL PLANT(COF) AND KINGSTON FOSSIL PLANT(KIF)

The original evaluations from the EPA's request to evaluate liquefaction in an operational condition resulted in TVA continuing analysis at BRF, COF and KIF. TVA communicated to EPA in 2014 that two dimensional FLAC modeling would be performed at each site to understand the magnitude of deformation resulting from the potential liquefaction. On December 19th, 2014, the EPA released the pre-published CCR Rule that provided TVA guidance for managing CCR impoundments and landfills. The CCR Rule states that stability criteria must be met for impoundments that will continue to receive CCR's six months after the rule is published. It also states impoundments must meet four specific factors of safety within eighteen months of the published date.

TVA has taken the following position for BRF, COF, and KIF based on our intent to comply with the Rule.

- The CCR Rule specifically states that a factor of safety of 1.2 or greater must be demonstrated for the liquefaction potential of the constructed dikes. The rule does not allow for a demonstration of potential deformations due to liquefaction and therefore TVA is discontinuing deformation analysis unless it benefits TVA in closure planning.
- In accordance with the CCR Rule, KIF and BRF will cease to receive CCRs by October 19, 2015, and will close by April 17, 2018. Therefore seismic stability will be addressed during closure of these facilities.
- As part of the closure design for COF, TVA is implementing soil improvement of potentially liquefiable soils. Construction of the soil improvement will be complete by December 2015. Receipt of CCRs will cease at this location in April 2016.

As stated above, TVA intends to manage any seismic stability concerns in closure of these facilities and appreciates EPA's understanding to discontinue deformation analysis for the operational loading condition at each of these locations.

We appreciate your attention in this matter. If you have questions or need additional information, please contact Sam Hixson at (423) 751-6705 or Amos Smith at (423) 751-7636 in Chattanooga or by email at swhixson@tva.gov or alsmith@tva.gov.

Sincerely,

Wilbourne C. Markham, Jr.

Wilbourne C. Markham, Jr.

cc: Mr. Patrick J. Flood, P.E.
Director, Division of Solid Waste Management
Tennessee Department of Environment
and Conservation
William R. Snodgrass TN Tower
312 Rosa L. Parks Avenue, 5th Floor
Nashville, Tennessee 37243

Ms. Glenda Dean
Chief, Water Division
Alabama Department of Environmental
Management
1400 Coliseum Boulevard
Montgomery, Alabama 36110-2400

ALS:SMF

cc: J. A. Birdwell, WT 6A-K
J. L. Dodd, LP 1F-C
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J. C. Kammeyer, LP 5D-C
B. C. Portis, OMA 1A-WDC
M. S. Turnbow, LP 5G-C
EDMS, ENVrecords

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND
EMERGENCY RESPONSE

DEC 16 2015

Ms. Brenda Brickhouse
Vice President
Tennessee Valley Authority
Environmental Permits & Compliance
1101 Market Street, BR 4A
Chattanooga, Tennessee 37402-2801

Dear Ms. Brickhouse:

After the catastrophic release of coal ash from the Tennessee Valley Authority's (TVA) Kingston, Tennessee facility in December 2008, the U.S. Environmental Protection Agency (EPA), in collaboration with the States, undertook a nationwide, comprehensive effort to assess the structural integrity of surface impoundments and similar units that contain coal combustion residuals (CCR). The purpose of the assessments was to determine whether the units were structurally stable, or whether any corrective measures were needed, and, if so, to work with each facility to secure its commitment to complete any necessary corrective measures.

The units at TVA's facilities have been assessed by the EPA contractors who are experts in dam safety, working under the direction of the EPA. You have received a final report containing recommendations for corrective measures or studies needed to ensure the ongoing structural integrity of your impoundments and you have submitted an action plan to the EPA setting out how you plan to implement the recommendations. We thank you for your cooperation throughout this process. We have enclosed (at the conclusion of this letter) a list of the facilities your company owns or operates and that were assessed during assessment Round 11.

EPA's assessment effort was an extraordinary effort undertaken due to the critical need to ensure the structural integrity of these units. The EPA was able to bring dam safety experts in quickly and to subject these units to careful scrutiny. The assessments, analyses, reports, and recommendations constitute a critical body of information which serves all of us in our ongoing efforts to protect human health and the environment. For complete information on structural integrity assessments, analyses, reports, and recommendations, please visit EPA's website http://www3.epa.gov/epawaste/nonhaz/industrial/special/fossil/surveys2/.

The assessments, however, reflect the condition of each unit at the point in time during which the assessment took place. Going forward, an ongoing, routine program to assess these units and take any needed corrective measures is required to ensure the units' continued structural integrity. The continuing responsibility to ensure that these units are structurally sound lies with you. However, as you are aware, agencies within your State have an important role in the ongoing monitoring and oversight of these units. We are therefore providing all of the information that you have sent to EPA to the appropriate State agency for their use in their routine monitoring and oversight of these units and expect that they will be the primary point of contact with respect to the continued oversight of these units. However, should EPA become aware of a situation where there is a threat of release or other potential endangerment to human health or the environment, EPA may take appropriate action. In such circumstances, EPA will coordinate with your State agency to ensure that measures protective of human health and the environment are taken in a timely fashion.

The action plans for three of TVA's facilities have not fully responded to EPA's assessment recommendations and they are therefore not complete. TVA's Bull Run, Colbert, and Kingston Fossil Plants, each have at least one CCR unit that does not have a completed determination showing that the liquefaction potential for soils and materials under the design seismic event do not pose a safety concern. Specifically:

Bull Run Fossil Plant - In a letter to the EPA dated December 16, 2014, TVA informed EPA (and also copied Tennessee's Department of Environment and Conservation (TN DEC)) that the results of the embankment liquefaction potential analysis for Bottom Ash Disposal Area 1 and Gypsum Disposal Area 2A yielded factors of safety that did not meet the minimum criteria used during EPA's assessment effort (i.e., a factor of safety of 1.0 or greater for post-liquefaction slope stability). In a subsequent letter dated May 1, 2015, TVA indicated that these units will cease receiving CCR by October 19, 2015, and close by April 17, 2018. In this same letter, TVA also stated that seismic stability of these units will be addressed during closure of these facilities.

Colbert Fossil Plant – In a letter to the EPA dated October 27, 2014, TVA informed the EPA (and also copied Alabama's Department of Environmental Management (AL DEM)) that the results of an embankment liquefaction potential analysis of Ash Pond 4 yielded factors of safety that did not meet the minimum criteria used during EPA's assessment effort (i.e., a factor of safety of 1.0 or greater for post-liquefaction slope stability). In a subsequent letter dated May 1, 2015, TVA indicated that it intends to implement soil improvement actions of potentially liquefiable soils at the Colbert Fossil Plant, which is anticipated to be completed by December 2015. In this same letter, TVA also stated that the receipt of CCR at the Colbert Fossil Plant will cease in April 2016.

Kingston Fossil Plant – In a letter to the EPA dated June 4, 2014, TVA informed the EPA (and also copied TN DEC) that the results of the embankment liquefaction potential analysis of Stilling Pond (Pond C) yielded factors of safety that did not meet the minimum criteria used during EPA's assessment effort (i.e., a factor of safety of 1.0 or greater for post-liquefaction slope stability). In a subsequent letter dated May 1, 2015, TVA indicated that this unit will cease receiving CCR by October 19, 2015, and close by April 17, 2018. In this same letter, TVA also stated that seismic stability of these units will be addressed during closure of these facilities.

Until determined otherwise, the underlying potential for liquefaction-induced failure of these units remain a concern that should be addressed by taking necessary actions to ensure that these units will be structurally sound. Going forward, I ask that you give these units particular attention and that you continue to work closely with the appropriate regulatory officials in the States of Alabama and Tennessee.

Finally, as you are aware, the EPA issued a final rule on April 17, 2015 that establishes a comprehensive set of requirements for the disposal of coal combustion residuals in surface impoundments (and landfills). Among the requirements, the rule establishes structural integrity criteria and requires certain owners and operators to conduct periodic structural integrity related assessments to help prevent the damage associated with structural failures of surface impoundments. Some of your units may be subject to the requirements in this rule which became effective on October 19, 2015. If you have any questions on any aspect of these new requirements, please call Mr. Patrick M. Kelly, P.E., Environmental Engineer, of my staff at (703) 308-7271. For more information on the final rule, please visit EPA's website: http://www2.epa.gov/coalash/coal-ash-rule.

We again thank you for your cooperation throughout the assessment process and encourage you to continue your efforts to ensure the structural integrity of these units.

Sincerely,

Barnes Johnson

Barnes Johnson, Director
Office of Resource Conservation and Recovery

cc: Mr. Lyle Bentley, Chief, Dam Safety Program, Tennessee Department of Environment & Conservation
Mr. Robert J. Martineau, Jr., Commissioner, Tennessee Department of Environment & Conservation
Mr. Lance R. LeFleur, Director, Alabama Department of Environmental Management
Mr. Leslie A. Durham, P.E., Office of Water Resources, Alabama Department of Economic & Community Affairs

Enclosure

Kingston Stilling Pond – EPA / TVA Correspondence and Commitments

2011 · 2012 · 2013 · 2014 · 2015 · 2016 · 2017 · 2018

September 21st 2011 - EPA/Dewberry KIF Assessment

June 13th 2013 – EPA Request for Action Plan regarding Tennessee Valley Authority - Kingston Fossil Plant*:*

EPA asked TVA to confirm liquefaction potential at Pond C (Stilling Pond) for continued operation.

June 4th 2014 - TVA's Seismic Risk Assessment For Operating Conditions – Kingston Stilling Pond:

Stantec reported that a 4 year remaining design life had a 0.68% chance of seismic failure.

June 16th 2014 – EPA response to Liquefaction Analysis of Stilling Pond:

Based on results, EPA requested TVA drop the pool level and respond with an action plan to increase seismic safety factors.

July 9th 2014 – Stantec presents Kingston Stilling Pond Closure to TDEC and EPA.

September 30th 2014 - EPA's response to September 11th teleconference with TDEC, TVA:

All parties agreed an additional study of deformation would be performed by means of a FLAC analysis provided by TVA.

October 22nd 2014 – TVA's response to EPA's September 30th 2014 letter:

TVA committed to performing FLAC analysis and to communicate results on a quarterly basis.

February 3rd 2015 – TVA's progress report on FLAC analysis:

Analysis was progressing.

May 1st 2015 – TVA's seismic risk assessment progress report:

TVA committed to performing deformation in a closed condition and it communicated that it would cease sending CCRs to the stilling pond by October 19th 2015 and close by April 17th 2018 in accordance with the CCR Rules.

December 16th 2015 – EPA's final communication on TVA's action plans:

EPA recognized TVA's action plans to cease operations and close by April 17th 2018 and required TVA to continue to take the necessary actions to ensure the stilling pond will be structurally sound.

April 2018 Commitment to EPA to Close

Chuck Head, Senior Advisor
Bureau of Environment
TN Department of Environment & Conservation
William R. Snodgrass - TN Tower
312 Rosa L. Parks Ave., 2nd Floor
Nashville, TN 37243
615 532-0998
chuck.head@tn.gov

Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

June 14, 2016

Mr. Paul Pearman, Project Manager
Tennessee Valley Authority
1101 Market Street
Chattanooga, TN 37402

RE: TVA Kingston Fossil Plant
Environmental Investigation Plan

Dear Mr. Pearman:

This letter serves as a follow-up to our meeting with the Tennessee Valley Authority (TVA) on April 28th 2016 regarding the TVA Kingston Fossil Plant (TVA Kingston). This meeting fulfilled Section VII.A.a. of Commissioner's Order OGC15-0177 (the Order). The TN Department of Environment and Conservation (TDEC) appreciates the time and effort of your staff and consultants in presenting a summary of the geologic, hydrologic, analytical, engineering and historic data for TVA Kingston. Our staff found the information presented to be more easily understood than by reviewing all the written records for the site and greatly appreciated the opportunity to ask questions and to discuss technical issues. TVA Kingston is an active CCR disposal site adjacent to Emory Reservoir.

The TVA Kingston site is unique when compared to the other 7 TVA Fossil Plant sites in Tennessee.

a. Work was completed by TVA to address the December 2008 TVA Kingston CCR release from the permitted industrial landfill. Due to the magnitude of the release, the U.S Environmental Protection Agency (EPA) and TDEC jointly oversaw the investigation and remediation of the Kingston CCR release. That work has been completed, with both EPA and TDEC approving the clean-up of the historic landfill area; and

b. TDEC has permitted a new industrial landfill at the TVA Kingston site located on the peninsula adjacent to the TVA Kingston Fossil Plant. This landfill was designed to meet Tennessee's Class I Solid Waste Municipal Landfill design criteria and is constructed with a geologic buffer, synthetic liner and leachate collection system. Further, the landfill is required by TDEC to have an active ground water monitoring program and quarterly inspections.

Given these considerations, the application of the TDEC/TVA Consent Order is to address the other CCR disposal areas at the TVA Kingston Fossil Plant. Specifically, the TVA Kingston Stilling Pond, the historic CCR sluice trench and the "ball field" CCR disposal area.

Our staff members met following the April 28, 2016 TVA Kingston meeting to discuss what we learned about the site and identified additional information needed from TVA to fully understand the site's current status and the amount and location of all CCR material disposed at the site. Section VII.A.b. of the Order requires TDEC, after the initial TDEC/TVA on-site meeting to provide TVA with a written response identifying additional work and/or information needed at each TVA CCR site. TVA is required to submit this information in a proposed Environmental Investigation Plan (EIP).

TDEC has specific questions the Stilling Pond, the Ball field area and the old sluice channel area at the TVA Kingston site. Our questions are listed below. You will also find attached to this letter a guidance document (Attachment A) which contains a general description of the items that should be addressed in the Environmental Investigation Plan for each TVA Fossil Plant site (active and closed); excluding the TVA Gallatin Fossil Plant which is governed by a separate legal document.

TVA Kingston Environmental Investigation Plan Questions

TDEC requests that TVA provide responses to the points presented below in the EIP for the TVA Kingston site.

1. Existing or additional site characterization shall include a discussion of fluctuations in ground water elevations that may be connected to Watts Bar Lake levels, seasonal variations or other factors.

2. Existing or additional site characterization shall estimate the amount of CCR material that is below the upper most aquifer for the Stilling Pond, historic Sluice Channel and the "ball field" temporary storage area. The upper most aquifer must be identified to determine to meet this request and properly characterize the site.

3. Ground Water samples analyzed from Monitoring Well KIF-22 exceeded the Drinking Water MCL for Arsenic. TVA suggested the AS levels were higher than

expected due to the influenced of Total Suspended Solids in the ground water samples taken. TVA shall provide a science based explanation of this statement. TVA should explain its position that the Stilling Pond is contributing to the AS levels in Monitoring Well KIF-22.

4. TVA shall provide a schedule for the placement of any additional borings/monitoring wells proposed at the Kingston site as well as a map identifying the location all borings and monitoring wells that TVA plans to use as a part of its Environmental Investigation (existing and proposed). TVA shall present the reasons for selecting the location of additional boings/monitoring wells at the site. Further, TVA shall install/identify two ground water monitoring wells to serve as background ground water monitoring wells for the site. TVA shall have a TN Licensed Professional Geologist on site to log the installation borings and/or ground water monitoring to install borings and ground water monitoring wells as well as the method of construction for ground water monitoring wells. TVA shall propose a sampling plan to analyze soil, overburden and CCR material generated during on-site drilling for Appendix 3 and 4 CCR constituents. TVA shall only install the ground water monitoring wells and soil/rock borings after approval by TDEC.

5. Due to the 2008 CCR release, there is extens4e data for this site including ground water monitoring data. TVA should include a catalog of existing ground water monitoring wells and soil borings that will be used in determining ground water flow rates, current ground water elevation, direction of ground water flow, subsurface geological conditions and stability and characteristics of local hydrogeology. TVA shall provide a ground water monitoring schedule that identifies the ground water monitoring wells that will be sampled, sampling methodology, sample collection and transportation, analytical methods used for analyses and the qualifications of the laboratory performing the analyses. All samples shall be analyzed for Appendix 3 and IV CCR constituents. Disposal units regulated by a landfill permit will need to incorporate the additional constituents through the end of post closure care period.

6. TVA shall characterize the site's hydrogeology to better understand the cause of the Red-Water seeps at the East Dike/Engineered Red-Water Wetlands. The seeps need to be investigated to identify if the source of water generating the seeps is either infiltration through the Interim Ash Staging Area (ball field) or groundwater flow from offsite or perhaps another source.

   TDEC recommends closure of the Interim Ash Staging Area (ball field) and Sluice Channel to help eliminate Red-Water seep flow, treatment and mitigation. TVA shall collect representative soil and water samples from the Red-water seeps at the East Dike/Engineered Red-Water Wetlands and provide the analytical results for Appendix 3 & 4 CCR constituents found in those samples. The source of contaminants is a critical part of the environmental investigation.

7. Given the site stabilization work completed as a part of the CERCLA closure of the industrial landfill, additional analyses of the seismic stability of the Stilling Pond is

needed for the Stilling Pond once it is dewatered and site conditions if the Stilling Pond is closed in place. TVA shall provide a description of the methods it will employ to conduct seismic stability analyses, specifically, embankment liquefaction potential analysis for the Stilling Pond. TVA shall provide a schedule for conducting this analysis.

8. TDEC has reviewed EPA's comments about the seismic stability of the Stilling Pond. TDEC concurs with EPA's statement "the underlying potential for liquefaction-induced failure of these units remain a concern". The Stilling Pond at KIF is one of the units referenced.

9. TVA shall also propose the methodology it will use to determine the structural stability of the Stilling Pond area to determine if the Stilling Pond area has the load bearing capacity to remain stable after the Stilling Pond is dewatered. TVA shall conduct the same stability analysis to evaluate the possibility of closing the Stilling Pond in place. This analysis is needed to help determine if closure in place is an option for corrective action at the Kingston site. TVA shall provide a schedule performing this analysis. TVA shall address the foundation settlement and the potential for unconsolidated materials in the Stilling Pond area

TVA shall submit the proposed EIP for the TVA Kingston site on or before close of business on September 16, 2016.

It is our goal to work with TVA to ensure the environmental investigation of the TVA Kingston site is complete, accurate and timely. Please review the Kingston specific questions presented in this letter and Attachment A as you prepare the draft Kingston EIP. If you or staff members have any questions, please contact us.

Sincerely,

Chuck Head

Chuck Head

CC:	Shari Meghreblian, Ph. D.	Tisha C. Benton	Wilbourne C. Markham, Jr., P.E.
	E. Joseph Sanders	Britton Dotson	Samuel Hixson
	Patrick J. Flood, P.E.	Glen Pugh	Neil Carricker

Appendix A

General Guidelines for Environmental Investigation Plans

TVA Fossil Plants

TDEC anticipates that the 1st iteration of each TVA Environmental Investigation Plan (EIP) will generate comments and/or questions from TDEC as the review is conducted. TDEC recognizes that each TVA site will have differences due to local geology and plant operation. TDEC believes providing TVA with the guidance for the scope of work for the EIP will significantly limit review time and increase the pace of environmental investigation work at each TVA site. This guidance document is divided into 5 sections based upon different aspects of the TVA Fossil Plants that must be fully environmentally assessed to accurately characterize the site as required in the TN Department of Environment and Conservation (TDEC) and Tennessee Valley Authority Multi-site Order (Order). TDEC believes that successful implementation of the EIP and completion of the corresponding Environmental Assessment Report (EAR) shall provide sufficient information to determine the most appropriate corrective action options to address any environmental and/or public health concerns.

Environmental Investigation Plan Guidance

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:

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.

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.

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);

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.

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.

   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.

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;

<u>B. Water Use Survey</u>

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.

C. Groundwater Monitoring and Mapping

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 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 shall be analyzed for the CCR constituents listed in **Appendices** 3 and 4 of the federal CCR regulations. Items to include in the EIP are:

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.

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

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 CRCR 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.

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

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.

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. 7.

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

D. TVA Site Conditions

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;

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.

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.

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

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.

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.

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.

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.

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.

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 **analyse**s 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.**

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.

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 non-registered 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.

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).

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.

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 a 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 shall also describe in the EIP how it will assess any impact CCR material and/or dissolved CCR constituents may have on water quality and/or the impact on fish and aquatic life.

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.

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.

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.

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).

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.

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.

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.

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.

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402-2801

March 6, 2017

Ms. Tisha Calabrese Benton
Division of Water Resources
Tennessee Department of Environment
and Conservation (TDEC)
William R. Snodgrass Building TN Tower
312 Rosa L Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1548

Mr. Patrick J. Flood
Division of Solid Waste Management
Tennessee Department of Environment
and Conservation
William R. Snodgrass TN Tower
312 Rosa L. Parks Ave. 14th Floor
Nashville, Tennessee 37243-1548

Dear Ms. Benton and Mr. Flood:

TENNESSEE VALLEY AUTHORITY (TVA) – KINGSTON FOSSIL PLANT (KIF) – NPDES PERMIT NO. TN0005452 – STILLING POND CLOSURE PLAN

As discussed in TVA's October 19, 2016 letter to TDEC, TVA has completed construction of the polishing pond at KIF, which takes the place of the existing stilling pond, and the new polishing pond is receiving plant wastewaters for final treatment prior to discharging through NPDES Outfall 001. TVA has begun preliminary drawdown of the stilling pond as authorized in Section VII.D.4 of Commissioner's Order OGC15-0177 (Order) to install infrastructure connecting the polishing pond to the existing NPDES outfall structure. This infrastructure will be utilized to implement an operational pool lowering plan during the stilling pond closure to ensure wastewater discharges from Outfall 001 continue to maintain compliance with the NPDES permit and remain protective of in-stream water quality.

As part of the Environmental Protection Agency's (EPA) Assessment of Coal Ash Impoundments, TVA has been informing EPA of seismic analyses of the stilling pond since EPA completed its final review and report of the stilling pond on June 13, 2013. The purpose of EPA's assessment was to determine whether the stilling pond was structurally stable and if any corrective measures were needed. Since then, TVA has completed various action plans, analyses, and reports on the stilling pond that included studies on seismic stability, post seismic deformation and liquefaction potential. The results of these studies were submitted to EPA with TDEC included on the correspondence. When analyzing the stilling pond in a closed condition, the results of the analysis indicated there would not be a release of CCR to the environment as a result of the evaluated seismic event. Also, a key component to the EPA approved closure of the adjacent Kingston Recovery Project Ash Landfill is the buttress effect of the closed stilling pond. As stated in TVA's letters to EPA and TDEC, TVA committed to closing the stilling pond by April 17, 2018 which would address the seismic stability. EPA is copied on this closure plan submittal for an Assessment update.

TVA completed its Ash Impoundment Closure Environmental Impact Statement (EIS) in June 2016. Part I of this EIS evaluated Closure-in-Place and Closure-by-Removal scenarios on a programmatic basis. Part II of this EIS included a site-specific review for KIF which encompassed the stilling pond. Analysis of the alternatives included examining subject areas such as groundwater impacts, transportation, public health and safety, etc. The EIS identified closure-in-place as the preferred closure method for the stilling pond given that the stilling pond could be closed within 5 years as required by 40 CFR 257.102(f) using this method, and this method would avoid adverse impacts associated with the off-site transport of 700,000 cubic yards of CCR. By contrast, off-site transport was estimated to take over ten years because of the amount of CCR and because maintaining the stability of the adjacent landfill perimeter berm required excavated CCR to be replaced with borrow in a controlled manner.

A stilling pond closure plan has been completed that complies with the standards in TDEC Solid Waste Management regulations Chapter 0400-11-01 and 40 CFR 257.102(d). The stilling pond last received wastewater on December 16, 2016. Per 40 CFR 257.102(e), TVA was required to and did initiate closure activities of the stilling pond within 30 days after the date on which the CCR unit received the final receipt of waste, CCR or non-CCR. The initial closure activities included the aforementioned preliminary drawdown of the stilling pond into the completed polishing pond, which is necessary first step towards closure. Per 40 CFR 257.102(f), TVA must complete closure of the stilling pond within five years of commencing closure activities, absent force majeure situations for which the CCR Rule allows limited extensions.

TVA is closing the stilling pond in accordance with Section VII.D.1 the Order. In this section, TDEC recognizes that TVA may, in compliance with CCR Rule requirements, elect to close CCR surface impoundments before the investigative process outlined in the Order is complete. While TVA must commence closure of the stilling pond to meet the required CCR Rule closure completion date and an EPA commitment, TVA remains dedicated to the Order and completing the site-wide investigation, comprehensive environmental assessment, and any corrective actions identified. TVA recognizes that TDEC may later require TVA to take other and/or further remedial actions with respect to the stilling pond deemed appropriate as a result of the investigative process.

In summary, TVA plans to continue stilling pond closure activities by beginning construction in April 2017 and ultimately close the stilling pond with CCR in place by TVA's closure commitment date to EPA of April 17, 2018. This closure method is congruent with TVA's analysis in the EIS, is in compliance with TDEC Solid Waste Management regulations Chapter 0400-11-01 and 40 CFR Part 257, and is in accordance with the Order.

Enclosed is the closure plan for the KIF stilling pond for your review. TVA requests any TDEC comments be submitted within 30 days after receipt of this letter. As indicated in TVA's letter of February 9, 2017, to Commissioner Martineau, TVA will place the stilling pond closure plan into TVA's operating record and on TVA's CCR Rule website.

If you have questions regarding this information, please contact Paul Pearman at (423) 751-3972 or by email at *pjpearman@tva.gov*. You may also contact me at (423) 751-3304 or by email at *sstidwell@tva.gov*.

Sincerely,

M. Susan Smelley

M. Susan Smelley
Director
Environmental Compliance and Operations

Enclosures

cc: (Enclosures)

Mr. Michael Atchley
Knoxville Environmental Field Office
Tennessee Department of Environment and Conservation
3711 Middlebrook Pike
Knoxville, Tennessee 37921-5602

Mr. Revendra Awasthi
Knoxville Environmental Field Office
Division of Solid Waste Management
Tennessee Department of Environment and Conservation
3711 Middlebrook Pike
Knoxville, Tennessee 37921-5602

Mr. Robert Burnette, P.E.
Tennessee Department of Environment and Conservation
1301 Riverfront Parkway, Suite 206
Chattanooga, Tennessee 37402

Mr. Chuck Head
Tennessee Department of Environment and Conservation
William R. Snodgrass TN Tower
312 Rosa L Parks Avenue
Nashville, Tennessee 37243-1548

Mr. Vojin Janjic
Division of Water Resources
Tennessee Department of Environment and Conservation
William R. Snodgrass TN Tower
312 Rosa L Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1548

Mr. Barnes Johnson
Director, Office of Resource Conservation and Recovery
U.S. EPA Headquarters
William Jefferson Clinton Building
1200 Pennsylvania Avenue, N. W., 5310P
Washington, DC 20460

cc: (w/o Enclosures)

Mr. Glen Pugh
Division of Solid Waste Management
Tennessee Department of Environment and Conservation
William R. Snodgrass TN Tower
312 Rosa L. Parks Avenue, 14th Floor
Nashville, Tennessee 37243

Mr. E. Joseph Sanders
Office of General Counsel
Tennessee Department of Environment and Conservation
William R. Snodgrass TN Tower
312 Rosa L. Parks Avenue, 2nd Floor
Nashville, Tennessee 37243

Ms. Jenny Howard
Office of General Counsel
Tennessee Department of Environment and Conservation
William R. Snodgrass TN Tower
312 Rosa L. Parks Avenue, 2nd Floor
Nashville, Tennessee 37243

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@tn.gov

Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

May 3, 2017

M. Susan Smelley, Director
Environmental Compliance and Operations
Tennessee Valley Authority
1101 Market Street, BR 4A,
Chattanooga, Tennessee 37402-2801

RE: TVA Kingston Coal Fired Power Plant
Proposed Stilling Pond Closure
March 6, 2017 TVA Letter and Closure Plan

Dear Ms. Smelley;

The TN Department of Environment and Conservation (TDEC) reviewed your March 6, 2017 letter (the letter) and the accompanying closure plan for the Stilling Pond at the Tennessee Valley Authority (TVA) Kingston Coal Fired Power Plant (Fossil Plant). TDEC understands that TVA is currently working to meet two different requirements at the Kingston Fossil Plant.

1. The Coal Combustion Residual (CCR) Regulations issued by The U. S. Environment Protection Agency (EPA) on April 17, 2015; and [1]
2. TDEC Commissioner's Order OGC15-0177 (the Order).

The EPA CCR regulations require TVA to close CCR surface impoundments meeting the criteria for closure and the deadlines for closure as set by rule. Your letter and accompanying documents describe TVA's plan to close the TVA Kingston Fossil Plant Stilling Pond in place.

The Order requires TVA to perform specific activities at seven[1] TVA Fossil Plants in Tennessee. For each TVA Fossil Plant site, TVA is required to:

1. Develop an Environmental Investigation Plan (EIP) to determine the extent of CCR contamination at each TVA Fossil Plant;

[1] The environmental investigation and remediation of CCR materials disposed at the TVA Gallatin Fossil Plant is being completed under an Agreed Temporary Injunction administered by the Chancery Court of Davidson County

2. Conduct the environmental investigation after TDEC approves the EIP;
3. Prepare an Environmental Assessment report that determines the location and amount of all CCR material at the site, evaluates the impact of CCR disposal on public health and the environment;
4. Submit a Corrective Action/Risk Assessment (CARA) Plan for TDEC review and approval; and
5. Upon approval by TDEC, TVA is required to take corrective measures as identified in the CARA Plan.

The Order is not intended to prevent TVA from meeting the requirements of the EPA CCR regulations. Specifically, Paragraph VI. D. 1. states:

"The requirements of Sections A. and B. of this Order are supplemental to the CCR rule and are not intended to impede or delay actions that TVA takes in compliance with CCR rule requirements. The Department recognizes that TVA may, in compliance with CCR rule requirements, elect to close CCR surface impoundments and/or landfills before the full extent of contamination at a site has been determined. However, if TVA elects to do so, it may later be required by Section A. of this Order to take other and further remedial actions."

However, Paragraph VII.D. of the Order does provide TDEC the opportunity to review and comment on plans developed by TVA to comply with the EPA CCR regulations. Specifically Paragraph VII. D. 3. states:

"*The Department shall have 60 days to review CCR rule related plans, demonstrations, and assessments, after they are placed on TVA's public CCR rule website. If the Department does not inform TVA that it has comments on a plan, demonstration, or assessment within this 60-day period, TVA may proceed with such plan, demonstration, or assessment.* ***If the Department informs TVA that it has comments, the Department and TVA shall meet to discuss those comments within 30 days. Thereafter, TVA shall appropriately modify its plans, demonstrations, or assessments to respond to the Department's final comments and resubmit the plan, demonstration, or assessment to the Department. Thirty (30) days thereafter, unless informed otherwise by the Department, TVA may proceed with such plan, demonstration, or assessment****. The Department's review and comment on a CCR-rule plan, demonstration, or assessment shall not be deemed its approval of actions required under Section A of this Order. However, TVA may assume the risk of implementing a CCR-rule plan"*

TDEC has performed an initial review of the TVA Kingston Stilling Pond Closure Plan. There were seismic and structural stability assessments completed when TVA submitted its Corrective Action Plan for the TVA Kingston CCR Landfill release. Theses analyses determined the need for substantial subsurface stability improvements as a part of the final Corrective Action Plan. At this time, TVA has not completed an Environmental Investigation for the TVA Kingston Fossil Plant as required by the Order.

Per this letter, TDEC plans to provide TVA with comments regarding the Stilling Pond Closure Plan, as allowed in Paragraph VII. D.3. TDEC suggests meeting to discuss the proposed TVA Kingston Stilling Pond Closure Plan.

If you have questions or concerns, please contact me.

Sincerely,

Chuck Head

Chuck Head

CC:	Robert J. Martineau, Jr.	Tisha Calabrese-Benton	Roy Quinn
	Shari Meghreblian	Patrick J. Flood	Anna Fisher
	Jenny Howard	Emily Vann	Paul Pearman
	Joseph Sanders	Britton Dotson	Rob Burnette

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

June 22, 2017

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

RE: TDEC Commissioner's Order OGC 15-1077
TVA Coal Fired Fossil Fuel Plants
Environmental Investigation Plans
Conference Dates and EIP Due Dates

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.

Environmental Investigation Plan Submittals

TDEC and TVA have discussed the format of the Environmental Investigation Plans for the seven TVA Coal Fired Power Plants included in the Commissioner's Order. The sites included in the Commissioner's Order are:

- the TVA Allen Fossil Plant (TVA ALF);
- the TVA Bull Run Fossil Plant (TVA BRF);
- the TVA Cumberland Fossil plant (TVA CUF);
- the TVA Johnsonville Fossil Plant (TVA JoF);
- the TVA John Sevier Fossil Plant (TVA JSF);
- the TVA Kingston Fossil Plant (TVA KIF); and
- the TVA Watts bar Fossil Plant (TVA WBF).

TVA and TDEC met to discuss the format for the Environmental Investigation Plans (EIPs) after the first submission of the TVA CUF EIP. During this discussion, TDEC and TVA determined that the best approach to the investigation of the seven sites was to develop a comprehensive EIP. The EIP should include all activities planned for the initial investigation of each site, maps with historical and current information, identification of soil, ground water and surface water sampling; the methods to be employed to determine ground water elevations, flow rate and velocity, etc. We also discussed including the Standard Operating Procedures, Quality Assurance Project Plans, Sample Collection and Analysis Methods, Procedures for installation of Soil Borings and Monitoring Wells, etc. in the Appendices of the EIP for each site. The primary purpose of the EIP is to provide TDEC and the public with a complete description of the CCR site investigation activities and a schedule for those activates.

TDEC's goal is to work with TVA to ensure the environmental investigation of each TVA site is complete, accurate and timely. We believe working with TVA, following the protocol above, will help TDEC and TVA reach these goals. TVA is required to post each EIP for public notice and comment, once it is approved by TDEC as complete. The greater the detail of the EIP, the better the public will understand how each TVA site will be investigated.

TVA has submitted Revision 1 of the TVA CUF and TVA ALF EIPs to TDEC for review, following the structure described above. TDEC has found this EIP format to be comprehensive and practical. TDEC and TVA plan to meet on June 29, 2017 to discuss the status of the TVA JoF EIP, which has a due date of July 24, 2017. The pre-EIP Submittal meetings have been very helpful in exchange of thoughts, ideas and questions for each site.

Per our conversations, TDEC and TVA have agreed to a schedule for submission of the Revision 1 EIPS for TVA BRF, TVA JSF, TVA KIF and TVA WBF sites. This letter formalizes that schedule. The table below includes the dates for submittal of Revision 1 EIPs.

TVA CCR Environmental Investigation Plan Due Dates

TVA Coal Fired Power Plant	EIP Due Date
TVA Kingston	9/8/2017
TVA Bull Run	10/27/2017
TVA John Sevier	12/15/2017
TVA Watts Bar	2/09/2018

Attached to this letter are environmental investigation comments for the TVA BRF and KIF sites. We will provide comments for the TVA JSF and TVA WBF by July 15, 2017. We look forward to working with TVA in the investigation and remediation of each TVA CCR site. If you have questions or concerns about this letter, please give me a call.

Sincerely,

Chuck Head

Chuck Head

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

Bull Run (BRF) Environmental Investigation Comments and Questions

General

- Bedding Planes dip 30-40 degrees to the southeast. Groundwater will typically flow in the direction of dip. Was the bedding planes considered when TVA selected locations for groundwater monitoring wells? TVA should demonstrate how the underlying strata near the Bull Run property influence the direction of groundwater flow. TVA's monitoring well locations at all ash disposal areas should be selected based on these findings.

- Two fault lines were identified on crossing the TVA Bull Run property. Were the faults considered when TVA selected locations for groundwater monitoring wells? TVA should demonstrate how the direction of groundwater flow is or could be influenced by the underlying faults at the Bull Run property and show how the well locations were selected. If groundwater is flowing along these fault lines, TVA should place monitoring wells at adequate locations to properly monitor it.

- The off-site water use survey needs to be updated and all potential supply sources verified whether used for human consumption or otherwise.

- The Groundwater Use Survey identifies multiple residential wells and municipal water intakes within one mile of the landfill. The water supply points within the one-mile range must be evaluated and sampled to determine if the water is impacted from CCR waste.

- Settlement analysis reference on page 84 of the multisite order presentation appears to have been misinterpreted from a previous TDEC questions. Please provide available documents relating to foundation settlement that may have or is calculated to occur as a result of the CCR loading on the natural foundation.

- Provide seismic stability calculations for Phase I of the Dry Fly Ash Stack, the Bottom Ash Disposal Area and the Gypsum Disposal Area 2A.

Dry Ash Stack – IDL 01 000 0080

- Residuum and upper bedrock hydrogeology and geotechnical properties appear to be adequately characterized. However, water-bearing zones in deeper bedrock are not characterized. The potential for downward vertical migration of CCR ash-derived contaminants, the potential for their migration along deeper structural and stratigraphic interfaces, and any bedrock migration fate and transport considerations have not been evaluated. To fully understand potential contaminant migration and risks to potential receptors, the vertical gradients and flow patterns need to be established.

- 8 monitoring wells were installed from 1983 to 1990, and 6 observation wells were installed from 2005 to 2006. Where are these wells and are they still being used? Reference page 90 of the multisite order presentation.

- The DSWM SW Rules requires that all permitted facilities that go into assessment submit a Ground Water Quality Assessment Plan. TVA should submit this plan and incorporate all comments/concerns addressed in this review.

- Please provide the current permitted version for drawing 10W299-11 as indicated on page 162 of the multisite order presentation. Please clarify if TVA plans to submit a vertical expansion overlaying phases I & II as indicated in the May 11, 2012 letter to Rick Brown. This expansion is also noted in Volume II of III of the Phase III Expansion permit document for IDL01-0080. This will direct the landfill's regulation under the Federal CCR rule and will also provide guidance on future closure plan submittals. Please confirm volumes and projected landfill life calculations presented in the approved permit documents and that site operations have the final approved plans.

- The document provided to TDEC identified as BRF47_102-229 Slope Stability Analyses Revised 082911 is not the final permitted stability calculations for the Dry Fly Ash Stack. The permitted stability calculations were submitted as on April 4, 2012. Please verify the current landfill geometry with the permitted documents and provide stability calculations for Phase I of the Dry Fly Ash Stack.

- Justify using a peak ground acceleration of 0.21g in the seismic stability analysis for the Dry Fly Ash Stack.

- Provide documentation and drawing illustrating the limits of closure for Phase I for the Dry Fly Ash Stack

Rail Loop

- No hydrogeologic, geotechnical, or structural stability assessments have been conducted at the Rail Loop site. Full subsurface characterization needs to be conducted to understand any potential groundwater or surface water impacts, contaminant fate/transport considerations and structural instability issues there may be.

- The Draft EIS for TVA Bull Run Fossil Plant Landfill Environmental Review, Project Number 2012-33, makes reference to a spring at The Rail Loop site. Please locate this feature on a map in relationship to the CCR limits.

Bottom Ash/Gypsum Ponds - IDL 01 000 0280

- When the Ash Ponds were originally constructed and the initial wastes placed, the pond bottoms were natural soil (elevation approx. 788 MSL) above the reservoir water level elevation (approx. 768 MSL). The current reservoir level is approximately 795 MSL. Despite claims that natural soils and dykes are composed of low permeability clays that affect "separation" of waste from the reservoir, the reservoir elevation and groundwater elevations in monitoring wells at the site indicate waste is likely to be submerged in groundwater at the lower levels of the fill.

- The Uppermost Aquifer cannot be adequately defined if water level data reflect saturated zones influenced by the ponds, sluice channels, saturated ash, and river elevations.

- The nature of groundwater flow and hydraulic interconnection between the waste, dykes, natural soils, and the ultimate discharge to the reservoir or deeper geologic formations are unknown. Vertical gradients between saturated waste, groundwater in unconsolidated deposits, and groundwater in bedrock have not been characterized. The dynamics of groundwater flow through the waste, dykes, pond floor and underlying soils, and bedrock need to be characterized to determine if potential contaminants from the waste fill migrate (or have the potential to migrate) from the unit and not be monitored by the existing shallow groundwater monitoring network.

- Historical groundwater data from sampled monitoring wells around the ponds complex indicates numerous statistically significant exceedances of monitored constituents above background. Likewise, there have been periodic MCL exceedances. These have typically been attributed to “naturally occurring” elements, excessive turbidity in groundwater samples, and/or laboratory/analysis-related interferences. Stated advantages of the Closure Plan include “improved groundwater quality”. It is unclear to the reviewer to what extent the waste ponds have affected groundwater quality, to what extent offsite resources are impacted, and what basis the Owner has for stating that Closure will result in improved groundwater quality. If the facility has caused groundwater degradation that Closure is purported to alleviate, the Owner needs to state to what the extent groundwater has been degraded, how the Closure will improve the degradation, and to what extent.

- TVA must install monitoring wells screened in bedrock and located in appropriate locations to adequately define the potentiometric surface and monitor groundwater.

- The DSWM SW Rules requires that all permitted facilities that go into assessment submit a Ground Water Quality Assessment Plan. TVA should submit this plan and incorporate all comments/concerns addressed in this review.

- Please provide locations and inverts for the French drains installed in the Gypsum Disposal Area 2A.

- Please clarify the Gypsum Stack volume on page 160 of the multisite order presentation. The CCR volume and size provided indicate an average depth of 10 to 11 feet. Section I-I’ on page 78 of the multisite order presentation does not identify gypsum in the disposal units stratigraphy. TVA shall provide details of the stratigraphy of the Gypsum Disposal Area 2A, from the final grade to bedrock. TVA shall provide stability calculations that include the Gypsum’s material properties and account for the Gypsum in the analysis.

- Clarify the ratio of sluiced fly ash to bottom ash for material; contained in the Bottom Ash Disposal Area. Section D-D’ on page 76 of the multisite order presentation indicates a majority of the CCR depth is sluiced fly ash. Would the CCR closure elevations indicated on page 155 of the multisite order intersect (excavate into) the sluiced fly ash? Please provide a detail of the stratigraphy of the Bottom Ash Disposal Area from the final grade to bedrock.

- Please provide a schedule for determining the Stilling Pond CCR volume and the test methods that will be used to determine the types and amounts of CCR materials in the Stilling Pond.

- Identify the test methods to be used (in situ or remolded) to determine the permeability of clay below the CCR disposal areas. Explain why permeability tests were not performed below the Gypsum Disposal Area 2.

- Clarify if the ash disposal line presented on page 19 of the multisite order presentation has been abandoned. TDEC requests that TVA verify the location of seep investigations that have been conducted, the repairs made to the seeps and whether any seeps continue to flow including TVA repaired seeps.

- The stability calculations should evaluate the south corner of Gypsum Disposal Area 2A. This area is of interest due to its proximity to the original flow path of Bull Run Creek and because it is not known if clay foundation soils are present in this area.

<u>TVA Kingston (KIF Environmental Investigation Comments and Questions</u>

TDEC requests that TVA provide responses to the points presented below in the revised EIP for the TVA Kingston site. TDEC has followed the format TVA used with the submittal of the TVA Cumberland Rev. 1 Environmental Investigation Plan.

1. Site Specific Information

- Existing or additional site characterization shall include a discussion of fluctuations in ground water elevations that may be connected to Watts Bar Lake levels, seasonal variations or other factors.
- Existing or additional site characterization shall estimate the amount of CCR material that is below the upper most aquifer for the Stilling Pond, historic Sluice Channel and the “ball field” temporary storage area. The upper most aquifer must be identified to accurately make this determination.
- TVA shall provide a schedule for the placement of any additional borings/monitoring wells proposed at the Kingston site as well as a map identifying the location all borings and monitoring wells that TVA plans to use as a part of its Environmental Investigation (existing and proposed). TVA shall present the reasons for selecting the location of additional boings/monitoring wells at the site. Further, TVA shall install/identify two ground water monitoring wells to serve as background ground water monitoring wells for the site. TVA shall have a TN Licensed Professional Geologist on site to log the installation borings and/or ground water monitoring to install borings and ground water monitoring wells as well as the method of construction for ground water monitoring wells. TVA shall propose a sampling plan to analyze soil, overburden and CCR material generated during on-site drilling for Appendix III and IV CCR constituents.
- TVA shall characterize the site’s hydrogeology to better understand the cause of the Red-Water seeps at the East Dike/Engineered Red-Water Wetlands. The investigation should determine if the source might be either infiltration through the Interim Ash Staging Area (ballfield) or groundwater flow from offsite.
- TVA shall gather sufficient information to provide a three dimensional picture of the CCR material disposed in the Stilling Pond, Sluice Trench and “Ballfield” area. TVA shall gather enough information to determine the volume of CCR material disposed in each area.

2. Hydrogeologic Report

- TVA shall collect sufficient data from existing and proposed ground water monitoring wells and from existing and proposed soil borings to allow TVA to determine the following results that will be included in the Environmental Assessment Report:

  i. A ground water map for the site presenting the ground water elevation

  ii. Ground water flow rate and direction; and

iii. Location of ground water monitoring wells where the level of CCR constituents exceed the EPA CCR levels provided in Appendices III and IV of the rule;

3. Water Use Survey

- TVA shall conduct a water use survey as required by TDEC for the environmental investigation at other TVA Coal fired power plants. The survey shall include water wells and springs used by for either domestic or business purposes.

4. Ground Water Monitoring

- Due to the 2008 CCR release, there is extensive data for this site including ground water monitoring data. TVA should include a catalog of existing ground water monitoring wells that will be used in determining ground water flow rates, current ground water elevation and direction of ground water flow. TVA shall propose additional ground water monitoring wells, as needed, to accurately identify ground water quality, flow direction, velocity, quality and influence due to release of CCR constituents. TVA shall provide a ground water monitoring schedule that identifies the ground water monitoring wells that will be sampled, sampling methodology, sample collection and transportation, analytical methods used for analyses and the qualifications of the laboratory performing the analyses. All samples shall be analyzed for Appendix III and IV CCR constituents. Disposal units regulated by a landfill permit will need to incorporate the additional constituents through the end of post closure care period.

5. Ground Water - Chemical and Physical Properties

- Ground Water samples analyzed from Monitoring Well KIF-22 exceeded the Drinking Water MCL for Arsenic. TVA suggested the AS levels were higher than TVA Kingston Fossil Plant Environmental Investigation Plan expected due to the influenced of Total Suspended Solids in the ground water samples taken. TVA shall provide a science based explanation of this statement. TVA should explain its position that the Stilling Pond is contributing to the AS levels in Monitoring Well KIF-22.

- TVA shall determine if the level of the ground water at the TVA KIF site is controlled by the level of the Emory River. If the Emory River affects the ground water level, then TVA shall collect data to determine the extent of the impact of the Emory River on the ground water table below the TVA KIF site.

6. Structural and Seismic Stability

- Given the site stabilization work completed as a part of the CERCLA closure of the industrial landfill, additional analyses of the structural and seismic stability of the Stilling Pond is needed for the Stilling Pond once it is dewatered to determine if the Stilling Pond may be closed in place. TDEC has reviewed EPA's comments about the seismic stability of the Stilling Pond. TDEC concurs with EPA's statement "the underlying potential for liquefaction-induced failure of these units remains a concern". The Stilling Pond at KIF is one of the units referenced.

- TVA shall provide a description of the methods it will employ to conduct seismic stability analyses, specifically, embankment liquefaction potential analysis for the Stilling Pond. TVA shall provide a schedule for conducting this analysis.

- It is our understanding that TVA has conducted seismic analyses for the Stilling Pond area and that if the Stilling Pond were closed in place there would be movement of Stilling Pond during a seismic event. TDEC cannot approve closure of the Stilling Pond in place, if the seismic and structural stability of the Stilling Pond does not meet the criteria established in the U.S. Environmental Protection Agency Coal Combustion Residual Rule, even if the Stilling Pond may not be “specifically” subject to those rules.

7. Site Geology

- Due to the 2008 CCR release, there is extensive data for this site including subsurface geology. TVA should include a catalog of existing ground water monitoring wells and soil borings subsurface geological conditions and stability and characteristics of local hydrogeology. TVA shall propose the location and construction of additional ground water monitoring wells and soil borings that will provide data to fully characterize the geology of this site.

- TVA shall collect sufficient data to prepare a three dimensional picture of the subsurface environment from ground surface to bedrock. This shall include the depth of CCR material and native soil, sand and rock, the physical characteristics of these materials and any geologic anomalies discovered during investigation.

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
William R. Snodgrass - Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1102

July 28, 2017

TN Valley Authority
c/o John Kammeyer
1101 Market Street, Mail Stop LP 5D-C
Chattanooga, TN 37402

Subject: Individual ARAP Permit/§401 Water Quality Certification
NRS16.142
Eastern Dike Repair
TVA Kingston Fossil Plant
Emory River Watershed
Robertson County, TN

Dear Mr. Kammeyer:

We have reviewed your proposal to make repairs along the eastern dike at the TVA Kingston Fossil Plan. These activities have been modified based on public comments and efforts by the TVA to avoid and minimize impacts to Waters of the State. This activity includes1000 linear feet of dike stabilization with a reverse grade aggregate filter structure and to replace an outfall structure. The reverse grade filter structure will also include a seepage collection system. These impacts will occur in the KIF artificial channel along the Emory River. Mechanisms for the purpose of managing, collecting, and treating seepage flow must conform to the terms and conditions of the NPDES permit.

The attached Aquatic Resource Alteration Permit/§401 Water Quality Certification authorizes the work you have proposed in your application.

This activity is governed by the enclosed permit. The work must be accomplished in conformance with accepted plans and information submitted in support of application NRS16.142 and the limitations and conditions set forth in the permit (enclosed). It is the responsibility of the permittee to ensure that all contractors involved with this project have read and understand the permit conditions before the project begins.

Coverage Termination
Authorization under this permit cannot be extended beyond the expiration date. If all work is not completed on or before July 27, 2022 it is the applicants responsibility to apply for additional coverage.

Thank you for your time and consideration. If you have any questions please contact me by e-mail at *Vena.L.Jones@tn.gov or by phone at (615) 253-5320*

Sincerely,

Vena Jones
Natural Resources Unit

Encl: copy of permit
CC: DWR, Nashville Environmental Field Office
Brad Love, TVA
Tennessee Clean Water Network
Amanda Garcia, SELC
Terry Cheek, TVA
U.S. Army Corps of Engineers, Nashville Regulatory Branch
File copy

STATE OF TENNESSEE

§401 WATER QUALITY CERTIFICATION

AQUATIC RESOURCE ALTERATION PERMIT NRS16.142

Pursuant to §401 of *The Federal Clean Water Act* (33 U.S.C. 1341), any applicant for a Federal license or permit to conduct any activity which may result in any discharge into the waters of the U.S., shall provide the federal licensing or permitting agency a certification from the State in which the discharge originates or will originate. Accordingly, the Division of Water Resources requires reasonable assurance that the activity will not violate provisions of *The Tennessee Water Quality Control Act of 1977* (T.C.A. §69-3-101 et seq.) or provisions of §§301, 302, 303, 306 or 307 of *The Clean Water Act.*

Subject to conformance with accepted plans, specifications and other information submitted in support of the application, pursuant to 33 U.S.C. 1341 the State of Tennessee hereby certifies the activity described below. This shall serve as authorization under T.C.A. §69-3-101 et seq.

PERMITTEE: TN Valley Authority
c/o John Kammeyer
1101 Market Street, Mail Stop LP 5D-C
Chattanooga, TN 37402

AUTHORIZED WORK: The Tennessee Valley Authority is authorized to make repairs along the eastern dike at the TVA Kingston Fossil Plan. These activities have been modified based on public comments and efforts by the TVA to avoid and minimize impacts to Waters of the State. This activity includes1000 linear feet of dike stabilization with a reverse grade aggregate filter structure and to replace an outfall structure. The reverse grade filter structure will also include a seepage collection system. These impacts will occur in the KIF artificial channel along the Emory River. Mechanisms for the purpose of managing, collecting, and treating seepage flow must conform to the terms and conditions of the NPDES permit.

LOCATION: 714 Swan Pond Road, Harriman, TN 37748

Impact 1:
Latitude 35.902959 Longitude -84.514748
Impact 2:
Latitude 35.900718 Longitude -84.517961

EFFECTIVE DATE: July 28, 2017

EXPIRATION DATE: July 27, 2022

Tisha Calabrese Benton
Director, Division of Water Resources

RDA 1071 MINOR

Table of Contents

PART I

Authorized Impacts:

STR-1: Emory River (TN06010208001_2000)
Latitude 35.902959 Longitude -84.514748
1000 linear feet of a reverse grade aggregate filter and a lined seepage collection system along the dike in the intake channel.

STR-1: Emory River (TN06010208001_2000)
Latitude 35.900718 Longitude -84.517961
An outfall replacement for a 42" reinforced concrete pipe including riprap outlet protection.

Special Conditions:

a. The work shall be accomplished in conformance with the revised and accepted plans, specifications, data and other information submitted in support of the revised application NRS16.142 and the limitations, requirements and conditions set forth herein.

b. Mechanisms for the purpose of managing, collecting, and treating seepage flow must conform to the terms and conditions of the NPDES permit.

c. All riprap areas shall be placed as to mimic the existing/proposed contours of the stream bank. Riprap shall be countersunk and placed at the grade with the existing stream substrate.

d. Voids within the riprap shall be filled with suitable substrate to prevent loss of stream within the riprap areas. Do not over-excavate for placement of riprap. Grouting of riprap is prohibited.

e. The use of monofilament-type erosion control netting or blanket is prohibited.

f. Best Management Practices (BMPs) shall be stringently implemented throughout the construction period to prevent sediments, oils, or other project-related pollutants from being discharged into the Willow Branch or its tributaries.

g. Streambeds shall not be used as transportation routes for construction equipment. Temporary stream crossings shall be limited to one point in the construction area and erosion prevention and sediment control measures shall be utilized where stream banks are disturbed.

h. Appropriate steps shall be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the state. All spills must be reported to the appropriate emergency management agency, and measures shall be taken immediately to prevent the pollution of waters of the state, including groundwater, should a spill occur.

General Conditions:

a. It is the responsibility of the permittee to convey all terms and conditions of this permit to all contractors. A copy of this permit, approved plans and any other documentation pertinent to the activities authorized by this permit shall be maintained on site at all times during periods of construction activity.

b. Work shall not commence until the permittee has received the federal §404 permit from the U. S. Army Corps of Engineers, a §26a permit from the Tennessee Valley Authority or authorization under a Tennessee NPDES Storm Water Construction Permit where necessary. The permittee is responsible for obtaining these permits.

c. All work shall be carried out in such a manner as will prevent violations of water quality criteria as stated in Rule 0400-40-03-.03 of the Rules of the Tennessee Department of Environment and Conservation. This includes, but is not limited to, the prevention of any discharge that causes a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the uses designated by Rule 0400-40-04. These uses include fish and aquatic life (including trout streams and naturally reproducing trout streams), livestock watering and wildlife, recreation, irrigation, industrial water supply, domestic water supply, and navigation.

d. Impacts to waters of the state other than those specifically addressed in the plans and this permit are prohibited. All streams, springs and wetlands shall be fully protected prior, during and after construction until the area is stabilized. Any questions, problems or concerns that arise regarding any stream, spring or wetland either before or during construction, shall be addressed to the Division of Water Resource's Knoxville's Environmental Field Office (865-594-6035), or the permit coordinator in the division's Natural Resources Unit (615-253-5320).

e. Adverse impact to formally listed state or federal threatened or endangered species or their critical habitat is prohibited.

f. This permit does not authorize adverse impacts to cultural, historical or archeological features or sites.

PART III

Duty to Reapply

If any portion of the permitted activities, including the authorized impacts to water resources, compensatory mitigation requirements, or post-project monitoring is not completed before the expiration date of this permit the permittee must apply for permit re-issuance. The permittee shall submit such information and forms as are required to the director of the Division of Water Resources at least ninety (90) days prior to its expiration date. Such applications must be properly signed and certified.

Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

Other Information

If the permittee becomes aware that he/she failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, then he/she shall promptly submit such facts or information.

Changes Affecting the Permit

Transfer/Change of Ownership

a. This permit may be transferred to another party, provided there are no activity or project modifications, no pending enforcement actions, or any other changes which might affect the permit conditions contained in the permit, by the permittee if:

b. The permittee notifies the Director of the proposed transfer at least 30 days in advance of the proposed transfer date;

c. The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage, and contractual liability between them; and

d. The Director does not notify the current permittee and the new permittee, within 30 days, of his intent to modify, revoke, reissue, or terminate the permit, or require that a new application be filed rather than agreeing to the transfer of the permit.

e. The permittee must provide the following information to the division in their formal notice of intent to transfer ownership:

    i. the permit number of the subject permit;
    ii. the effective date of the proposed transfer;
    iii. the name and address of the transferor;
    iv. the name and address of the transferee;
    v. the names of the responsible parties for both the transferor and transferee;
    vi. a statement that the transferee assumes responsibility for the subject permit;
    vii. a statement that the transferor relinquishes responsibility for the subject permit;
    viii. the signatures of the responsible parties for both the transferor and transferee, and;
    ix. a statement regarding any proposed modifications to the permitted activities or project, its operations, or any other changes which might affect the permit conditions contained in the permit.

Change of Mailing Address

The permittee shall promptly provide to the Director written notice of any change of mailing address. In the absence of such notice the original address of the permittee will be assumed to be correct.

Noncompliance

Effect of Noncompliance

All discharges shall be consistent with the terms and conditions of this permit. Any permit noncompliance constitutes a violation of applicable State and Federal laws and is grounds for enforcement action, permit termination, permit modification, or denial of permit reissuance.

Reporting of Noncompliance

24-Hour Reporting

a. In the case of any noncompliance which could cause a threat to public drinking supplies, or any other discharge which could constitute a threat to human health or the environment, the required notice of non-compliance shall be provided to the Division of Water Resources in the appropriate Environmental Field Office within 24-hours from the time the permittee becomes aware of the circumstances. (The Environmental Field Office should be contacted for names and phone numbers of environmental response personnel).

b. A written submission must be provided within five (5) days of the time the permittee becomes aware of the circumstances unless this requirement is waived by the Director on a case-by-case basis. The permittee shall provide the Director with the following information:

    1. A description of the discharge and cause of noncompliance;
    2. The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and
    3. The steps being taken to reduce, eliminate, and prevent recurrence of the non-complying discharge.

Scheduled Reporting

For instances of noncompliance which are not reported under subparagraph a. above, the permittee shall report the noncompliance by contacting the permit coordinator, and provide all information concerning the steps taken or planned to reduce, eliminate, and prevent recurrence of the violation and the anticipated time the violation is expected to continue.

Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to the waters of Tennessee resulting from noncompliance with this permit, including but not limited to, accelerated or additional monitoring as necessary to determine the nature and impact of the noncompliance. It shall not be a defense for the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

Liabilities

Civil and Criminal Liability

Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Notwithstanding this permit, the permittee shall remain liable for any damages sustained by the State of Tennessee, including but not limited to fish kills and losses of aquatic life and/or wildlife, as a result of the discharge of pollutants to any surface or subsurface waters. Additionally, notwithstanding this Permit, it shall be the responsibility of the permittee to conduct its discharge activities in a manner such that public or private nuisances or health hazards will not be created.

Liability under State Law

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or the Federal Water Pollution Control Act, as amended.

This permit does not preclude requirements of other federal, state or local laws. This permit also serves as a State of Tennessee Aquatic Resource Alteration Permit (ARAP) pursuant to the Tennessee Water Quality Control Act of 1977 (T.C.A. §69-3-101 et seq.).

Reopener Clause

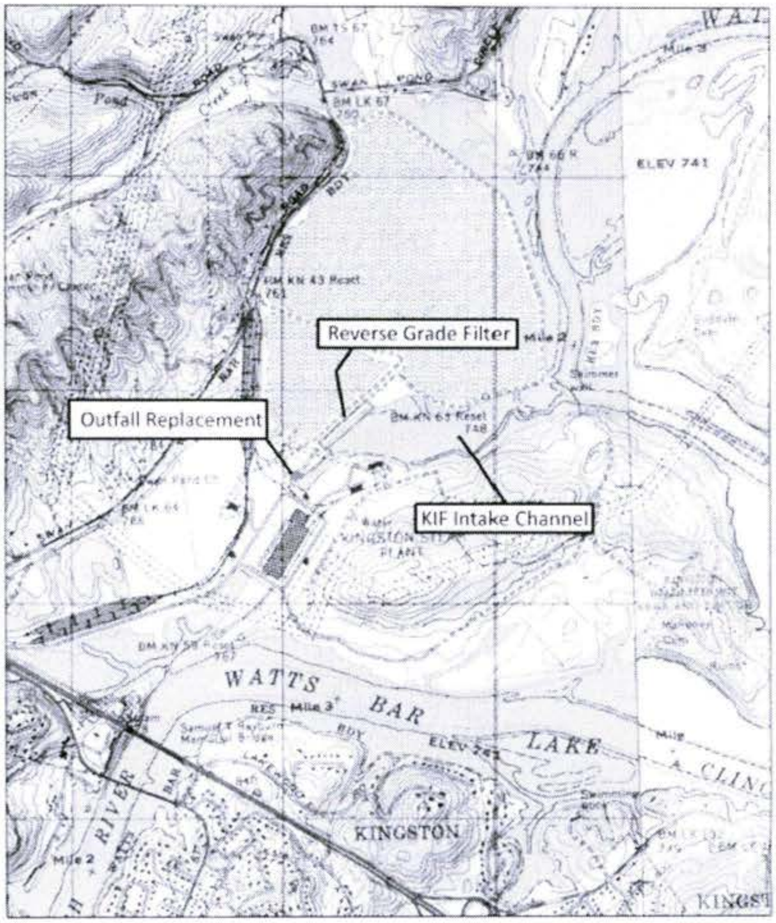
This permit may be revoked, suspended, or modified for cause, including:

1. Violation of any of the terms or conditions of this permit or of T.C.A § 69-3-101 et. seq.;
2. Obtaining the permit by misrepresentation or failing to disclose fully all relevant facts;
3. A change in any condition that requires either a temporary or permanent change in the conditions of this permit.

An appeal of this action may be made as provided in T.C.A. §69-3-105(i) and Rule 0400-40-05-.12 by submitting a petition for appeal. This petition must be filed within THIRTY (30) DAYS after public notice of the issuance of the permit. The petition must specify what provisions are being appealed and the basis for the appeal. It should be addressed to the technical secretary of the Tennessee Board of Water Quality, Oil and Gas at the following address: Tisha Calabrese Benton, Director, Division of Water Resources, William R. Snodgrass - Tennessee Tower, 312 Rosa L. Parks Avenue, Nashville, Tennessee 37243-1102. Any hearing would be in accordance with T.C.A. §§69-3-110 and 4-5-301 et seq.

APPENDIX I

Location/Topographic Map



Tennessee Valley Authority
Kingston Fossil Plant
Eastern Dike Seepage Mitigation
Reverse Grade Filter Construction Project
ARAP Topo Map

Site Designs

AECOM

TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

AQUATIC RESOURCE ALTERATION PERMIT APPLICATION FOR BALL FIELD CLOSURE & DRAINAGE AND FLOW MANAGEMENT

SEEP PROTECTION REVERSE-GRADE FILTER PROFILE VIEW

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
REGULATORY DIVISION
3701 BELL ROAD
NASHVILLE, TENNESSEE 37214

SUBJECT: File No. 2016-00521, Tennessee Valley Authority, Dike Maintenance including Installation of Reverse Grade Filter Mitigation, Emory River Mile 1.9R, Kingston, Roane County, Tennessee (Kingston Fossil Plant KIF Intake Channel)

Tennessee Valley Authority
C/o John Kammeyer
1101 Market Street
Chattanooga, TN 37402

Dear Mr. Kammeyer:

This correspondence is in regard to your proposal to place fill along 1000 linear feet of a perennial stream to install reverse grade filter mitigation along the Emory River near Kingston, Roane County, Tennessee (Lat. 35.90286°, Lon. -84.51485°). This project has been assigned number LRN 2016-00521. Please refer to this number in all communication concerning this matter.

Based on the information you provided, Nationwide Permit (NWP) #3, Maintenance, which became effective March 19, 2017 [82 FR 1860], authorizes your proposal as depicted on the enclosed plans. In order for this authorization to be valid, you must ensure the work is performed in accordance with the enclosed *NWP 3, Terms and Conditions*, and the *2017 Nationwide Permit General Conditions*. The work must also comply with the special conditions listed in the enclosed "SPECIAL CONDITIONS FOR PERMIT LRN-2016-00521, TENNESSEE VALLEY AUTHORITY."

This verification is valid until March 18, 2022, unless the NWP authorization is modified, suspended, or revoked prior to that date. Furthermore, if you commence or are under contract to commence this activity before the date of NWP expiration, modification, or revocation, you will have 12 months from the date of expiration, modification or revocation to complete the activity under the present terms and conditions of the NWP. This will apply to all NWPs unless discretionary authority has been exercised on a case-by-case basis to modify, suspend, or revoke the authorization in accordance with 33 CFR 330.4(e) and 33 CFR 330.5(c) or (d).

This NWP 3 verification does not obviate your responsibility to obtain and abide by all other federal, state and local permits or approvals required. This NWP verification should not be considered as an approval of the design features of any activity authorized or an implication that such construction is considered adequate for the purpose intended. In addition, it does not grant any property rights or exclusive privileges and does not authorize any injury to the property or rights of others. Failure to comply with all terms and conditions of this NWP verification invalidates this authorization and could result in a violation of Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act.

Upon completing the authorized work, you must fill out and return the enclosed *Certificate of Compliance with Department of the Army Permit* form. Thank you for your cooperation during the permitting process. If you have any questions, please contact me at (865) 986-7296), or via e-mail mark.m.mcintosh@usace.army.mil.

Sincerely,

Mark M McIntosh
Regulatory Specialist
Regulatory Division

Enclosures

Enclosure 1 – Special Conditions
Enclosure 2 – Drawings, pages 1-6
Enclosure 3 – NWP 3, Terms and Conditions
Enclosure 4 – 2017 Nationwide Permit General Conditions
Enclosure 5 – Compliance Certification
Enclosure 6 – TDEC ARAP/ 401 Water Quality Certification

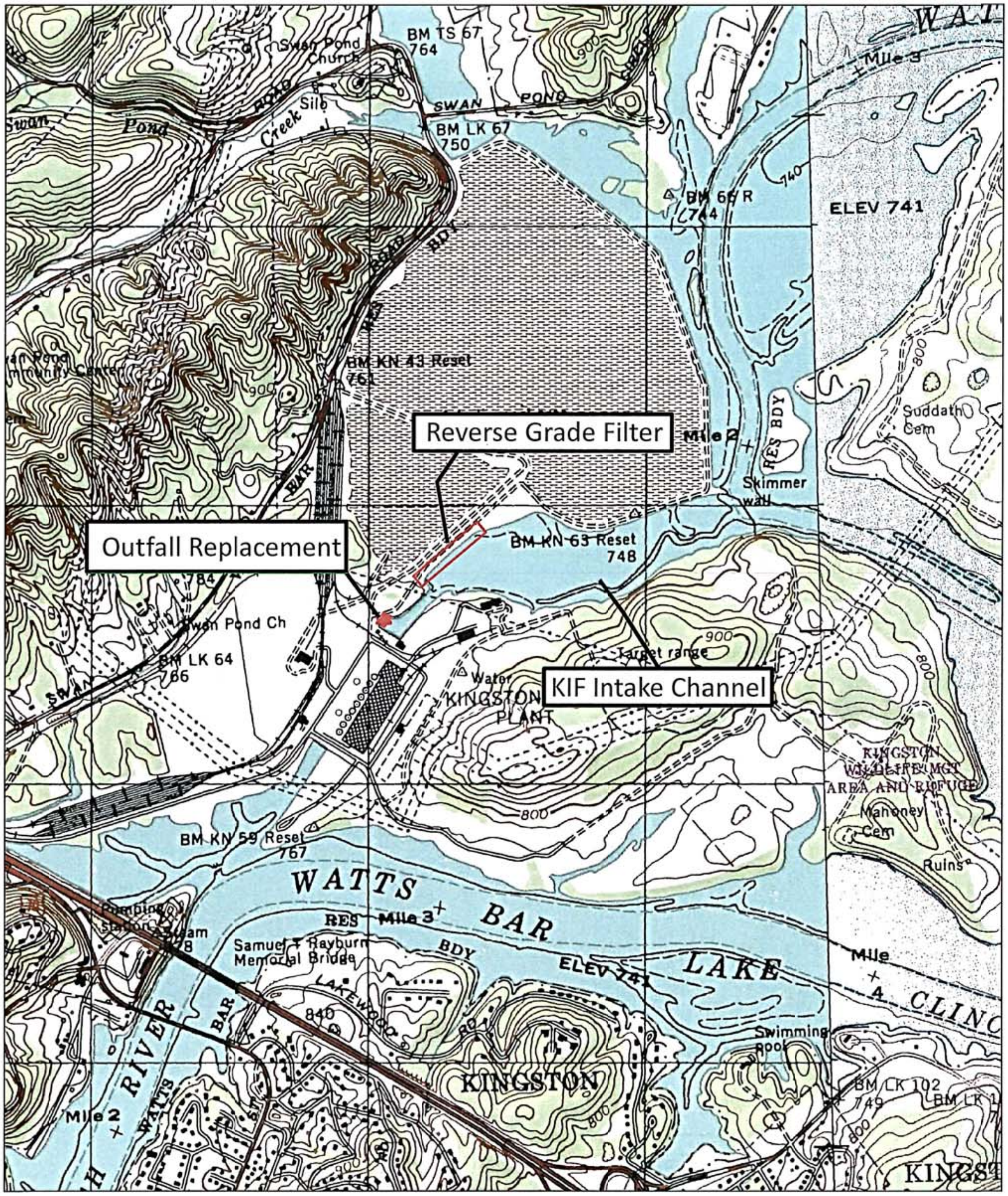
cc:
Brad Love, Tennessee Valley Authority, via email

US Army Corps
of Engineers ®
Nashville District

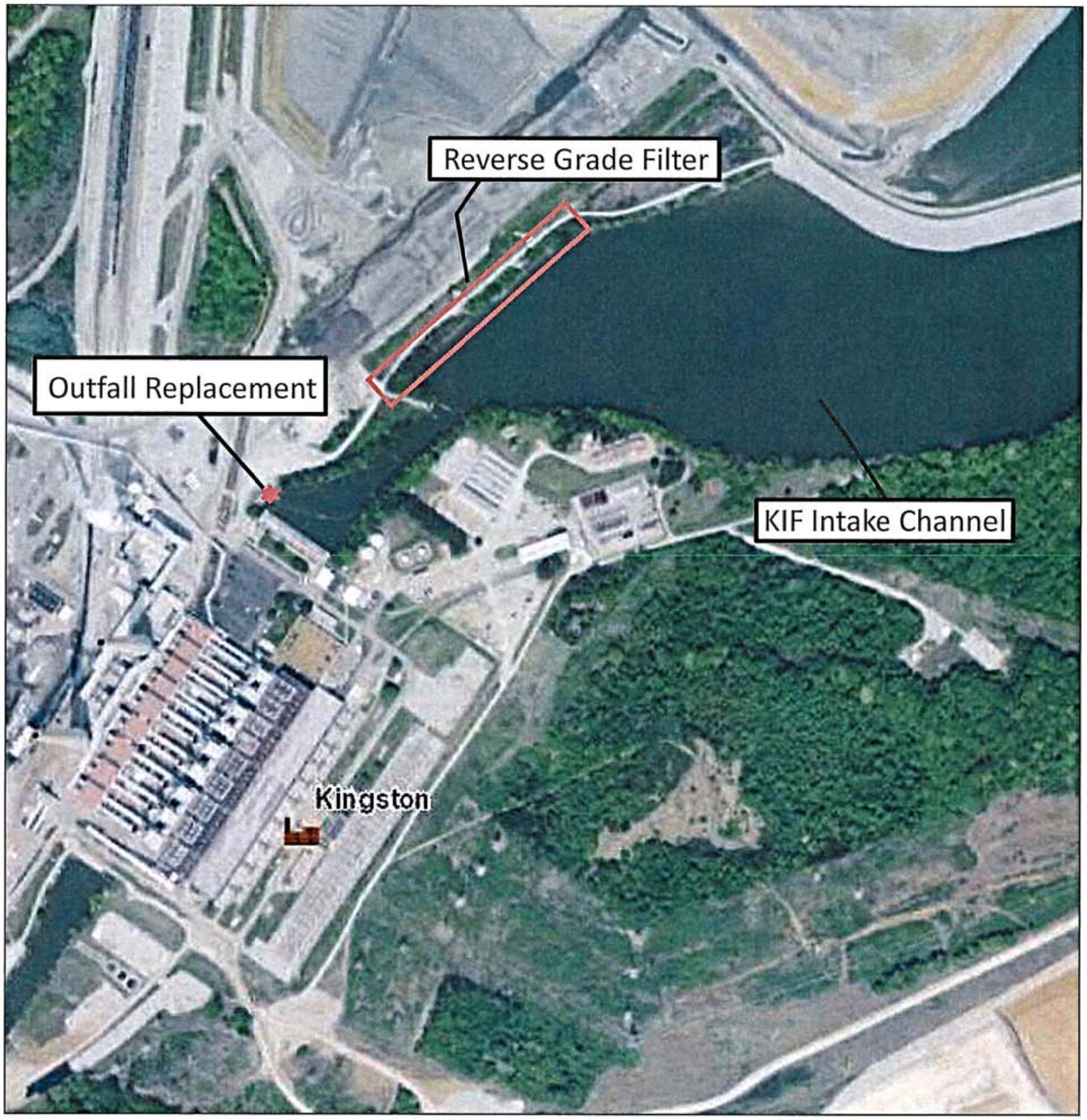
SPECIAL CONDITIONS FOR

PERMIT LRN-2016-00521, TENNESSEE VALLEY AUTHORITY

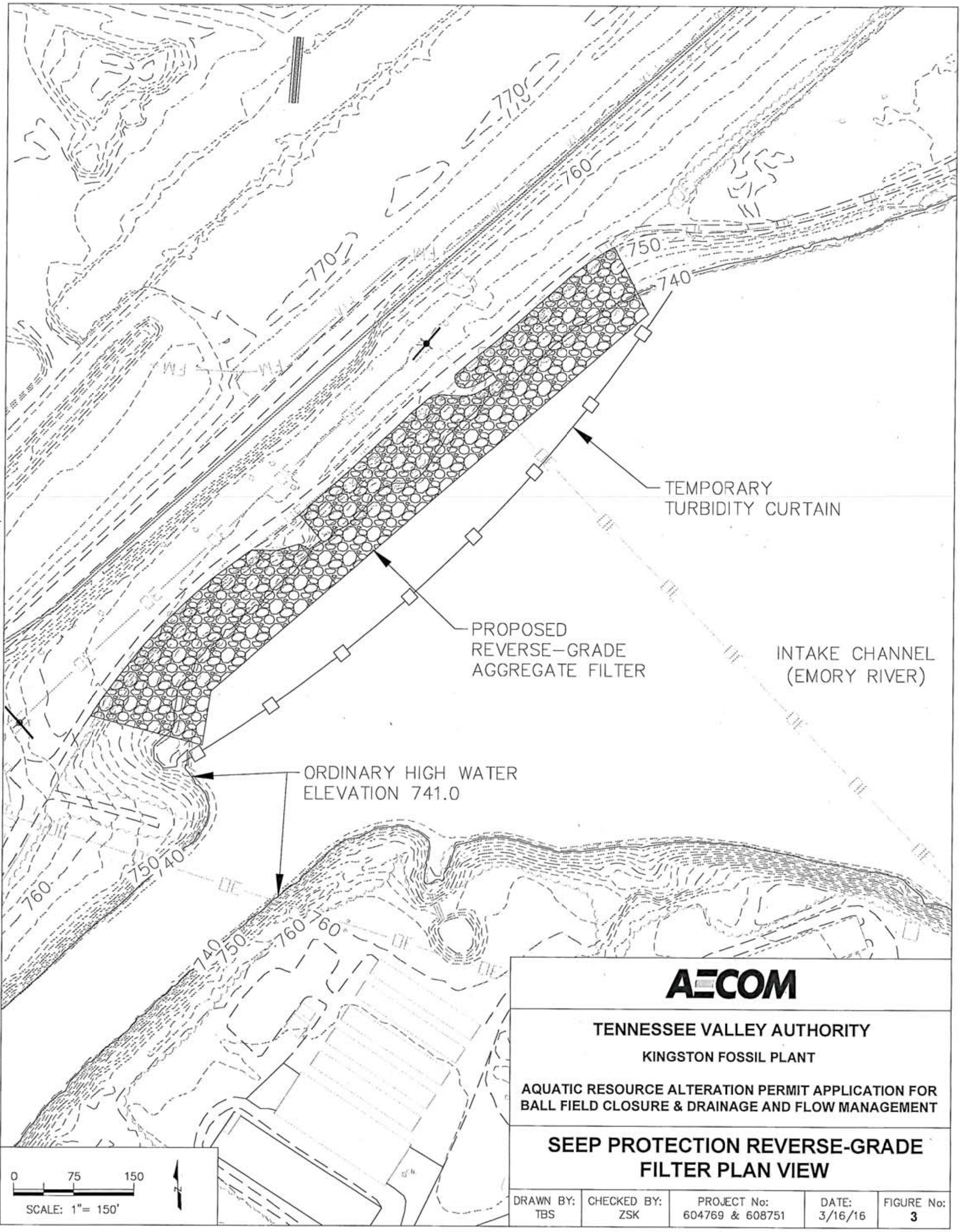
1. **Water Quality Certification:** The Permittee shall comply with the enclosed Tennessee Department of Environment and Conservation, Division of Water Resources Individual Aquatic Resources Alteration Permit (NRS16.142) notice of coverage effective 27 July 2017.



Tennessee Valley Authority
Kingston Fossil Plant
Eastern Dike Seepage Mitigation
Reverse Grade Filter Construction Project
USACE Topo Map



Tennessee Valley Authority
Kingston Fossil Plant
Eastern Dike Seepage Mitigation
Reverse Grade Filter Construction Project
USACE Satellite Overview



AECOM

TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

AQUATIC RESOURCE ALTERATION PERMIT APPLICATION FOR BALL FIELD CLOSURE & DRAINAGE AND FLOW MANAGEMENT

SEEP PROTECTION REVERSE-GRADE FILTER PLAN VIEW

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
TBS	ZSK	604769 & 608751	3/16/16	3

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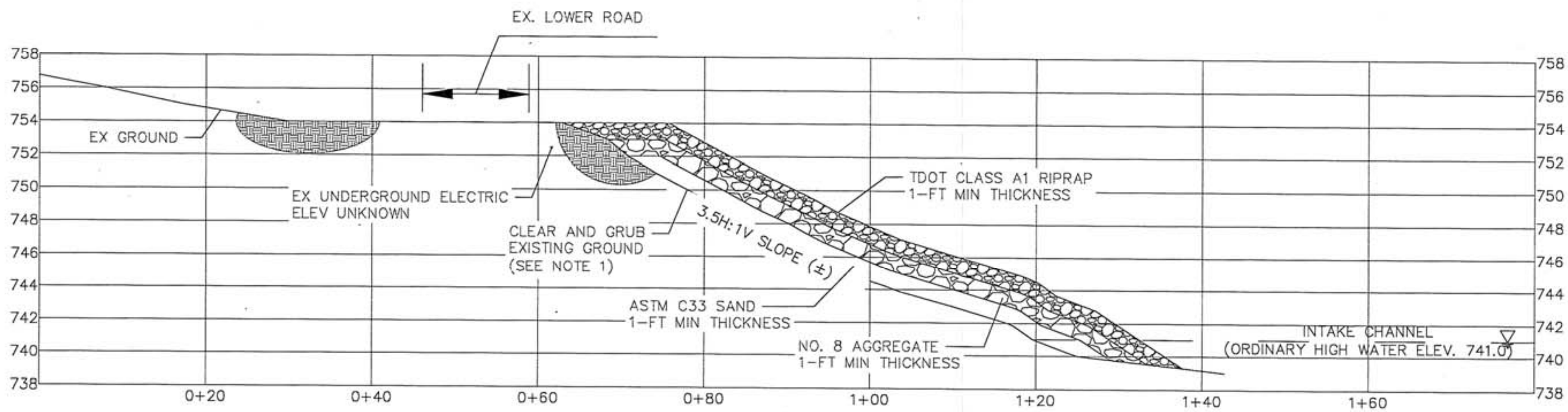

REVERSE GRADE FILTER
PROFILE VIEW

NOT TO SCALE

AECOM

TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

AQUATIC RESOURCE ALTERATION PERMIT APPLICATION FOR BALL FIELD CLOSURE & DRAINAGE AND FLOW MANAGEMENT

SEEP PROTECTION REVERSE-GRADE FILTER PROFILE VIEW

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
TBS	ZSK	604769 & 608751	3/16/16	4

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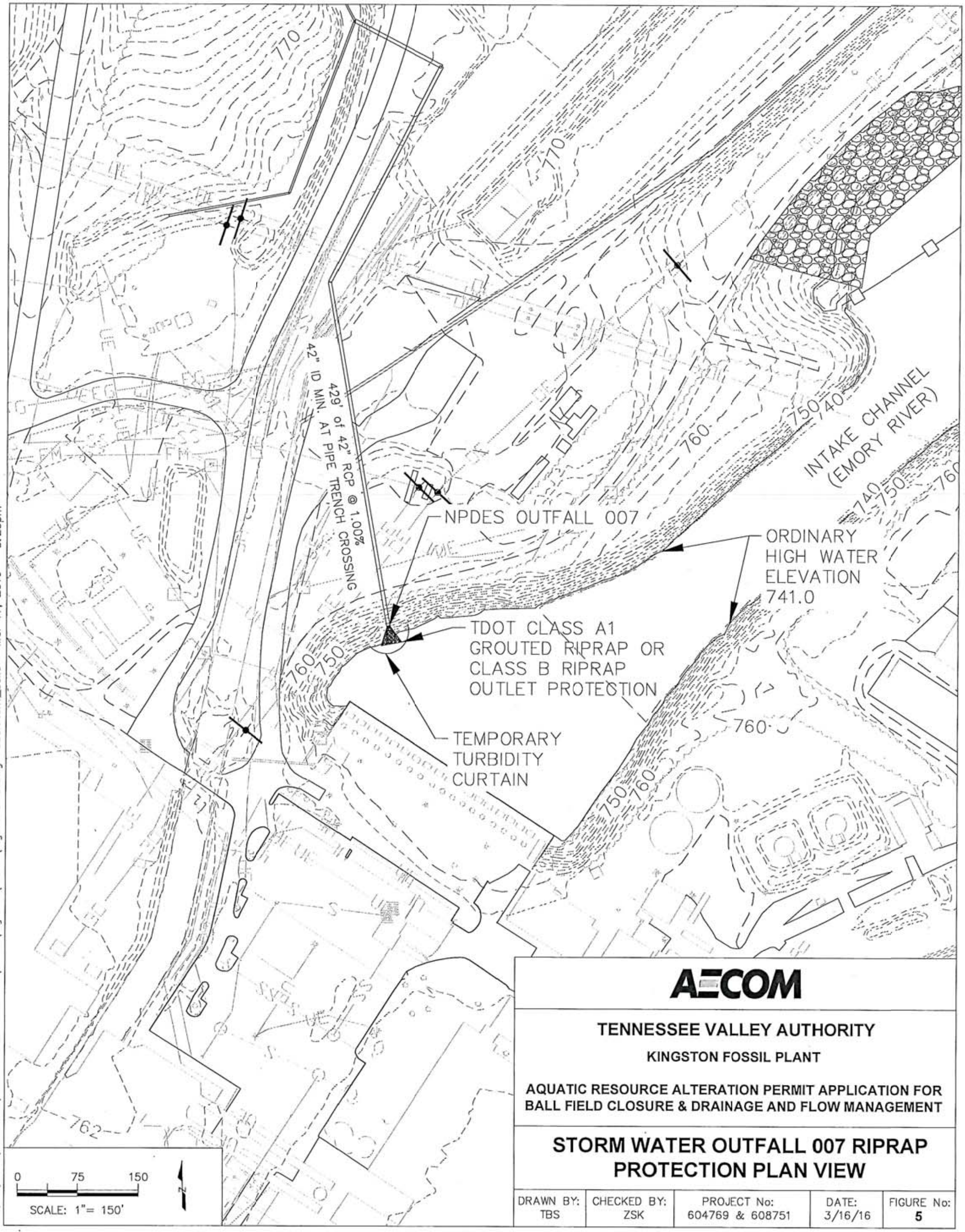


AECOM

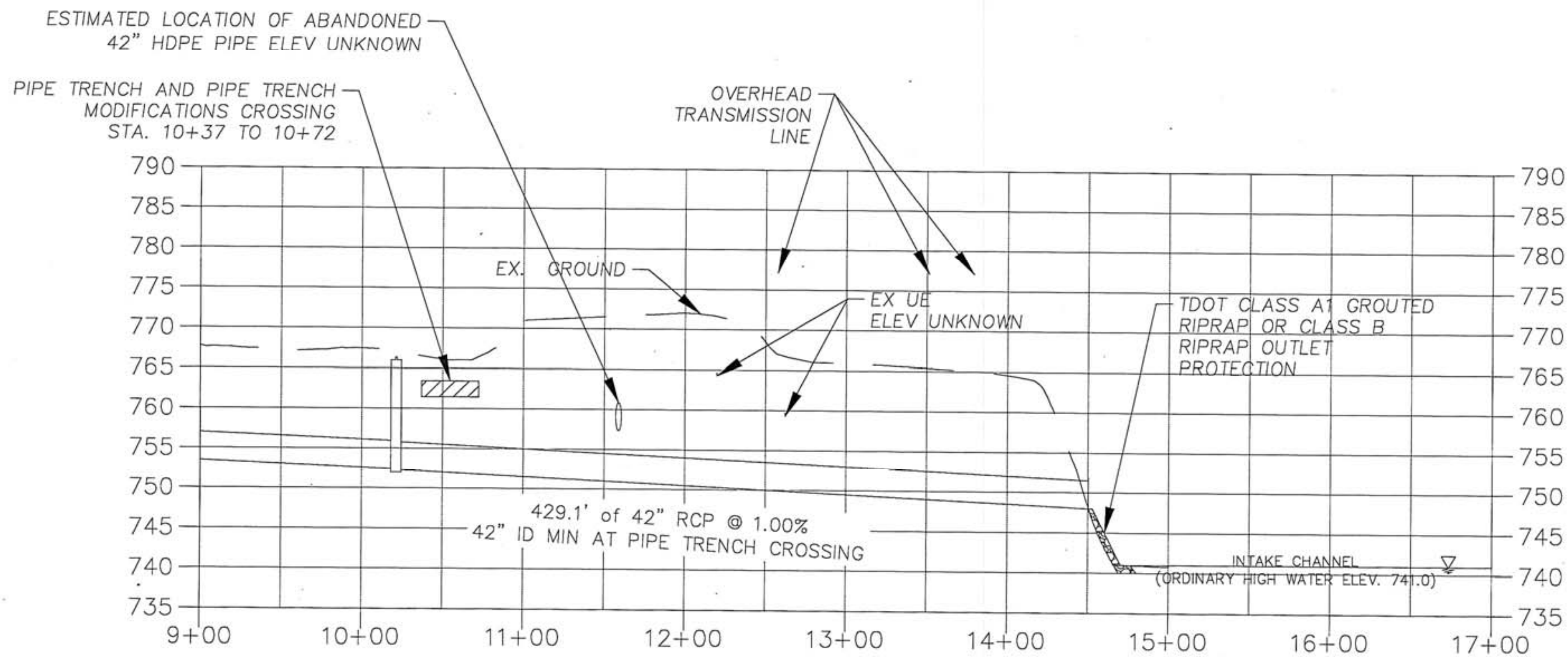
TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

AQUATIC RESOURCE ALTERATION PERMIT APPLICATION FOR BALL FIELD CLOSURE & DRAINAGE AND FLOW MANAGEMENT

STORM WATER OUTFALL 007 RIPRAP PROTECTION PLAN VIEW

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
TBS	ZSK	604769 & 608751	3/16/16	5



OUTFALL 007 PROFILE
RIPRAP PROTECTION VIEW

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SCALE
VERTICAL: 1"=20"
HORIZONTAL: 1"=10"

AECOM

TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

AQUATIC RESOURCE ALTERATION PERMIT APPLICATION FOR BALL FIELD CLOSURE & DRAINAGE AND FLOW MANAGEMENT

STORM WATER OUTFALL 007 RIPRAP PROTECTION PROFILE VIEW

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
TBS	ZSK	604769 & 608751	3/16/16	6

3. Maintenance

(a) The repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure or fill, or of any currently serviceable structure or fill authorized by 33 CFR 330.3, provided that the structure or fill is not to be put to uses differing from those uses specified or contemplated for it in the original permit or the most recently authorized modification. Minor deviations in the structure's configuration or filled area, including those due to changes in materials, construction techniques, requirements of other regulatory agencies, or current construction codes or safety standards that are necessary to make the repair, rehabilitation, or replacement are authorized. This NWP also authorizes the removal of previously authorized structures or fills. Any stream channel modification is limited to the minimum necessary for the repair, rehabilitation, or replacement of the structure or fill; such modifications, including the removal of material from the stream channel, must be immediately adjacent to the project. This NWP also authorizes the removal of accumulated sediment and debris within, and in the immediate vicinity of, the structure or fill. This NWP also authorizes the repair, rehabilitation, or replacement of those structures or fills destroyed or damaged by storms, floods, fire or other discrete events, provided the repair, rehabilitation, or replacement is commenced, or is under contract to commence, within two years of the date of their destruction or damage. In cases of catastrophic events, such as hurricanes or tornadoes, this two-year limit may be waived by the district engineer, provided the permittee can demonstrate funding, contract, or other similar delays.

(b) This NWP also authorizes the removal of accumulated sediments and debris outside the immediate vicinity of existing structures (e.g., bridges, culverted road crossings, water intake structures, etc.). The removal of sediment is limited to the minimum necessary to restore the waterway in the vicinity of the structure to the approximate dimensions that existed when the structure was built, but cannot extend farther than 200 feet in any direction from the structure. This 200 foot limit does not apply to maintenance dredging to remove accumulated sediments blocking or restricting outfall and intake structures or to maintenance dredging to remove accumulated sediments from canals associated with outfall and intake structures. All dredged or excavated materials must be deposited and retained in an area that has no waters of the United States unless otherwise specifically approved by the district engineer under separate authorization.

c) This NWP also authorizes temporary structures, fills, and work, including the use of temporary mats, necessary to conduct the maintenance activity. Appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work, and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows. After conducting the maintenance activity, temporary fills must be removed in their entirety and the affected areas returned to preconstruction elevations. The areas affected by temporary fills must be revegetated, as appropriate.

(d) This NWP does not authorize maintenance dredging for the primary purpose of navigation. This NWP does not authorize beach restoration. This NWP does not authorize new stream channelization or stream relocation projects.

<u>Notification</u>: For activities authorized by paragraph (b) of this NWP, the permittee must submit a preconstruction notification to the district engineer prior to commencing the activity (see general condition 32). The pre-construction notification must include information regarding the original design capacities and configurations of the outfalls, intakes, small impoundments, and canals.

(**Authorities**: Section 10 of the Rivers and Harbors Act of 1899 and section 404 of the Clean Water Act (Sections 10 and 404))

Note: This NWP authorizes the repair, rehabilitation, or replacement of any previously authorized structure or fill that does not qualify for the Clean Water Act section 404(f) exemption for maintenance.

US Army Corps of Engineers ®
Nashville District

2017 Nationwide Permit General Conditions

The following General Conditions must be followed in order for any authorization by NWP to be valid:

State of Tennessee Regional General Conditions (Applicable to ALL Nationwide Permits):

1. A PCN is required for all proposed activities in *Exceptional Tennessee Waters* and/or *Outstanding National Resource Waters*. A list of known Exceptional Tennessee Waters and Outstanding National Resource Waters can be obtained from the Tennessee Department of Environment and Conservation's website: https://tn.gov/environment/article/wr-water-resources-data-viewer . A map of known Exceptional Tennessee Waters and Outstanding National Resource Waters can be obtained from the Tennessee Department of Environment and Conservation's website: http://tdeconline.tn.gov/dwr/ .
2. All impacts to wetlands/open waters shall be calculated and reported in acres. Stream impacts shall be calculated separately and reported in both linear feet and acres.

Additional Information

Endangered Species Act: Nationwide Permit General Condition 32*, Pre-Construction Notification*, requires a PCN to be submitted to the District Engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat. To determine if any listed species, critical habitat, migratory birds or other natural resources may be impacted by your proposed project, please consult the U.S. Fish and Wildlife Services' IPAC website: http://ecos.fws.gov/ipac .

Historic Properties: Nationwide Permit General Condition 32*, Pre-Construction Notification*, requires a PCN to be submitted to the District Engineer if the NWP activity might have the potential to cause effects to a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places. The PCN must state which historic property might have the potential to be affected by the proposed activity or include a vicinity map indicating the location of the historic property. Information regarding cultural resources and the National Historic Preservation Act, can be reviewed at the National Park Service's website: http://www.nps.gov/nr/ . A map of non-restricted listed properties on the National Register of Historic Places at can be viewed at: https://www.nps.gov/maps/full.html?mapId=7ad17cc9-b808-4ff8-a2f9-a99909164466

National General Conditions:

1. Navigation.

(a) No activity may cause more than a minimal adverse effect on navigation.

(b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.

(c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. Aquatic Life Movements. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species. If a bottomless culvert cannot be used, then the crossing should be designed and constructed to minimize adverse effects to aquatic life movements.

3. Spawning Areas. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

4. Migratory Bird Breeding Areas. Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

5. Shellfish Beds. No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48, or is a shellfish seeding or habitat restoration activity authorized by NWP 27.

6. Suitable Material. No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see section 307 of the Clean Water Act).

7. Water Supply Intakes. No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

8. Adverse Effects From Impoundments. If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

9. Management of Water Flows. To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization, storm water management activities, and temporary and permanent road crossings, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. Fills Within 100-Year Floodplains. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

11. Equipment. Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

12. Soil Erosion and Sediment Controls. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow, or during low tides.

13. Removal of Temporary Fills. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

14. Proper Maintenance. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

15. Single and Complete Project. The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

16. Wild and Scenic Rivers.

(a) No NWP activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status.

(b) If a proposed NWP activity will occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, the permittee must submit a pre-construction notification (see general condition 32). The district engineer will coordinate the PCN with the Federal agency with direct management responsibility for that river. The permittee shall not begin the NWP activity until notified by the district engineer that the Federal agency with direct management responsibility for that river has determined in writing that the proposed NWP activity will not adversely affect the Wild and Scenic River designation or study status.

(c) Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency responsible for the designated Wild and Scenic River or study river (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service). Information on these rivers is also available at: http://www.rivers.gov/ .

17. Tribal Rights. No NWP activity may cause more than minimal adverse effects on tribal rights (including treaty rights), protected tribal resources, or tribal lands.

18. Endangered Species.

(a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless ESA section 7 consultation addressing the effects of the proposed activity has been completed. Direct effects are the immediate effects on listed species and critical habitat caused by the NWP activity. Indirect effects are those effects on listed species and critical habitat that are caused by the NWP activity and are later in time, but still are reasonably certain to occur.

(b) Federal agencies should follow their own procedures for complying with the requirements of the ESA. If pre-construction notification is required for the proposed activity, the Federal permittee must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will verify that the appropriate documentation has been submitted. If the appropriate documentation has not been submitted, additional ESA section 7 consultation may be necessary for the activity and the respective federal agency would be responsible for fulfilling its obligation under section 7 of the ESA.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species or designated critical habitat, the pre-construction notification must include the name(s) of the endangered or threatened species that might be affected by the proposed activity or that utilize the designated critical habitat that might be affected by the proposed activity. The district engineer will determine whether the proposed activity "may affect" or will have "no effect" to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps' determination within 45 days of receipt of a complete pre-construction notification. In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the activity, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification that the proposed activity will have "no effect" on listed species or critical habitat, or until ESA section 7 consultation has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific permit conditions to the NWPs.

(e) Authorization of an activity by an NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the FWS or the NMFS, the Endangered Species Act prohibits any person subject to the jurisdiction of the United States to take a listed species, where "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. The word "harm" in the definition of "take" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

(f) If the non-federal permittee has a valid ESA section 10(a)(1)(B) incidental take permit with an approved Habitat Conservation Plan for a project or a group of projects that includes the proposed NWP activity, the non-federal applicant should provide a copy of that ESA section 10(a)(1)(B) permit with the PCN required by paragraph (c) of this general condition. The district engineer will coordinate with the agency that issued the ESA section 10(a)(1)(B) permit to determine whether the proposed NWP activity and the associated incidental take were considered in the internal ESA section 7 consultation conducted for the ESA section 10(a)(1)(B) permit. If that coordination results in concurrence from the agency that the proposed NWP activity and the associated incidental take were considered in the internal ESA section 7 consultation for the ESA section 10(a)(1)(B) permit, the district engineer does not need to conduct a separate ESA section 7 consultation for the proposed NWP activity. The district engineer will notify the non-federal applicant within 45 days of receipt of a complete pre-construction notification whether the ESA section 10(a)(1)(B) permit covers the proposed NWP activity or whether additional ESA section 7 consultation is required.

(g) Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the FWS and NMFS or their world wide Web pages at http://www.fws.gov/ or http://www.fws.gov/ipac and http://www.nmfs.noaa.gov/pr/species/esa/ respectively.

19. Migratory Birds and Bald and Golden Eagles. The permittee is responsible for ensuring their action complies with the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The permittee is responsible for contacting appropriate local office of the U.S. Fish and Wildlife Service to determine applicable measures to reduce impacts to migratory birds or eagles, including whether "incidental take" permits are necessary and available under the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act for a particular activity.

20. Historic Properties.

(a) In cases where the district engineer determines that the activity may have the potential to cause effects to properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.

(b) Federal permittees should follow their own procedures for complying with the requirements of section 106 of the National Historic Preservation Act. If pre-construction notification is required for the proposed NWP activity, the Federal permittee must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will verify that the appropriate documentation has been submitted. If the appropriate documentation is not submitted, then additional consultation under section 106 may be necessary. The respective federal agency is responsible for fulfilling its obligation to comply with section 106.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if the NWP activity might have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties might have the potential to be affected by the proposed NWP activity or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of, or potential for, the presence of historic properties can be sought from the State Historic Preservation Officer, Tribal Historic Preservation Officer, or designated tribal representative, as appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). When reviewing pre-construction notifications, district engineers will comply with the current procedures for addressing the requirements of section 106 of the National Historic Preservation Act. The district engineer shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. Based on the information submitted in the PCN and these identification efforts, the district engineer shall determine whether the proposed NWP activity has the potential to cause effects on the historic properties. Section 106 consultation is not required when the district engineer determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR 800.3(a)). Section 106 consultation is required when the district engineer determines that the activity has the potential to cause effects on historic properties. The district engineer will conduct consultation with consulting parties identified under 36 CFR 800.2(c) when he or she makes any of the following effect determinations for the purposes of section 106 of the NHPA: no historic properties affected, no adverse effect, or adverse effect. Where the non-Federal applicant has identified historic properties on which the activity might have the potential to cause effects and so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects to historic properties or that NHPA section 106 consultation has been completed.

(d) For non-federal permittees, the district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA section 106 consultation is required. If NHPA section 106 consultation is required, the district engineer will notify the non-Federal applicant that he or she cannot begin the activity until section 106 consultation is completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(e) Prospective permittees should be aware that section 110k of the NHPA (54 U.S.C. 306113) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, the degree of damage to the integrity of any historic properties affected, and proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.

21. Discovery of Previously Unknown Remains and Artifacts. If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal, and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

22. Designated Critical Resource Waters. Critical resource waters include, NOAA-managed marine sanctuaries and marine monuments, and National Estuarine Research Reserves. The district engineer may designate, after notice and opportunity for public comment, additional waters officially designated by a state as having particular environmental or ecological significance, such as outstanding national resource waters or state natural heritage sites. The district engineer may also designate additional critical resource waters after notice and opportunity for public comment.

(a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, and 52 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.

(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, 38, and 54, notification is required in accordance with general condition 32, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

23. Mitigation. The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that the individual and cumulative adverse environmental effects are no more than minimal:

(a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).

(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating for resource losses) will be required to the extent necessary to ensure that the individual and cumulative adverse environmental effects are no more than minimal.

(c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse environmental effects of the proposed activity are no more than minimal, and provides an activity-specific waiver of this requirement. For wetland losses of 1/10-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in only minimal adverse environmental effects.

(d) For losses of streams or other open waters that require pre-construction notification, the district engineer may require compensatory mitigation to ensure that the activity results in no more than minimal adverse environmental effects. Compensatory mitigation for losses of streams should be provided, if practicable, through stream rehabilitation, enhancement, or preservation, since streams are difficult-to-replace resources (see 33 CFR 332.3(e)(3)).

(e) Compensatory mitigation plans for NWP activities in or near streams or other open waters will normally include a requirement for the restoration or enhancement, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, the restoration or maintenance/protection of riparian areas may be the only compensatory mitigation required. Restored riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to restore or maintain/protect a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or maintaining/protecting a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of minimization or compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.

(f) Compensatory mitigation projects provided to offset losses of aquatic resources must comply with the applicable provisions of 33 CFR part 332.

(1) The prospective permittee is responsible for proposing an appropriate compensatory mitigation option if compensatory mitigation is necessary to ensure that the activity results in no more than minimal adverse environmental effects. For the NWPs, the preferred mechanism for providing compensatory mitigation is mitigation bank credits or in-lieu fee program credits (see 33 CFR 332.3(b)(2) and (3)). However, if an appropriate number and type of mitigation bank or in-lieu credits are not available at the time the PCN is submitted to the district engineer, the district engineer may approve the use of permittee-responsible mitigation.

(2) The amount of compensatory mitigation required by the district engineer must be sufficient to ensure that the authorized activity results in no more than minimal individual and cumulative adverse environmental effects (see 33 CFR 330.1(e)(3)). (See also 33 CFR 332.3(f)).

(3) Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, aquatic resource restoration should be the first compensatory mitigation option considered for permittee-responsible mitigation.

(4) If permittee-responsible mitigation is the proposed option, the prospective permittee is responsible for submitting a mitigation plan. A conceptual or detailed mitigation plan may be used by the district engineer to make the decision on the NWP verification request, but a final mitigation plan that addresses the applicable requirements of 33 CFR 332.4(c)(2) through (14) must be approved by the district engineer before the permittee begins work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation (see 33 CFR 332.3(k)(3)).

(5) If mitigation bank or in-lieu fee program credits are the proposed option, the mitigation plan only needs to address the baseline conditions at the impact site and the number of credits to be provided.

(6) Compensatory mitigation requirements (e.g., resource type and amount to be provided as compensatory mitigation, site protection, ecological performance standards, monitoring requirements) may be addressed through conditions added to the NWP authorization, instead of components of a compensatory mitigation plan (see 33 CFR 332.4(c)(1)(ii)).

(g) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2-acre, it cannot be used to authorize any NWP activity resulting in the loss of greater than 1/2-acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that an NWP activity already meeting the established acreage limits also satisfies the no more than minimal impact requirement for the NWPs.

(h) Permittees may propose the use of mitigation banks, in-lieu fee programs, or permittee-responsible mitigation. When developing a compensatory mitigation proposal, the permittee must consider appropriate and practicable options consistent with the framework at 33 CFR 332.3(b). For activities resulting in the loss of marine or estuarine resources, permittee-responsible mitigation may be environmentally preferable if there are no mitigation banks or in-lieu fee programs in the area that have marine or estuarine credits available for sale or transfer to the permittee. For permittee-responsible mitigation, the special conditions of the NWP verification must clearly indicate the party or parties responsible for the implementation and performance of the compensatory mitigation project, and, if required, its long-term management.

(i) Where certain functions and services of waters of the United States are permanently adversely affected by a regulated activity, such as discharges of dredged or fill material into waters of the United States that will convert a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse environmental effects of the activity to the no more than minimal level.

24. Safety of Impoundment Structures. To ensure that all impoundment structures are safely designed, the district engineer may require non-Federal applicants to demonstrate that the structures comply with established state dam safety criteria or have been designed by qualified persons. The district engineer may also require documentation that the design has been independently reviewed by similarly qualified persons, and appropriate modifications made to ensure safety.

25. Water Quality. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)). The district engineer or State or Tribe may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

26. Coastal Zone Management. In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). The district engineer or a State may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

27. Regional and Case-By-Case Conditions. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

28. Use of Multiple Nationwide Permits. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the United States authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the United States for the total project cannot exceed 1/3-acre.

29. Transfer of Nationwide Permit Verifications. If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:

When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s) of the property. To validate the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

____

(Transferee)

____

(Date)

30. Compliance Certification. Each permittee who receives an NWP verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and implementation of any required compensatory mitigation. The success of any required permittee-responsible mitigation, including the achievement of ecological performance standards, will be addressed separately by the district engineer. The Corps will provide the permittee the certification document with the NWP verification letter. The certification document will include:

(a) A statement that the authorized activity was done in accordance with the NWP authorization, including any general, regional, or activity-specific conditions;

(b) A statement that the implementation of any required compensatory mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(l)(3) to confirm that the permittee secured the appropriate number and resource type of credits; and

(c) The signature of the permittee certifying the completion of the activity and mitigation.

The completed certification document must be submitted to the district engineer within 30 days of completion of the authorized activity or the implementation of any required compensatory mitigation, whichever occurs later.

31. Activities Affecting Structures or Works Built by the United States. If an NWP activity also requires permission from the Corps pursuant to 33 U.S.C. 408 because it will alter or temporarily or permanently occupy or use a U.S. Army Corps of Engineers (USACE) federally authorized Civil Works project (a “USACE project”), the prospective permittee must submit a pre-construction notification. See paragraph (b)(10) of general condition 32. An activity that requires section 408 permission is not authorized by NWP until the appropriate Corps office issues the section 408 permission to alter, occupy, or use the USACE project, and the district engineer issues a written NWP verification.

32. Pre-Construction Notification.

(a) Timing. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, if the PCN is determined to be incomplete, notify the prospective permittee within that 30 day period to request the additional information necessary to make the PCN complete. The request must specify the information needed to make the PCN complete. As a general rule, district engineers will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. Prospective permittee shall not begin the activity until either:

(1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or

(2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical habitat might be affected or are in the vicinity of the activity, or to notify the Corps pursuant to general condition 20 that the activity might have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is “no effect” on listed species or “no potential to cause effects” on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or section 106 of the National Historic Preservation Act (see 33 CFR 330.4(g)) has been completed. Also, work cannot begin under NWPs 21, 49, or 50 until the permittee has received written approval from the Corps. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee may not begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) Contents of Pre-Construction Notification: The PCN must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed activity;

(3) Identify the specific NWP or NWP(s) the prospective permittee wants to use to authorize the proposed activity;

(4) A description of the proposed activity; the activity's purpose; direct and indirect adverse environmental effects the activity would cause, including the anticipated amount of loss of wetlands, other special aquatic sites, and other waters expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure; a description of any proposed mitigation measures intended to reduce the adverse environmental effects caused by the proposed activity; and any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity, including other separate and distant crossings for linear projects that require Department of the Army authorization but do not require pre-construction notification. The description of the proposed activity and any proposed mitigation measures should be sufficiently detailed to allow the district engineer to determine that the adverse environmental effects of the activity will be no more than minimal and to determine the need for compensatory mitigation or other mitigation measures. For single and complete linear projects, the PCN must include the quantity of anticipated losses of wetlands, other special aquatic sites, and other waters for each

single and complete crossing of those wetlands, other special aquatic sites, and other waters. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP. (Sketches usually clarify the activity and when provided results in a quicker decision. Sketches should contain sufficient detail to provide an illustrative description of the proposed activity (e.g., a conceptual plan), but do not need to be detailed engineering plans);

(5) The PCN must include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters on the project site, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many wetlands, other special aquatic sites, and other waters. Furthermore, the 45 day period will not start until the delineation has been submitted to or completed by the Corps, as appropriate;

(6) If the proposed activity will result in the loss of greater than 1/10-acre of wetlands and a PCN is required, the prospective permittee must submit a statement describing how the mitigation requirement will be satisfied, or explaining why the adverse environmental effects are no more than minimal and why compensatory mitigation should not be required. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.

(7) For non-Federal permittees, if any listed species or designated critical habitat might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat, the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed activity or utilize the designated critical habitat that might be affected by the proposed activity. For NWP activities that require pre-construction notification, Federal permittees must provide documentation demonstrating compliance with the Endangered Species Act;

(8) For non-Federal permittees, if the NWP activity might have the potential to cause effects to a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, the PCN must state which historic property might have the potential to be affected by the proposed activity or include a vicinity map indicating the location of the historic property. For NWP activities that require pre-construction notification, Federal permittees must provide documentation demonstrating compliance with section 106 of the National Historic Preservation Act;

(9) For an activity that will occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a “study river” for possible inclusion in the system while the river is in an official study status, the PCN must identify the Wild and Scenic River or the “study river” (see general condition 16); and

(10) For an activity that requires permission from the Corps pursuant to 33 U.S.C. 408 because it will alter or temporarily or permanently occupy or use a U.S. Army Corps of Engineers federally authorized civil works project, the pre-construction notification must include a statement confirming that the project proponent has submitted a written request for section 408 permission from the Corps office having jurisdiction over that USACE project.

(c) Form of Pre-Construction Notification: The standard individual permit application form (Form ENG 4345) may be used, but the completed application form must clearly indicate that it is an NWP PCN and must include all of the applicable information required in paragraphs (b)(1) through (10) of this general condition. A letter containing the required information may also be used. Applicants may provide electronic files of PCNs and supporting materials if the district engineer has established tools and procedures for electronic submittals.

(d) Agency Coordination:

(1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the activity's adverse environmental effects so that they are no more than minimal.

(2) Agency coordination is required for: (i) All NWP activities that require pre-construction notification and result in the loss of greater than 1/2-acre of waters of the United States; (ii) NWP 21, 29, 39, 40, 42, 43, 44, 50, 51, and 52 activities that require pre-construction notification and will result in the loss of greater than 300 linear feet of stream bed; (iii) NWP 13 activities in excess of 500 linear feet, fills greater than one cubic yard per running foot, or involve discharges of dredged or fill material into special aquatic sites; and (iv) NWP 54 activities in excess of 500 linear feet, or that extend into the waterbody more than 30 feet from the mean low water line in tidal waters or the ordinary high water mark in the Great Lakes.

(3) When agency coordination is required, the district engineer will immediately provide (e.g., via email, facsimile transmission, overnight mail, or other expeditious manner) a copy of the complete PCN to the appropriate Federal or state offices (FWS, state natural resource or water quality agency, EPA, and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will have 10 calendar days from the date the material is transmitted to notify the district engineer via telephone, facsimile transmission, or email that they intend to provide substantive, site-specific comments. The comments must explain why the agency believes the adverse environmental effects will be more than minimal. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame concerning the proposed activity's compliance with the terms and conditions of the NWPs, including the need for mitigation to ensure the net adverse environmental effects of the proposed activity are no more than minimal. The district engineer will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.

(4) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.

(5) Applicants are encouraged to provide the Corps with either electronic files or multiple copies of pre-construction notifications to expedite agency coordination.

Further Information

1. District Engineers have authority to determine if an activity complies with the terms and conditions of an NWP.
2. NWPs do not obviate the need to obtain other federal, state, or local permits, approvals, or authorizations required by law.
3. NWPs do not grant any property rights or exclusive privileges.
4. NWPs do not authorize any injury to the property or rights of others.
5. NWPs do not authorize interference with any existing or proposed Federal project (see general condition 31).

US Army Corps
of Engineers ®
Nashville District

COMPLIANCE CERTIFICATION

YOU ARE REQUIRED TO SUBMIT THIS SIGNED CERTIFICATION REGARDING THE COMPLETED ACTIVITY AND ANY REQUIRED MITIGATION

I hereby certify that the work authorized by **Permit No. _LRN-2016-00521____,** and any required mitigation was done in accordance with the Corps authorization, including any general, regional, or special conditions.

____
Permittee Signature

____
Date

Please note that your permitted activity is subject to a compliance inspection by an U.S. Army Corps of Engineers representative.

Submit this signed certification to the address below:

☐ U.S Army Corps of Engineers
Regulatory Division
3701 Bell Road
Nashville, TN 37214-2660

☒ East Regulatory Field Office
501 Adesa Parkway
Suite 250
Lenoir City, TN 37771

☐ West Regulatory Field Office
2042 Beltline Road, Southwest
Building C, Suite 415
Decatur, Al 35601

Emory River Mile 1.9R, Roane County, TN

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
William R. Snodgrass - Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1102

July 28, 2017

TN Valley Authority
c/o John Kammeyer
1101 Market Street, Mail Stop LP 5D-C
Chattanooga, TN 37402

Subject: Individual ARAP Permit/§401 Water Quality Certification
NRS16.142
Eastern Dike Repair
TVA Kingston Fossil Plant
Emory River Watershed
Robertson County, TN

Dear Mr. Kammeyer:

We have reviewed your proposal to make repairs along the eastern dike at the TVA Kingston Fossil Plan. These activities have been modified based on public comments and efforts by the TVA to avoid and minimize impacts to Waters of the State. This activity includes1000 linear feet of dike stabilization with a reverse grade aggregate filter structure and to replace an outfall structure. The reverse grade filter structure will also include a seepage collection system. These impacts will occur in the KIF artificial channel along the Emory River. Mechanisms for the purpose of managing, collecting, and treating seepage flow must conform to the terms and conditions of the NPDES permit.

The attached Aquatic Resource Alteration Permit/§401 Water Quality Certification authorizes the work you have proposed in your application.

This activity is governed by the enclosed permit. The work must be accomplished in conformance with accepted plans and information submitted in support of application NRS16.142 and the limitations and conditions set forth in the permit (enclosed). It is the responsibility of the permittee to ensure that all contractors involved with this project have read and understand the permit conditions before the project begins.

Coverage Termination
Authorization under this permit cannot be extended beyond the expiration date. If all work is not completed on or before July 27, 2022 it is the applicants responsibility to apply for additional coverage.

Thank you for your time and consideration. If you have any questions please contact me by e-mail at *Vena.L.Jones@tn.gov or by phone at (615) 253-5320*

Sincerely,

Vena Jones
Natural Resources Unit

Encl: copy of permit
CC: DWR, Nashville Environmental Field Office
Brad Love, TVA
Tennessee Clean Water Network
Amanda Garcia, SELC
Terry Cheek, TVA
U.S. Army Corps of Engineers, Nashville Regulatory Branch
File copy

STATE OF TENNESSEE

§401 WATER QUALITY CERTIFICATION

AQUATIC RESOURCE ALTERATION PERMIT NRS16.142

Pursuant to §401 of *The Federal Clean Water Act* (33 U.S.C. 1341), any applicant for a Federal license or permit to conduct any activity which may result in any discharge into the waters of the U.S., shall provide the federal licensing or permitting agency a certification from the State in which the discharge originates or will originate. Accordingly, the Division of Water Resources requires reasonable assurance that the activity will not violate provisions of *The Tennessee Water Quality Control Act of 1977* (T.C.A. §69-3-101 et seq.) or provisions of §§301, 302, 303, 306 or 307 of *The Clean Water Act*.

Subject to conformance with accepted plans, specifications and other information submitted in support of the application, pursuant to 33 U.S.C. 1341 the State of Tennessee hereby certifies the activity described below. This shall serve as authorization under T.C.A. §69-3-101 et seq.

PERMITTEE: TN Valley Authority
c/o John Kammeyer
1101 Market Street, Mail Stop LP 5D-C
Chattanooga, TN 37402

AUTHORIZED WORK: The Tennessee Valley Authority is authorized to make repairs along the eastern dike at the TVA Kingston Fossil Plan. These activities have been modified based on public comments and efforts by the TVA to avoid and minimize impacts to Waters of the State. This activity includes1000 linear feet of dike stabilization with a reverse grade aggregate filter structure and to replace an outfall structure. The reverse grade filter structure will also include a seepage collection system. These impacts will occur in the KIF artificial channel along the Emory River. Mechanisms for the purpose of managing, collecting, and treating seepage flow must conform to the terms and conditions of the NPDES permit.

LOCATION: 714 Swan Pond Road, Harriman, TN 37748

Impact 1:
Latitude 35.902959 Longitude -84.514748
Impact 2:
Latitude 35.900718 Longitude -84.517961

EFFECTIVE DATE: July 28, 2017

EXPIRATION DATE: July 27, 2022

Tisha Calabrese Benton
Director, Division of Water Resources

RDA 1071 MINOR

Table of Contents

PART I

Authorized Impacts:

STR-1: Emory River (TN06010208001_2000)
Latitude 35.902959 Longitude -84.514748
1000 linear feet of a reverse grade aggregate filter and a lined seepage collection system along the dike in the intake channel.

STR-1: Emory River (TN06010208001_2000)
Latitude 35.900718 Longitude -84.517961
An outfall replacement for a 42" reinforced concrete pipe including riprap outlet protection.

Special Conditions:

a. The work shall be accomplished in conformance with the revised and accepted plans, specifications, data and other information submitted in support of the revised application NRS16.142 and the limitations, requirements and conditions set forth herein.

b. Mechanisms for the purpose of managing, collecting, and treating seepage flow must conform to the terms and conditions of the NPDES permit.

c. All riprap areas shall be placed as to mimic the existing/proposed contours of the stream bank. Riprap shall be countersunk and placed at the grade with the existing stream substrate.

d. Voids within the riprap shall be filled with suitable substrate to prevent loss of stream within the riprap areas. Do not over-excavate for placement of riprap. Grouting of riprap is prohibited.

e. The use of monofilament-type erosion control netting or blanket is prohibited.

f. Best Management Practices (BMPs) shall be stringently implemented throughout the construction period to prevent sediments, oils, or other project-related pollutants from being discharged into the Willow Branch or its tributaries.

g. Streambeds shall not be used as transportation routes for construction equipment. Temporary stream crossings shall be limited to one point in the construction area and erosion prevention and sediment control measures shall be utilized where stream banks are disturbed.

h. Appropriate steps shall be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the state. All spills must be reported to the appropriate emergency management agency, and measures shall be taken immediately to prevent the pollution of waters of the state, including groundwater, should a spill occur.

General Conditions:

a. It is the responsibility of the permittee to convey all terms and conditions of this permit to all contractors. A copy of this permit, approved plans and any other documentation pertinent to the activities authorized by this permit shall be maintained on site at all times during periods of construction activity.

b. Work shall not commence until the permittee has received the federal §404 permit from the U. S. Army Corps of Engineers, a §26a permit from the Tennessee Valley Authority or authorization under a Tennessee NPDES Storm Water Construction Permit where necessary. The permittee is responsible for obtaining these permits.

c. All work shall be carried out in such a manner as will prevent violations of water quality criteria as stated in Rule 0400-40-03-.03 of the Rules of the Tennessee Department of Environment and Conservation. This includes, but is not limited to, the prevention of any discharge that causes a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the uses designated by Rule 0400-40-04. These uses include fish and aquatic life (including trout streams and naturally reproducing trout streams), livestock watering and wildlife, recreation, irrigation, industrial water supply, domestic water supply, and navigation.

d. Impacts to waters of the state other than those specifically addressed in the plans and this permit are prohibited. All streams, springs and wetlands shall be fully protected prior, during and after construction until the area is stabilized. Any questions, problems or concerns that arise regarding any stream, spring or wetland either before or during construction, shall be addressed to the Division of Water Resource's Knoxville's Environmental Field Office (865-594-6035), or the permit coordinator in the division's Natural Resources Unit (615-253-5320).

e. Adverse impact to formally listed state or federal threatened or endangered species or their critical habitat is prohibited.

f. This permit does not authorize adverse impacts to cultural, historical or archeological features or sites.

PART III

Duty to Reapply

If any portion of the permitted activities, including the authorized impacts to water resources, compensatory mitigation requirements, or post-project monitoring is not completed before the expiration date of this permit the permittee must apply for permit re-issuance. The permittee shall submit such information and forms as are required to the director of the Division of Water Resources at least ninety (90) days prior to its expiration date. Such applications must be properly signed and certified.

Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

Other Information

If the permittee becomes aware that he/she failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, then he/she shall promptly submit such facts or information.

Changes Affecting the Permit

Transfer/Change of Ownership

a. This permit may be transferred to another party, provided there are no activity or project modifications, no pending enforcement actions, or any other changes which might affect the permit conditions contained in the permit, by the permittee if:

b. The permittee notifies the Director of the proposed transfer at least 30 days in advance of the proposed transfer date;

c. The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage, and contractual liability between them; and

d. The Director does not notify the current permittee and the new permittee, within 30 days, of his intent to modify, revoke, reissue, or terminate the permit, or require that a new application be filed rather than agreeing to the transfer of the permit.

e. The permittee must provide the following information to the division in their formal notice of intent to transfer ownership:

    i. the permit number of the subject permit;
    ii. the effective date of the proposed transfer;
    iii. the name and address of the transferor;
    iv. the name and address of the transferee;
    v. the names of the responsible parties for both the transferor and transferee;
    vi. a statement that the transferee assumes responsibility for the subject permit;
    vii. a statement that the transferor relinquishes responsibility for the subject permit;
    viii. the signatures of the responsible parties for both the transferor and transferee, and;
    ix. a statement regarding any proposed modifications to the permitted activities or project, its operations, or any other changes which might affect the permit conditions contained in the permit.

Change of Mailing Address

The permittee shall promptly provide to the Director written notice of any change of mailing address. In the absence of such notice the original address of the permittee will be assumed to be correct.

Noncompliance

Effect of Noncompliance

All discharges shall be consistent with the terms and conditions of this permit. Any permit noncompliance constitutes a violation of applicable State and Federal laws and is grounds for enforcement action, permit termination, permit modification, or denial of permit reissuance.

Reporting of Noncompliance

24-Hour Reporting

a. In the case of any noncompliance which could cause a threat to public drinking supplies, or any other discharge which could constitute a threat to human health or the environment, the required notice of non-compliance shall be provided to the Division of Water Resources in the appropriate Environmental Field Office within 24-hours from the time the permittee becomes aware of the circumstances. (The Environmental Field Office should be contacted for names and phone numbers of environmental response personnel).

b. A written submission must be provided within five (5) days of the time the permittee becomes aware of the circumstances unless this requirement is waived by the Director on a case-by-case basis. The permittee shall provide the Director with the following information:

   1. A description of the discharge and cause of noncompliance;
   2. The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and
   3. The steps being taken to reduce, eliminate, and prevent recurrence of the non-complying discharge.

Scheduled Reporting

For instances of noncompliance which are not reported under subparagraph a. above, the permittee shall report the noncompliance by contacting the permit coordinator, and provide all information concerning the steps taken or planned to reduce, eliminate, and prevent recurrence of the violation and the anticipated time the violation is expected to continue.

Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to the waters of Tennessee resulting from noncompliance with this permit, including but not limited to, accelerated or additional monitoring as necessary to determine the nature and impact of the noncompliance. It shall not be a defense for the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

Liabilities

Civil and Criminal Liability

Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Notwithstanding this permit, the permittee shall remain liable for any damages sustained by the State of Tennessee, including but not limited to fish kills and losses of aquatic life and/or wildlife, as a result of the discharge of pollutants to any surface or subsurface waters. Additionally, notwithstanding this Permit, it shall be the responsibility of the permittee to conduct its discharge activities in a manner such that public or private nuisances or health hazards will not be created.

Liability under State Law

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or the Federal Water Pollution Control Act, as amended.

This permit does not preclude requirements of other federal, state or local laws. This permit also serves as a State of Tennessee Aquatic Resource Alteration Permit (ARAP) pursuant to the Tennessee Water Quality Control Act of 1977 (T.C.A. §69-3-101 et seq.).

Reopener Clause

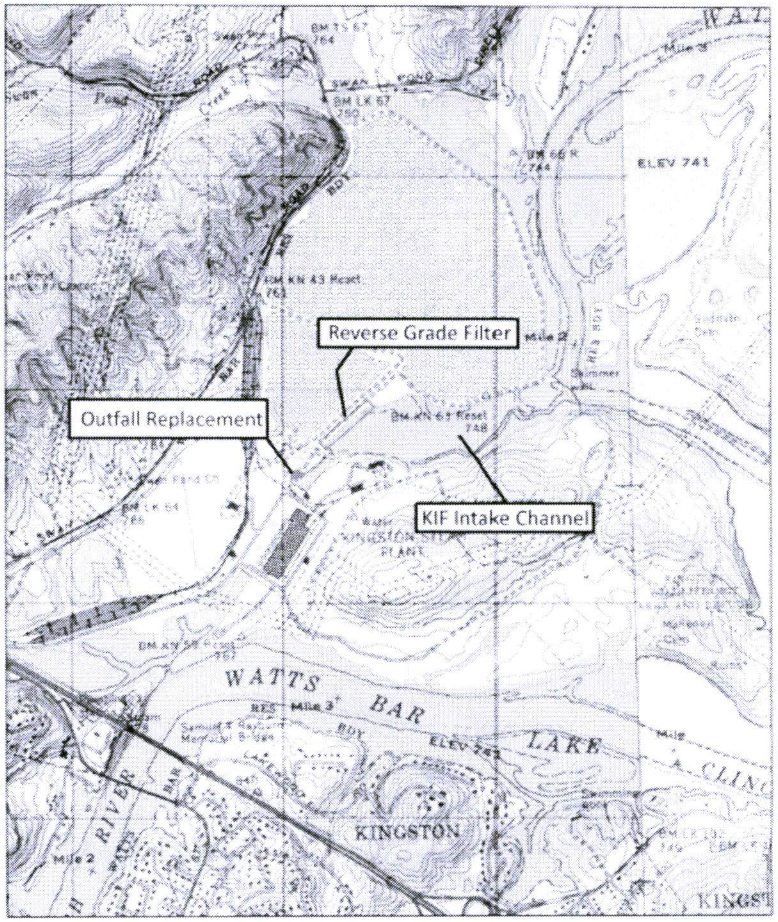
This permit may be revoked, suspended, or modified for cause, including:

1. Violation of any of the terms or conditions of this permit or of T.C.A § 69-3-101 et. seq.;
2. Obtaining the permit by misrepresentation or failing to disclose fully all relevant facts;
3. A change in any condition that requires either a temporary or permanent change in the conditions of this permit.

An appeal of this action may be made as provided in T.C.A. §69-3-105(i) and Rule 0400-40-05-.12 by submitting a petition for appeal. This petition must be filed within THIRTY (30) DAYS after public notice of the issuance of the permit. The petition must specify what provisions are being appealed and the basis for the appeal. It should be addressed to the technical secretary of the Tennessee Board of Water Quality, Oil and Gas at the following address: Tisha Calabrese Benton, Director, Division of Water Resources, William R. Snodgrass - Tennessee Tower, 312 Rosa L. Parks Avenue, Nashville, Tennessee 37243-1102. Any hearing would be in accordance with T.C.A. §§69-3-110 and 4-5-301 et seq.

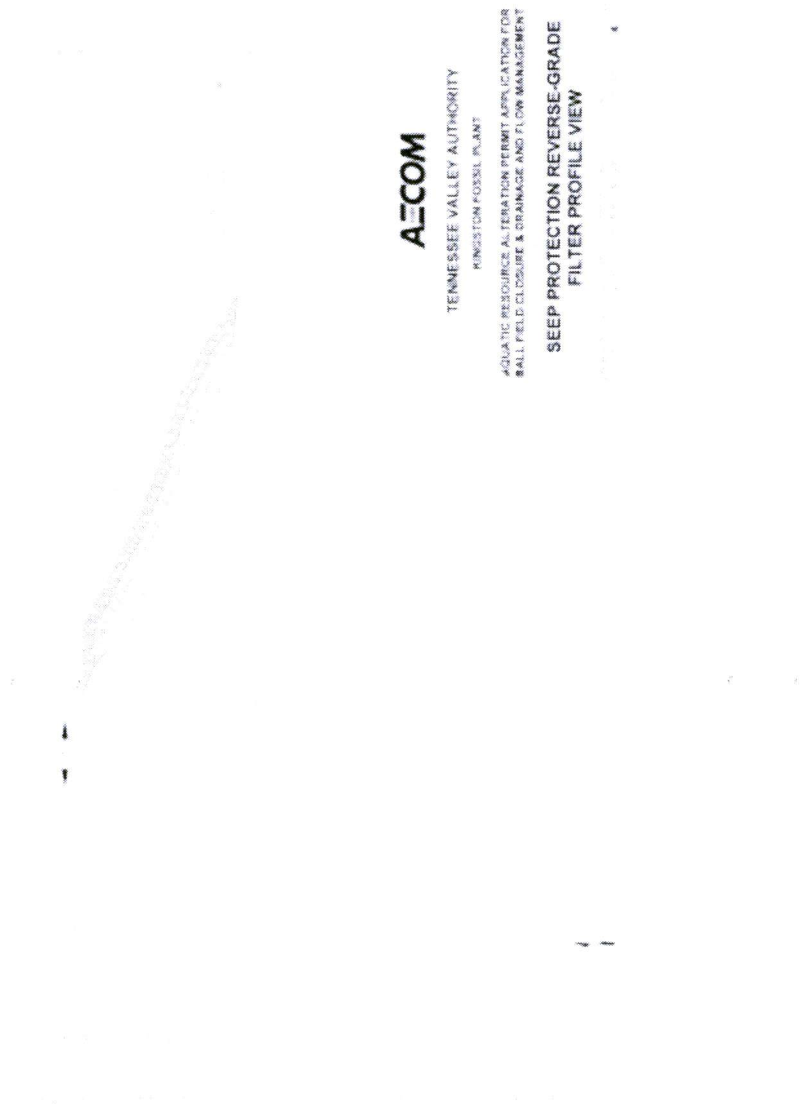
APPENDIX I

Location/Topographic Map



Tennessee Valley Authority
Kingston Fossil Plant
Eastern Dike Seepage Mitigation
Reverse Grade Filter Construction Project
ARAP Topo Map

Site Designs


AECOM
TENNESSEE VALLEY AUTHORITY
KINGSTON FOSSIL PLANT
AQUATIC RESOURCE ALTERATION PERMIT APPLICATION FOR BALL FIELD CLOSURE & DRAINAGE AND FLOW MANAGEMENT
SEEP PROTECTION REVERSE-GRADE FILTER PROFILE VIEW

Robert Wilkinson, PG, CHMM CCR Technical Manager
2nd Floor TN Tower, W.R. Snodgrass Building
312 Rosa L. Parks Avenue
Nashville, TN 37243
Office: (615) 253-0689
e-mail: Robert.S.Wilkinson@tn.gov

Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

December 8, 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 Kingston Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Revision 1 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.

Kingston CCR site EIP Rev 1 Comments

TVA submitted the EIP Rev 1 for TVA Kingston Coal Fired Fossil Power Plant (TVA KIF) on September 8, 2017. TDEC has completed its review of EIP Rev 1 and is providing comments listed in the attached **Table 1 TVA Kingston 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 **February 9, 2018**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA KIF 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	Paula Plont
	Revendra Awasthi	Shawn Rudder	Patrick Mulligan
	Amos Smith		

TVA Kingston EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
All	All	All	All	All	TVA has agreed to conduct an environmental investigation at the TVA Kingston 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.
All	All	All	All	All	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
All	All	All	All	All	General comment - TVA will include an applicability assessment of the TDEC General Guideline for Environmental Investigation Plans, TVA Fossil Plants when preparing the EIP. TDEC understands that not all aspects of the guidelines will be applicable at all TVA facilities, but each line item should be reviewed and assessed for applicability within the EIP. If an item is deemed not applicable to this facility, TVA should provide a written justification for exclusion within the EIP. Applicable items from the guidelines should be incorporated into the next revision of the EIP.
All	All	All	All	All	General comment - All monitor wells, geotechnical borings, and soil borings will be logged by a Tennessee licensed professional geologist.
All	All	All	All	All	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 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.

Section Number	Section Title	Page	Paragraph	Line	Comment
General Administrative	NA	NA	NA	NA	The document lacks a revision log.
General Administrative	NA	NA	NA	NA	The TDEC will be notified immediately by the TVA of any problems related to successful completion of field efforts as outlined in this EIP.
General Administrative	NA	NA	NA	NA	Please provide the following TVA TI, "Monitoring Well and Piezometer Installation and Development" (ENV-TI-05.80.25).
General Administrative	NA	NA	NA	NA	All liquid results shall be reported in parts per billion (µg/L). All results from soil, CCR material and other solids shall be reported in parts per million (mg/kg). All tables, figures and graphs shall use µg/L to report analytical results from analysis of liquids and mg/kg for analytical results from analysis of solids. Figures and graphs for more than one parameter may only be portrayed on the same page if the X and Y axis use the same units.
Global Exhibits	NA	NA	NA	NA	Please revise the figures to indicate the estimated waste boundary so that it does not appear that especially downgradient wells are being installed in ash.
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.

Section Number	Section Title	Page	Paragraph	Line	Comment
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?
1.4.2	Current Operations and Closure Plans	4	1	All	TDEC recognizes that TVA has initiated closure projects for the Interim Ash Staging Area, Sluice Trench, and Stilling Pond. These closure actions have occurred prior to complete characterization of the site as part of the EIP process, and, as such, are considered "at risk". Based on the results of the EIP, TVA may be required to take other and further remedial action at the site.
2.1	EIP Development and Structure	9	1	1	TVA will provide monthly (at a minimum) EIP progress reports to TDEC.
2.2	Proposed Schedule	All	All	All	Monthly schedule updates will be provided to TDEC depicting progress for all EIP activities. TVA will include explanations for lagging or incomplete EIP tasks.

Section Number	Section Title	Page	Paragraph	Line	Comment
2.2	Proposed Schedule	All	All	All	Proposed schedule is considered draft at this time, not final.
2.3	Quality Assurance Project Plan	9	1	1	Use common abbreviations for clarity, Appendix C uses KIF QAPP instead of KIF Quality Plan.
2.3	Quality Assurance Project Plan	10	2	4	Please include as an appendix to the EIP the referenced "Data Management Plan".
3.1.1	TDEC Site Specific Request No. 1	11	3	6	Not only does there need to be an analysis of correlations between groundwater and surface water elevations and seasonal variations but also the effects on the saturation level in the CCR landfills and impoundment need to be included in the EAR.
3.1.2	TDEC Site Specific Information Request No. 2	All	All	All	TVA will continue to sample groundwater at GW-2 and 22 during the EIP process.
3.1.2	TDEC Site Specific Request No. 2	12	3	3	Based on exhibit #2 it appears that near the ballfield and sluice trench there are only 2 downgradient monitoring wells. At a minimum there should be three downgradient wells. TDEC would like TVA to evaluate potentially placing the third downgradient well southeast of AD-2.
3.1.2	TDEC Site Specific Request No. 2	12	3	5	Please provide evidence on whether or not the unconsolidated materials above bedrock and the bedrock aquifers are hydraulically interconnected.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.2	TDEC Site Specific Request No. 2	12	3	5	Previous reports provided by TVA have indicated that the Conasauga Group underlying the CCR units are highly fractured and therefore would be dominated by fractured flow. The potential for downward vertical migration of CCR contaminants, the potential for their migration along fractures, joints and bedding planes have not been evaluated. TVA shall include in the EIP its plan for evaluating downward flow of ground water including a discussion of installing monitoring wells.
3.1.2	TDEC Site Specific Information Request No. 2	18	3	2	Wells 27A, 27B, 22, And 22B will be added to the Study Area monitoring network.
3.1.3	TDEC Site Specific Request No. 3	13	2	7	Groundwater monitoring well 27 (overburden) will be used as a monitoring well to provide groundwater level measurements to the northeast of the stilling pond between GW-2 and well 22 and also provide northern verification of the previous arsenic detection at well 22.
3.1.3	TDEC Site Specific Request No. 3	15	1	2	Drilling oversight and sampling/logging activities will be performed by a TN Professional Geologist.
3.1.4	TDEC Site Specific Request No. 4	13	2	7	Within the EAR there needs to be a discussion if there are any changes observed in the water levels at AD-2 from the March 2017-July 2017 caused by the remedy of the red water seep are and the installation of rip rap.
3.1.4	TDEC Site Specific Information Request No. 4	16	All	All	While TDEC's site specific comment on Kingston was specific to the red water seep at the East Dike/Engineered Wetlands, the EIP needs to include an appendix of all KIF historic seeps including discovery, remediation and current status.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.4	TDEC site specific request No. 4	22	3	NA	Investigation for the source of the hydraulic input for the collected Red-Water seeps needs to be included in the EIP.
3.2.1	TDEC hydrogelogic report information request No. 1	25	NA	NA	TVA must submit a report to TDEC characterizing the nature of the groundwater mounding beneath the ash disposal areas.
3.3.1	TDEC Water Use Survey Information Request No. 1	20	2	6	TVA will include all water wells and springs, whether or not they are owned by TVA.
3.4.1	TDEC Ground Water Monitoring Information Request No. 1	All	All	All	TVA will sample all groundwater monitoring wells and piezometers available onsite to accurately determine groundwater flow and quality as part of the EIP. Additionally, any data collected as part of compliance with federal CCR requirements will be included in the Cumberland EAR**.**
3.4.1	TDEC Groundwater Monitoring Information Request No. 4	28	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.5.1	TDEC Ground Water Monitoring Information Request No. 2	All	All	All	Please provide TDEC with documentation and justification for the reinstallation of MW-22. Please provide documentation demonstrating that the well is screened in ash (boring log, stratigraphy, water levels, etc..). the new MW-22 and existing MW-22 be sampled simultaneously to determine if there is a difference in concentration of CCR constituents and groundwater quality.
3.5.1	GW -Chem Properties	23	2	7	The replacement well location for MW KIF-22 must be authorized by TDEC's CCR Technical team before placement. TDEC's authorization shall include any other wells placed under this EIP. Are the proposed location identified in Appendix D still accurate?
3.5.1	TDEC Ground Water - Chemical and Physical Properties request No. 1	29	All	All	Recent sampling and analytical results for Arsenic at well 22 indicates results above the MCL for filter (dissolved) sample analysis. Well 22 shall not be replaced until TDEC approves this action. The new well, once approved by TDEC, must be sampled and analysis performed a minimum of four independent events to be justified as a replacement well.
3.5.2	TDEC Groundwater - Chemical and Physical Properties Information Request No. 2	24			*"TVA plans to address the arsenic concentrations observed in well 22 under the current Ash Disposal Area monitoring program by replacing well 22 with a new well in the same area to obtain data representative of groundwater conditions downgradient of the Ash Disposal Area."* Replacing Well 22 with a new well does not "address" the arsenic concentration at that location. The historic arsenic detection must be characterized or otherwise explained.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.6.1	TDEC Structural and Seismic Stability Information Request No. 1	25			*"TVA understands it is performing this work at risk, as discussions between TVA and TDEC concerning seismic stability of Dike C are ongoing."* TVA seems to be suggesting that the only issue with *"proceeding at risk"* is associated with the seismic assessment. This is not the case. Other EIP discoveries, such as impact to groundwater, may dictate that Closure in Place is not appropriate.
3.6.1	TDEC Structural and seismic Stability Information Request No. 1	31			While not enforcing the Federal CCR rule, TDEC will expect seismic analysis and methods to meet the standards required by the Federal CCR rule under authority of the Commissioner's Order.
3.6.1	TDEC Structural and seismic Stability Information Request No. 1	31/48 2	2	3&4	Please confirm that closure of the Stilling Pond by April 17, 2018 is a timeline requirement of the Federal CCR rule.

Section Number	Section Title	Page	Paragraph	Line	Comment
4	Additional Site Characterization Information	30	1	6	It was not TDEC's intent to have the second information request supersede the first. As stated in previous comments, TVA will include an applicability assessment of the TDEC General Guideline for Environmental Investigation Plans, TVA Fossil Plants when preparing the EIP. TDEC understands that not all aspects of the guidelines will be applicable at all TVA facilities, but each line item should be reviewed and assessed for applicability within the EIP. If an item is deemed not applicable to this facility, TVA should provide a written justification for exclusion within the EIP. Applicable items from the guidelines should be incorporated into the next revision of the EIP.
4.1	CCR Material Characteristics	30	All	All	TVA will conduct 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 from each investigation area. Samples should be run for total concentrations of CCR parameters, TCLP CCR parameters, and SPLP CCR parameters.
4.2	Background Soil SAP	31	All	All	Based on a review of historic aerials, background soil sample location KIF-BG-08 is within or in close proximity to the historic ash release impact area. TVA will relocate this sample to an area that is outside potential impacts from the historic ash release.
4.2	Background Soil SAP	31	2	2	Please include on Exhibit 9 the locations of the proposed background soil sampling locations overlain by a USDA soil map.
4.2	Background Soil SAP	32	4	5	Please clarify that the mid-point for grab samples will be the mid-point based on recovery.

TVA Kingston EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
4.2	Background Soil SAP	32	4	6	Please clarify that if a change in lithology occurs within the interval that the mid-point of both lithologies in the recovered core will be sampled.
4.2	Background Soil SAP	32	6	3	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.
4.2	Background Soil SAP	32	6	3	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.
4.2	Background Soil SAP	32	6	3	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.
4.2	Background Soil SAP	37	1	All	Provide proposed background soil sample locations overlaying a USDA soil map.
4.3	Sediment	All	All	All	Please confirm that existing sediment sampling data includes all applicable CCR parameters.
4.4	Surface Stream	All	All	All	Please confirm that existing water quality sampling data includes all applicable CCR parameters.
4.5	Fish Investigations	All	All	All	Please confirm that existing fish investigation sampling data includes all applicable CCR parameters.
4.6	Additional Stability Analysis	43	All	All	While not enforcing the Federal CCR rule, TDEC will expect seismic analysis and methods to meet the standards required by the Federal CCR rule under authority of the Commissioner's Order.
Appendix A	Schedule	All	All	All	Please update

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix B	TVA's March 6,2017 letter to TDEC	77	4	4	Please confirm that closure of the Stilling Pond by April 17, 2018 is a timeline requirement of the Federal CCR rule.
Appendix B	Drawing 6 of 6	114			Provide additional detail for the abandoned 42" pipe indicated on FN 2016-00521 Drawing 6 of 6. Describe design details and constructions methods used for the abandonment and indicate if the pipe is placed in ash material.
Appendix C, Section 9.1.2	QAPP	20	6	1	Some of the requirements in the QAPP are written as should. TVA will replace the word "should" with "shall" in the QAPP when discussing specific requirements. If multiple coolers are needed, one COC Record ~~should~~ will accompany each cooler that contains the samples identified on the COC.
Appendix C, Section10.0	QAPP	23	1	1	Detectability was not mentioned in the quality objectives and criteria for analytical data
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.

Section Number	Section Title	Page	Paragraph	Line	Comment
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~~ shall be performed when the instrument will not adequately calibrate. Maintenance of field equipment ~~should~~ shall be noted in an instrument logbook or field notebook. Suggest a universal comment, replace should with shall when used as part of procedure or requirement.
Appendix C, Section 17.0	QAPP	44	3	2	This audit report ~~should~~ will include a list of observed field activities, a list of reviewed documents, and any observed deficiencies.
Appendix C, Section 19.5	QAPP	51	1	4	By providing specific protocols for obtaining and analyzing samples, data sets ~~should~~ will be comparable regardless of who collects the sample or who performs the sample analysis.
Appendix C, QAPP Appendix A	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	QAPP Appendix A.2	A-13	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 D	QAPP Appendix D	D-2	Table A	All	Sample matrix codes do not have nomenclature for laboratory supplied deionized water.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix D	Exhibit 3	232	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.
Appendix D	Exhibit 9	238	All	All	Provide proposed background soil sample locations overlaying a USDA soil map.
Appendix E	Groundwater Investigation SAP	All	All	All	Statistical methods to be used for evaluating groundwater monitoring data are not developed in this EIP. TVA must include a discussion of the statistical procedure to be used in the EIP.
Appendix E, Section 2.0	Groundwater Investigation SAP, Objectives	2	1	3	Objectives need to include a comprehensive evaluation of groundwater flow direction(s), velocities and gradients; and an evaluation of groundwater quality (geochemical and CCR parameters).
Appendix E, Section 2.0	Groundwater Investigation SAP, Objectives	2	1	6	The Groundwater Investigation SAP indicates determining direction of groundwater flow, however TDEC requires the groundwater flow direction(s), velocities and gradients each time groundwater is sampled or measurements are taken from piezometers.
Appendix E, Section 4.0	Sampling Locations	All	All	All	TVA will sample all available groundwater monitoring wells and piezometers onsite to accurately determine groundwater flow and quality as part of the EIP. Additionally, any data collected as part of compliance with federal CCR requirements should be included in the EIP process.
Appendix E, Section 4.0	Sampling Locations	250	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.
Appendix E, Section 4.0	Groundwater Investigation SAP, Sampling Locations	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. All applicable groundwater monitoring wells be sampled as part of the EIP and the data provided to TDEC for review. Or monitoring wells should be installed to fill gaps in characterization.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix E, Section 4.0	Groundwater Investigation SAP, Sampling Scope	4	2	1	Please include well 27 in water level gauging and sampling. Also wells AD-1, AD-2, AD-3, 6AR, 22, 27 need to be sampled for CCR related constituents listed in 40 CFR 257, Appendices III and IV as well as Appendix I of TN Rule 0400-11-01-.04 along with the proposed wells (KIF-102, KIF-103, KIF-104).
Appendix E, Section 4.0	Groundwater Investigation SAP, Sampling Frequency	5	1	2	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. Four quarterly events are not adequate to determine statistical significance or determine groundwater fluctuation caused by the rise in pool elevation of the Emory River.
Appendix E, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	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 E, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm in the bulletized list.
Appendix E, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	4	According to TVA's TI document ENV-TI-05.80.42 (pg. 9/20) the turbidity is required to be below 5 NTUs. Please clarify which document is correct and adjust as necessary. If the final turbidity after sample collection is greater than 5NTU is there any additional requirements sampling?

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix E, Section 5.2.5.1	Groundwater Investigation SAP, Groundwater Sampling	9	2	3	This should be 5NTU according to ENV-TI-05.80.42
Appendix E, Table 5	Groundwater Investigation SAP	14	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. There is not a hold time associated with the field measurement of pH by Method 9040C.
Appendix E, Section 5.2.8	Groundwater Investigation SAP	15	4	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.
Appendix E, Section 6.2	Groundwater Investigation SAP	16	1	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 E, Section 6.2	Groundwater Investigation SAP	16	3	1	If an analyte is not amenable to the MS/MSD procedure it should be collected as a lab duplicate (e.g., TSS and radium) as indicated in QAPP.
Appendix E, Section 7.0	Groundwater Investigation SAP, Schedule	19	2	1	Four quarterly events are not adequate to determine statistical significance or determine groundwater fluctuation caused by the rise in pool elevation of the Emory River.
Appendix E	Attachment A - Figure 1	269	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.

TVA Kingston EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix F, Section 2.0	Objectives	2	1	2	TVA will sample three downgradient wells. The additional well will be downgradient of the Interim Ash Staging Area and Sluice Trench/Ball Field
Appendix F	Hydrogeological Investigation SAP	All	All	All	The SAP is missing a description of soil sampling activities indicated in Section 3.1.3. Please include a description of sample collection, handing and analytical procedures to include (at a minimum) CCR parameters.
Appendix F, Section 4.0	Hydrogeological Investigation SAP	4	All	All	Please include a table of proposed well construction details and a potentiometric map showing most recent groundwater flow conditions.
Appendix F, Section 5.1	Hydrogeological Investigation SAP	6	1	1	A TN professional geologist will oversee the installation of the wells and be responsible for logging the soil in accordance with ASTM standards
Appendix F, 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.
Appendix F, Section 5.1	Hydrogeological Investigation SAP	6	3	2	There needs to be a discussion on project objectives and potential hazards with project personnel.
Appendix F, Section 5.2	Hydrogeological Investigation SAP	6	1	2	The elevation of the top of casing shall be correlated to Mean Sea Level, allowing river levels to be easily corrrelated.
Appendix F, Section 5.2.1	Hydrogeological Investigation SAP	6	1	1	Since the wells will be installed using rotosonic drilling techniques, TVA shall store the soil cores that are archived in core boxes, allowing further review of soil borings should questions on composition arise.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix F, Section 5.2.1	Hydrogeological Investigation SAP	6	1	3	Drilling oversight and sampling/logging activities will be performed by a TN Professional Geologist.
Appendix F, Section 5.2.1	Hydrogeological Investigation SAP	6	2	1	A TN Professional Geologist will prepare the boring and monitoring well installation logs.
Appendix F, Section 5.2.5	Hydrogeological Investigation SAP	8	1	5	Since rotosonic will be the method utilized and there is typically a large volume of drilling water produced, it will need to be containerized and processed as CCR contaminated water or labeled and stored in accordance with appropriate regulation pending analysis.
Appendix F, Section 5.2.5	Hydrogeological Investigation SAP	9	1	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.
Appendix F, Section 5.2.6.1	Hydrogeological Investigation SAP	10	1	5	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 F, Section 5.2.6.2	Hydrogeological Investigation SAP	10	1	1	Monitoring well development should not begin until a minimum of 24 hours following completion of the well.
Appendix F, Section 5.2.6.2	Hydrogeological Investigation SAP	10	1	12	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 F, Attachment A	Hydrogeological Investigation SAP		Figure 2		The well pump inlet should be at the midpoint of the screen, if the screen is fully submerged, otherwise the pump inlet should be placed at the midpoint of the saturated interval. It is unclear by this figure that the pump is placed correctly.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix F, Attachment A	Hydrogeological Investigation SAP		Figure 2		Water encountered during drilling should be shown on stratigraphy log adjacent to monitoring well construction log.
Appendix F, Attachment A	Hydrogeological Investigation SAP		Figure 2		The sand filter pack will extend a minimum of two feet above the screen
Appendix F	Attachment A - Figure 1	290	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.
Appendix H	All	All	All	All	Based on a review of historic aerials, background soil sample location KIF-BG-08 is within or in close proximity to the historic ash release impact area. TVA shall relocate this sampling point to an area that is outside potential impacts from the historic ash release.
Appendix H, Section 3.0	Background Soil SAP	3	1	4	Field teams shall include (at a minimum) an experienced TN licensed professional geologist.
Appendix H, Section 5.2.1.1	Background Soil SAP	7	3	11	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?
Appendix H, Section 5.2.1.1	Background Soil SAP	7	3	16	Grab samples only. The collection of composite soil samples is not acceptable to determine if CCR constituents are present because the evidence of a release may be diluted.
Appendix H, Section 5.2.1.1	Background Soil SAP	8	1	1	Boreholes shall 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.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix H, Section 5.2.1.2	Background Soil SAP	8	1	3	The color of the soil shall be determined using the Munsell color chart and shall be described while the soil is still at or near the in-situ moisture condition. It should be noted if the Munsell Color Charts are not used for soil color descriptions.
Appendix H, 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
Appendix H, Section 5.2.1.2	Background Soil SAP	8	1	5	Soil will be logged to include soil consistency or density, size, shape and angularity of particles, plasticity (for fine-grained soil)
Appendix H, Section 5.2.5	Background Soil SAP	13	Table 4		A pH field test kit will be employed to measure soil pH and to determine if soil pH promotes mobilization of CCR contaminants in the environment (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 increases the likelihood that soil pH will not ne determined within the 15 min holding time, please consider a field method measurement of pH for comparison.
Appendix H, Section 5.2.7	Background Soil SAP	14	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.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix H	Attachment A - Figure 1	331	All	All	Provide proposed background soil sample locations overlaying a USDA soil map.
Appendix I	All	All	All	All	Any geotechnical data that may have been affected (directly or indirectly) by the 2008 dredge cell failure will be excluded from the EIP process.
Appendix I, Section 3.8.1	Field Activities	19	2	All	Please provide additional justification and explanation for the exclusion of the indicated CCR material at STN-50
Appendix I	Attachment A - Figure 1	406	All	All	Confirm that the perimeter wall is continuous along the KRP Ash Landfill and the Stilling Pond interface.
Appendix K, Figure 1 and Data Tables	All	All	All	All	Data indicates exceedances for monitor wells 2, 9, 13, 10, and 6. Of particular concern are the exceedances associated with the now capped Interim Ash Staging Area and Sluice Trench/Ball Field East of Sluice Trench Area. TVA install additional wells near these historic exceedances to evaluate current water quality with regards to CCR constituents.
Appendix K	Figure 1	444	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.
Appendix K	Table 1A	445	All	All	Provide groundwater chemical data for wells 27A, 27B, 22, and 22B.
Appendix K	Table 1B	458	All	All	Provide groundwater physical data for wells 27A, 27B, 22, and 22B.
Appendix K	Table 1C	466	All	All	Provide groundwater elevation data for wells 27A, 27B, and 22B.
Appendix K	Table 1C	466	All	All	Why are the well depths variable at the same locations over multiple sampling events?
Appendix K	All	All	All	All	Please include a summary table for all existing well construction details

TVA

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402-2801

January 8, 2018

Mr. Robert S. Wilkinson
Tennessee Department of Environment
and Conservation
William R. Snodgrass Building TN Tower
312 Rosa L Parks Avenue
Nashville, Tennessee 37243-1548

Dear Mr. Wilkinson:

TENNESSEE VALLEY AUTHORITY (TVA) – EXTENSION REQUEST FOR KINGSTON FOSSIL PLANT (KIF) ENVIRONMENTAL INVESTIGATION PLAN (EIP) REVISION 2 -- COMMISSIONER'S ORDER NUMBER OGC15-0177

This letter is requesting an extension per Section VII.C of Commissioner's Order OCG015-0177 for the TVA Kingston Fossil Plant EIP Revision 2. This EIP is required by Section VII.A.d of the Order for each site following the initial investigation conference.

The Kingston Fossil Plant Revision 1 EIP was submitted to TDEC on September 8, 2017. TVA received TDEC's December 8, 2017 letter which described TDEC's comments on the EIP Revision 1. This letter stated a due date for the EIP Revision 2 of February 9, 2018.

To ensure TVA accurately and completely addresses all comments on EIP Revision 1, TVA proposes an EIP Revision 2 due date of March 2, 2018. This additional time will allow TVA to include the additional information requested in your comments. TVA requests TDEC's response to confirm or deny this requested due date.

Thank you for your consideration of this request. If you have questions regarding this information, please contact Paul Pearman at (423) 751-3972 or by email at *pjpearman@tva.gov* or me (423) 751-3304 or by email at *sstidwell@tva.gov*.

Sincerely,

M. Susan Smelley

M. Susan Smelley
Director
Environmental Compliance and Operations

cc: Ms. Shari Meghreblian, Ph.D.
Deputy Commissioner, Bureau of Environment
Tennessee Department of Environment
and Conservation (TDEC)
William R. Snodgrass Building TN Tower
312 Rosa L Parks Avenue
Nashville, Tennessee 37243-1548

Mr. Chuck Head
Senior Advisor
Tennessee Department of Environment
and Conservation (TDEC)
William R. Snodgrass Building TN Tower
312 Rosa L Parks Avenue
Nashville, Tennessee 37243-1548

Ms. Jenny Howard
General Council
Tennessee Department of Environment
and Conservation (TDEC)
William R. Snodgrass Building TN Tower
312 Rosa L Parks Avenue, 2nd Floor
Nashville, Tennessee 37243-1548

Mr. Robert Burnette, P.E.
Tennessee Department of Environment
and Conservation (TDEC)
1301 Riverfront Parkway, Suite 206
Chattanooga, Tennessee 37402

Mr. James Clark
Chief Geologist
Tennessee Department of Environment
and Conservation (TDEC)
Columbia Field Office
1421 Hampshire Road
Columbia, Tennessee 38401

Mr. Britton Dotson
Environmental Fellow
Tennessee Department of Environment
and Conservation (TDEC)
William R. Snodgrass Building TN Tower
312 Rosa L Parks Avenue
Nashville, Tennessee 37243-1548

Ms. Angela Adams
CCR Environmental Consultant
Tennessee Department of Environment
and Conservation (TDEC)
Division of Water Resources
761 Emory Valley Road
Oak Ridge, Tennessee 37830

PJP:SMF
cc (Electronic Distribution):
J. A. Birdwell, WT 6A-K
B. E. Brickhouse, BR 4A-C
J. L. Brundige, SP 6B-C
T. E. Cheek, BR 4A-C
S. M. Connors, LP 3K-C
R. M. Deacy, Sr., LP 5D-C
A. B. Fisher, BR 4A-C
B. S. Fowler, BR 4A-C
J. C. Kammeyer, LP 5D-C
K. A. Love, SP 6B-C
P. J. Pearman, BR 4A-C
J. R. Quinn, III, LP 5G-C
T. S. Rudder, BR 4A-C
A. L. Smith, BR 4A-C
M. S. Turnbow, LP 5G-C
J. B. Woodward, MR 3H-C
ECM, ENVrecords@tva.gov

Robert Wilkinson, PG, CHMM CCR Technical Manager
2^{nd} Floor TN Tower, W.R. Snodgrass Building
312 Rosa L. Parks Avenue
Nashville, TN 37243
Office: (615) 253-0689
e-mail: Robert.S.Wilkinson@tn.gov

Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

January 22, 2018

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

RE: TDEC Commissioner's Order OGC 15-1077
TVA Kingston Coal Fired Fossil Fuel Plant
TVA Extension Request Environmental Investigation Plan

Dear Ms. Smelley:

The Tennessee Department of Environment and Conservation (TDEC) has received the Tennessee Valley Authority's (TVA) letter requesting an extension per Section VII.C of Commissioner's Order OGC 15-0177 for the Kingston Fossil Plant (KIF) Environmental Investigation Plan (EIP) Revision 2 to **March 2, 2018**. TDEC approves the request for extension.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA KIF 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	Paula Plont
	Revendra Awasthi	Jenny Howard	Shari Meghreblian
	Shawn Rudder	Patrick Mulligan	Amos Smith

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
1	All	All	All	All	All	TVA has agreed to conduct an environmental investigation at the TVA Kingston 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.
2	All	All	All	All	All	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 shall continue to collect, test and report outfall samples in accordance with the conditions of the NPDES permit. TVA has included NPDES outfall sampling information, as well as detailed constituent information provided in its NPDES permit applications. NPDES compliance data previously submitted to TDEC will be included in the revised EIP as an appendix. The KIF renewal NPDES permit, TN0005452, was issued by TDEC on January 31, 2018, and will become effective on March 1, 2018, and includes updated monitoring schedules for an expanded list of parameters further detailed in the permit. If after reviewing the existing data, TDEC desires additional surface water data as part of the investigation, TDEC and TVA can jointly determine a path forward.
3	All	All	All	All	All	General comment - TVA will include an applicability assessment of the TDEC General Guideline for Environmental Investigation Plans, TVA Fossil Plants when preparing the EIP. TDEC understands that not all aspects of the guidelines will be applicable at all TVA facilities, but each line item should be reviewed and assessed for applicability within the EIP. If an item is deemed not applicable to this facility, TVA should provide a written justification for exclusion within the EIP. Applicable items from the guidelines should be incorporated into the next revision of the EIP.	Comment is acknowledged, and the corresponding changes have been made in the document.
4	All	All	All	All	All	General comment - All monitor wells, geotechnical borings, and soil borings will be logged by a Tennessee 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.
5	All	All	All	All	All	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.
6	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.
7	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.
8	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.
9	General Administrative	NA	NA	NA	NA	The 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.
10	General Administrative	NA	NA	NA	NA	Please provide the following TVA TI, "Monitoring Well and Piezometer Installation and Development" (ENV-TI-05.80.25).	Comment is acknowledged. The TI was submitted to TDEC on November 9th, 2017.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
11	General Administrative	NA	NA	NA	NA	All liquid results shall be reported in parts per billion (µg/L). All results from soil, CCR material and other solids shall be reported in parts per million (mg/kg). All tables, figures and graphs shall use µg/L to report analytical results from analysis of liquids and mg/kg for analytical results from analysis of solids. Figures and graphs for more than one parameter may only be portrayed on the same page if the X and Y axis use the same units.	Comment acknowledged. The document will be revised as necessary and tables, figures and graphs will be completed in the requested format and provided in the EAR to address this comment.
12	Global Exhibits	NA	NA	NA	NA	Please revise the figures to indicate the estimated waste boundary so that it does not appear that especially downgradient wells are being installed in ash.	The linework shown on the figures is intended to delineate the approximate CCR unit area, not the estimated waste boundary. In some instances, the approximate unit area encompasses perimeter dikes, through which proposed wells are to be installed. Refer to the Hydrogeological Investigation SAP for more discussion on the locations of individual proposed wells.
13	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.
14	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.
15	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.	Comment is acknowledged. Following the collection of leachate data from the proposed work in the EI, the data will be evaluated for trends between the common leachate indicators and the total amount of CCR metals in contaminated water samples, in the EAR. "Leachate" is any liquid that, in the course of passing through matter, extracts soluble or suspended solids, or any other component of the material through which it has passed. "Groundwater" may be defined as the water found in the interstitial spaces within the soil, whereas "pore water" refers to the water in the interstitial spaces within the CCR material (ash) in a CCR unit. Based on its definition, both groundwater and pore water may be considered leachate; however, to clarify its use in the EIP, the term "pore water" will be used to specifically refer to the water contained within a CCR unit, while "groundwater" will refer to subsurface water outside the physical boundaries of the CCR unit.
16	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?	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.
17	1.4.2	Current Operations and Closure Plans	4	1	All	TDEC recognizes that TVA has initiated closure projects for the Interim Ash Staging Area, Sluice Trench, and Stilling Pond. These closure actions have occurred prior to complete characterization of the site as part of the EIP process, and, as such, are considered "at risk". Based on the results of the EIP, TVA may be required to take other and further remedial action at the site.	Comment is acknowledged. The Stilling Pond has been closed to meet an EPA requirement set in motion before the CCR Rule came into effect. TVA communicated with TDEC before and during these closure projects. While TVA commenced closure of the stilling pond to meet the required CCR Rule closure completion date and an EPA commitment, TVA remains dedicated to the Order and completing the site-wide investigation, comprehensive environmental assessment, and any corrective actions identified. TVA recognizes that TDEC may later require TVA to take other and/or further remedial actions deemed appropriate as a result of the investigative process.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
18	2.1	EIP Development and Structure	9	1	1	TVA will provide monthly (at a minimum) EIP progress reports to TDEC.	Monthly progress reports and schedule updates will be provided to TDEC. Change will be made in the document.
19	2.2	Proposed Schedule	All	All	All	Monthly schedule updates will be provided to TDEC depicting progress for all EIP activities. TVA will 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.
20	2.2	Proposed Schedule	All	All	All	Proposed schedule is considered draft at this time, not final.	Comment is acknowledged.
21	2.3	Quality Assurance Project Plan	9	1	1	Use common abbreviations for clarity, Appendix C uses KIF QAPP instead of KIF Quality Plan.	Comment is acknowledged, and the corresponding changes have been made in the document.
22	2.3	Quality Assurance Project Plan	10	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 has been 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.
23	3.1.1	TDEC Site Specific Request No. 1	11	3	6	Not only does there need to be an analysis of correlations between groundwater and surface water elevations and seasonal variations but also the effects on the saturation level in the CCR landfills and impoundment need to be included in the EAR.	Three-dimensional models will be developed for the CCR units in the Study Area. An analysis of correlations between groundwater, surface water and saturation levels in the CCR units, and seasonal variations will be incorporated into the three-dimensional models to estimate the volume of CCR below groundwater levels and saturation levels within the CCR units. This information will be provided in the EAR.
24	3.1.2	TDEC Site Specific Request No. 2	All	All	All	TVA will continue to sample groundwater at GW-2 and 22 during the EIP process.	Groundwater level measurements will be collected from wells GW-2 and 22 for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from well 22 as part of other ongoing programs associated with the KRP Ash Landfill. Wells GW-2 and 22 are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the QAPP will be utilized in the EAR.
25	3.1.2	TDEC Site Specific Request No. 2	12	3	3	Based on exhibit #2 it appears that near the ballfield and sluice trench there are only 2 downgradient monitoring wells. At a minimum there should be three downgradient wells. TDEC would like TVA to evaluate potentially placing the third downgradient well southeast of AD-2.	A third monitoring well downgradient of the ballfield and sluice trench and northeast of well AD-2 has been added to the proposed monitoring well network for the investigation as shown on Exhibit No. 2. Monitoring well installation and sampling procedures for the additional well are included in the updated Hydrogeological Investigation and Groundwater Investigation SAPs, respectively.
26	3.1.2	TDEC Site Specific Request No. 2	12	3	5	Please provide evidence on whether or not the unconsolidated materials above bedrock and the bedrock aquifers are hydraulically interconnected.	The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater quality and flow direction in overburden above bedrock. Based on the results of the initial phase of work, if it is determined that there is a need to investigate vertical gradients and groundwater quality in bedrock, then TVA will prepare a modified investigation plan for TDEC review and comment.
27	3.1.2	TDEC Site Specific Request No. 2	12	3	5	Previous reports provided by TVA have indicated that the Conasauga Group underlying the CCR units are highly fractured and therefore would be dominated by fractured flow. The potential for downward vertical migration of CCR contaminants, the potential for their migration along fractures, joints and bedding planes have not been evaluated. TVA shall include in the EIP its plan for evaluating downward flow of ground water including a discussion of installing monitoring wells.	The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater quality and flow direction in overburden above bedrock. Based on the results of the initial phase of work, if it is determined that there is a need to investigate vertical gradients and groundwater quality in bedrock, then TVA will prepare a modified investigation plan for TDEC review and comment. This information has been included in Section 3.1.3.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
28	3.1.2	TDEC Site Specific Request No. 2	18	3	2	Wells 27A, 27B, 22, And 22B will be added to the Study Area monitoring network.	Groundwater level measurements will be collected from wells 22, 22B, 27A and 27B for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from wells 22, 22B, 27A and 27B as part of other ongoing programs associated with the KRP Ash Landfill. These wells are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. In addition, wells 27B and 22B are screened within the bedrock and not within the saturated overburden, which is targeted for this investigation. . TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the QAPP will be utilized in the EAR.
29	3.1.3	TDEC Site Specific Request No. 3	13	2	7	Groundwater monitoring well 27 (overburden) will be used as a monitoring well to provide groundwater level measurements to the northeast of the stilling pond between GW-2 and well 22 and also provide northern verification of the previous arsenic detection at well 22.	Groundwater level measurements will be collected from 27A for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from well 27A as part of other ongoing programs associated with the KRP Ash Landfill. This well is also outside of the Study Area and groundwater quality data collected from well 27A would be more representative of conditions at the Landfill than at the Study Area.. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the QAPP will be utilized in the EAR.
30	3.1.3	TDEC Site Specific Request No. 3	15	1	2	Drilling oversight and sampling/logging activities will be performed by a TN Professional Geologist.	See response to comment 4.
31	3.1.4	TDEC Site Specific Request No. 4	13	2	7	Within the EAR there needs to be a discussion if there are any changes observed in the water levels at AD-2 from the March 2017-July 2017 caused by the remedy of the red water seep are and the installation of rip rap.	As part of the hydrogeological characterization, TVA will evaluate the cause of fluctuations in groundwater levels, including well AD-2, due to surface water level fluctuations, seasonal effects, or other factors such as the recent remedy for addressing the red-water seep.
32	3.1.4	TDEC Site Specific Information Request No. 4	16	All	All	While TDEC's site specific comment on Kingston was specific to the red water seep at the East Dike/Engineered Wetlands, the EIP needs to include an appendix of all KIF historic seeps including discovery, remediation and current status.	A history of seeps at KIF will be included in the EIP.
33	3.1.4	TDEC Site Specific Request No. 4	22	3	NA	Investigation for the source of the hydraulic input for the collected Red-Water seeps needs to be included in the EIP.	The hydrogeological characterization will include an evaluation of the correlation between groundwater levels and seepage rates.
34	3.2.1	TDEC hydrogelogic report information request No. 1	25	NA	NA	TVA must submit a report to TDEC characterizing the nature of the groundwater mounding beneath the ash disposal areas.	Piezometers with vibrating wire transducers have been installed within the ash disposal areas 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 instrumentation is proposed to be installed within the units. Under the TDEC Order investigation along with other CCR compliance programs, TVA is gathering information in several targeted areas including but not limited to groundwater flow direction. TVA feels the current investigative actions will characterize the ground water in and around each CCR unit at Cumberland. As the investigation progresses, TVA will communicate with TDEC and jointly determine if additional investigative actions are needed.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
35	3.3.1	TDEC Water Use Survey Information Request No. 1	20	2	6	TVA will include all water wells and springs, whether or not they are owned by TVA.	Comment is acknowledged, and the corresponding change has been made in the document. Water wells and springs within a 1/2 mile of the boundary of the Study Area will be included in the water use survey, including wells or springs on TVA owned property.
36	3.4.1	TDEC Ground Water Monitoring Information Request No. 1	All	All	All	TVA will sample all groundwater monitoring wells and piezometers available onsite to accurately determine groundwater flow and quality as part of the EIP. Additionally, any data collected as part of compliance with federal CCR requirements will be included in the Cumberland EAR.	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.
37	3.4.1	TDEC Ground Water Monitoring Information Request No. 4	28	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.
38	3.5.1	TDEC Ground Water Monitoring Information Request No. 2	All	All	All	Please provide TDEC with documentation and justification for the reinstallation of MW-22. Please provide documentation demonstrating that the well is screened in ash (boring log, stratigraphy, water levels, etc..). the new MW-22 and existing MW-22 be sampled simultaneously to determine if there is a difference in concentration of CCR constituents and groundwater quality.	TVA will provide the well construction logs showing well 22 screened in ash. TVA will sample well 22 and the new well 22C simultaneously for a minimum of four independent events.
39	3.5.1	GW -Chem Properties	23	2	7	The replacement well location for MW KIF-22 must be authorized by TDEC's CCR Technical team before placement. TDEC's authorization shall include any other wells placed under this EIP. Are the proposed location identified in Appendix D still accurate?	Comment acknowledged. The location of new well 22C is included in Appendix D. Proposed monitoring well locations in Appendix D are still accurate.
40	3.5.1	TDEC Ground Water Chemical and Physical Properties request No. 1	29	All	All	Recent sampling and analytical results for Arsenic at well 22 indicates results above the MCL for filter (dissolved) sample analysis. Well 22 shall not be replaced until TDEC approves this action. The new well, once approved by TDEC, must be sampled and analysis performed a minimum of four independent events to be justified as a replacement well.	Comment acknowledged. TDEC will review and approve new well 22C as part of the groundwater monitoring network for the KRP. TVA will sample well 22 and new well 22C simultaneously for a minimum of four independent events.
41	3.5.2	TDEC Ground Water Chemical and Physical Properties Request No. 2	24			*"TVA plans to address the arsenic concentrations observed in well 22 under the current Ash Disposal Area monitoring program by replacing well 22 with a new well in the same area to obtain data representative of groundwater conditions downgradient of the Ash Disposal Area."* Replacing Well 22 with a new well does not "address" the arsenic concentration at that location. The historic arsenic detection must be characterized or otherwise explained.	Refer to Section 3.5.1 for discussion of the rationale for installing replacement well 22C. Representative groundwater samples cannot be obtained from wells screened in ash.
42	3.6.1	TDEC Structural and Seismic Stability Information Request No. 1	25			*"TVA understands it is performing this work at risk, as discussions between TVA and TDEC concerning seismic stability of Dike C are ongoing."* TVA seems to be suggesting that the only issue with "proceeding at risk" is associated with the seismic assessment. This is not the case. Other EIP discoveries, such as impact to groundwater, may dictate that Closure in Place is not appropriate.	Comment is acknowledged.
43	3.6.1	TDEC Structural and seismic Stability Information Request No. 1	31			While not enforcing the Federal CCR rule, TDEC will expect seismic analysis and methods to meet the standards required by the Federal CCR rule under authority of the Commissioner's Order.	A Stability SAP will be added to the EIP, which includes an established matrix of load cases (static and seismic) that are appropriate for the CCR units at KIF. The same matrix is being used for each EIP under the TDEC Order. Available existing and ongoing (e.g., closure design) analyses for each CCR unit in the Study Area will be compared against the matrix and identified data gaps will be addressed with new analyses during the Investigation. Results will be presented in the EAR.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
44	3.6.1	TDEC Structural and seismic Stability Information Request No. 1	31/482	2	3&4	Please confirm that closure of the Stilling Pond by April 17, 2018 is a timeline requirement of the Federal CCR rule.	In the letter to EPA dated May 1, 2015, TVA committed to close the Stilling Pond by April 17, 2018, based on the 2014 seismic stability results of the unit (as it existed at the time) that did not meet the EPA's 2011 seismic assessment criteria. Although the closure date of April 17, 2018, happens to coincide with a key date in the CCR Rule (it is the original, published date that inactive surface impoundments were supposed to have completed closure), TVA's commitment to close the Stilling Pond is driven by the May 1, 2015, letter. The text in the EIP will be clarified.
45	4	Additional Site Characterization Information	30	1	6	It was not TDEC's intent to have the second information request supersede the first. As stated in previous comments, TVA will include an applicability assessment of the TDEC General Guideline for Environmental Investigation Plans, TVA Fossil Plants when preparing the EIP. TDEC understands that not all aspects of the guidelines will be applicable at all TVA facilities, but each line item should be reviewed and assessed for applicability within the EIP. If an item is deemed not applicable to this facility, TVA should provide a written justification for exclusion within the EIP. Applicable items from the guidelines should be incorporated into the next revision of the EIP.	Comment is acknowledged, and the corresponding changes have been made in the document.
46	4.1	CCR Material Characteristics	30	All	All	TVA will conduct 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 from each investigation area. Samples should be run for total concentrations of CCR parameters, TCLP CCR parameters, and SPLP CCR parameters.	TVA will include historical leachability testing data gathered at the KIF site. Based on this data, a new CCR Material Characteristics SAP does not need to be developed at this time. Upon review of the existing data, TDEC and TVA will jointly determine a path forward.
47	4.2	Background Soil SAP	31	All	All	Based on a review of historic aerials, background soil sample location KIF-BG-08 is within or in close proximity to the historic ash release impact area. TVA will relocate this sample to an area that is outside potential impacts from the historic ash release.	Comment is acknowledged, and the corresponding change has been made in the document.
48	4.2	Background Soil SAP	31	2	2	Please include on Exhibit 9 the locations of the proposed background soil sampling locations overlain by a USDA soil map.	Comment is acknowledged, and the corresponding change has been made in the document.
49	4.2	Background Soil SAP	32	4	5	Please clarify that the mid-point for grab samples will be the mid-point based on recovery.	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.
50	4.2	Background Soil SAP	32	4	6	Please clarify that if a change in lithology occurs within the interval that the mid-point of both lithologies in the recovered core will be sampled.	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.
51	4.2	Background Soil SAP	32	6	3	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).

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
52	4.2	Background Soil SAP	32	6	3	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. 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.
53	4.2	Background Soil SAP	32	6	3	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.	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 KIF and are positioned in areas previously determined to not be impacted by plant activities.
54	4.2	Background Soil SAP	37	1	All	Provide proposed background soil sample locations overlaying a USDA soil map.	Comment is acknowledged, and the corresponding change has been made in the document.
55	4.3	Sediment	All	All	All	Please confirm that existing sediment sampling data includes all applicable CCR parameters.	The sediment sampling events for KIF conducted under the removal and recovery efforts were performed under the authority, supervision, and approval of EPA and TDEC. Samples collected for quantitative analysis were analyzed for all the Appendix III and IV metals except for lithium. Sediment sampling did not include the following Appendix III constituents for detection monitoring: · Chloride · Fluoride · Sulfate ·Alkalinity
56	4.4	Surface Stream	All	All	All	Please confirm that existing water quality sampling data includes all applicable CCR parameters.	The surface stream sampling events for KIF conducted under the removal and recovery efforts were performed under the authority, supervision, and approval of EPA and TDEC. Surface stream sampling conducted for KIF did not include the following Appendix III constituents for detection monitoring: · Chloride · Fluoride · Sulfate ·Alkalinity However, the Appendix IV constituents for assessment monitoring, except for lithium, were addressed.
57	4.5	Fish Investigations	All	All	All	Please confirm that existing fish investigation sampling data includes all applicable CCR parameters.	The fish tissue sampling events for KIF conducted under the removal and recovery efforts were performed under the authority, supervision, and approval of EPA and TDEC. The Appendix III constituents for assessment monitoring were addressed, as were the Appendix IV constituents (except for lithium).
58	4.6	Additional Stability Analysis	43	All	All	While not enforcing the Federal CCR rule, TDEC will expect seismic analysis and methods to meet the standards required by the Federal CCR rule under authority of the Commissioner's Order.	A Stability SAP will be added to the EIP, which includes an established matrix of load cases (static and seismic) that are appropriate for the CCR units at KIF. The same matrix is being used for each EIP under the TDEC Order. Available existing and ongoing (e.g., closure design) analyses for each CCR unit in the Study Area will be compared against the matrix and identified data gaps will be addressed with new analyses during the Investigation. Results will be presented in the EAR.
59	Appendix A	Schedule	All	All	All	Please update	The schedule will be updated as part of the revision. The start date of investigation activities will depend on the EIP approval date.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
60	Appendix B	TVA's March 6,2017 letter to TDEC	77	4	4	Please confirm that closure of the Stilling Pond by April 17, 2018 is a timeline requirement of the Federal CCR rule.	See response to comment 44.
61	Appendix B	Drawing 6 of 6	114			Provide additional detail for the abandoned 42" pipe indicated on FN 2016-00521 Drawing 6 of 6. Describe design details and constructions methods used for the abandonment and indicate if the pipe is placed in ash material.	Revised comment for TVA review: TVA will compile the abandonment details of the 42" pipe, including what is known about the bedding conditions, and will provide this information in the EAR.
62	Appendix C Section 9.1.2	QAPP	20	6	1	Some of the requirements in the QAPP are written as should. TVA will replace the word "should" with "shall" in the QAPP when discussing specific requirements. 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."
63	Appendix C Section 10.0	QAPP	23	1	1	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. The reporting limits will be sufficient to meet project requirements and quality objectives for precision, accuracy, and sensitivity.
64	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."
65	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.
66	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.
67	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.	Comment acknowledged. The document will be revised as necessary to address calibration of field pH meters to meet the requirements of 9040C.
68	Appendix C Section 13.1	QAPP	34	2	4	Maintenance ~~should~~ shall be performed when the instrument will not adequately calibrate. Maintenance of field equipment should shall be noted in an instrument logbook or field notebook. Suggest a universal comment, replace should with shall when used as part of procedure or requirement.	"Should" will be replaced with "will."
69	Appendix C Section 17.0	QAPP	44	3	2	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."
70	Appendix C Section 19.5	QAPP	51	1	4	By providing specific protocols for obtaining and analyzing samples, data sets ~~should~~ will be comparable regardless of who collects the sample or who performs the sample analysis.	"Should" will be replaced with "will."
71	Appendix C, QAPP Appendix A	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."

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
72	Appendix C, QAPP Appendix A	QAPP Appendix A.2	A-13	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."
73	Appendix C, QAPP Appendix D	QAPP Appendix D	D-2	Table A	All	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".
74	Appendix D	Exhibit 3	232	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.
75	Appendix D	Exhibit 9	238	All	All	Provide proposed background soil sample locations overlaying a USDA soil map.	Comment is acknowledged, and the corresponding change has been made in the document.
76	Appendix E	Groundwater Investigation SAP	All	All	All	Statistical methods to be used for evaluating groundwater monitoring data are not developed in this EIP. TVA must include a discussion of the statistical procedure to be used in the EIP.	TVA will follow 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 prior to collection of the dataset. TVA will provide the basis for selection of statistical methods in the EAR.
77	Appendix E, Section 2.0	Groundwater Investigation SAP, Objectives	2	1	3	Objectives need to include a comprehensive evaluation of groundwater flow direction(s), velocities and gradients; and an evaluation of groundwater quality (geochemical and CCR parameters).	Comment is acknowledged; the overall objectives include a comprehensive evaluation of groundwater flow direction(s), velocities and gradients; and an evaluation of groundwater quality (geochemical and CCR parameters). The SAP has been updated to reflect this comment.
78	Appendix E, Section 2.0	Groundwater Investigation SAP, Objectives	2	1	6	The Groundwater Investigation SAP indicates determining direction of groundwater flow, however TDEC requires the groundwater flow direction(s), velocities and gradients each time groundwater is sampled or measurements are taken from piezometers.	TVA will provide information regarding the direction, gradient, and rate of groundwater flow each time groundwater is sampled.
79	Appendix E, Section 4.0	Sampling Locations	All	All	All	TVA will sample all available groundwater monitoring wells and piezometers onsite to accurately determine groundwater flow and quality as part of the EIP. Additionally, any data collected as part of compliance with federal CCR requirements should be included in the EIP process.	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.
80	Appendix E, Section 4.0	Sampling Locations	250	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.
81	Appendix E, Section 4.0	Groundwater Investigation SAP, Sampling Locations	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. All applicable groundwater monitoring wells be sampled as part of the EIP and the data provided to TDEC for review. Or monitoring wells should be installed to fill gaps in characterization.	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.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
82	Appendix E, Section 4.0	Groundwater Investigation SAP, Sampling Scope	4	2	1	Please include well 27 in water level gauging and sampling. Also wells AD-1, AD-2, AD-3, 6AR, 22, 27 need to be sampled for CCR related constituents listed in 40 CFR 257, Appendices III and IV as well as Appendix I of TN Rule 0400-11-01-.04 along with the proposed wells (KIF-102, KIF-103, KIF-104).	Groundwater quality samples and levels will be collected from existing wells AD-1, AD-2, AD-3 and 6AR and proposed wells KIF-102, KIF-103 and KIF-104 for the investigation. Groundwater levels will also be collected from wells 22, 27A and 27B for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from wells 22, 27A and 27B as part of other ongoing programs associated with the KRP Ash Landfill. These wells are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the requirements of the QAPP will be utilized in the EAR.
83	Appendix E, Section 4.0	Groundwater Investigation SAP, Sampling Frequency	5	1	2	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. Four quarterly events are not adequate to determine statistical significance or determine groundwater fluctuation caused by the rise in pool elevation of the Emory River.	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.
84	Appendix E, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	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 a NIST certified temperature sensor.
85	Appendix E, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm in the bulletized list.	Specific conductance will be measured and recorded in µS/cm in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017).
86	Appendix E, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	4	According to TVA's TI document ENV-TI-05.80.42 (pg. 9/20) the turbidity is required to be below 5 NTUs. Please clarify which document is correct and adjust as necessary. If the final turbidity after sample collection is greater than 5NTU is there any additional requirements sampling?	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. An older version of this TI used different criteria. Ten NTUs is standard practice. If turbidity is greater than 10 NTUs, then filtered samples will also be collected.
87	Appendix E, Section 5.2.5.1	Groundwater Investigation SAP, Groundwater Sampling	9	2	3	This should be 5NTU according to ENV-TI-05.80.42	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. An older version of this TI used different criteria. Ten NTUs is standard practice.
88	Appendix E, Table 5	Groundwater Investigation SAP	14	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. There is not a hold time associated with the field measurement of pH by Method 9040C.	Comment acknowledged. The document will be revised as necessary to address calibration of field pH meters to meet the requirements of 9040C.
89	Appendix E, Section 5.2.8	Groundwater Investigation SAP	15	4	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.	Comment is acknowledged. "Should" will be replaced with "will." Separate ongoing investigation activities are in progress to characterize the site-specific hydrogeology at the site. The results of the ongoing activities will be included in the EAR.
90	Appendix E, Section 6.2	Groundwater Investigation SAP	16	1	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 at a frequency of 1 per lot for other GW monitoring programs. EnvStd recommends collecting 1 tubing blank per sampling event unless the tubing is certified clean for trace metals.
91	Appendix E, Section 6.2	Groundwater Investigation SAP	16	3	1	If an analyte is not amenable to the MS/MSD procedure it should be collected as a lab duplicate (e.g., TSS and radium) as indicated in QAPP.	Comment acknowledged. The QAPP indicates that additional volume is collected for laboratory duplicate analysis for parameters not amenable to spiking.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
92	Appendix E, Section 7.0	Groundwater Investigation SAP, Schedule	19	2	1	Four quarterly events are not adequate to determine statistical significance or determine groundwater fluctuation caused by the rise in pool elevation of the Emory River.	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. TVA will sample monitoring wells installed as part of the EIP bi-monthly for one year. Other monitoring wells will continue to be sampled per the requirements of the program for which they were installed.
93	Appendix E	Attachment A - Figure 1	269	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.
94	Appendix F, Section 2.0	Objectives	2	1	2	TVA will sample three downgradient wells. The additional well will be downgradient of the Interim Ash Staging Area and Sluice Trench/Ball Field	A third monitoring well downgradient of the ballfield and sluice trench and northeast of well AD-2 has been added to the proposed monitoring well network for the investigation as shown on Exhibit No. 2. Monitoring well installation and sampling procedures for the additional well are included in the updated Hydrogeological Investigation and Groundwater Investigation SAPs, respectively.
95	Appendix F	Hydrogeological Investigation SAP	All	All	All	The SAP is missing a description of soil sampling activities indicated in Section 3.1.3. Please include a description of sample collection, handing and analytical procedures to include (at a minimum) CCR parameters.	Soil sampling activities discussed in Section 3.1.3 are described in detail in the Background Soil SAP. The Background Soil SAP includes details on sample collection, handling and analytical procedures for CCR parameters.
96	Appendix F, Section 4.0	Hydrogeological Investigation SAP	4	All	All	Please include a table of proposed well construction details and a potentiometric map showing most recent groundwater flow conditions.	A table will be included with details for existing and proposed wells. A potentiometric map showing recent groundwater flow conditions will be provided in the EAR.
97	Appendix F, Section 5.1	Hydrogeological Investigation SAP	6	1	1	A TN professional geologist will oversee the installation of the wells and be responsible for logging the soil in accordance with ASTM standards	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.
98	Appendix F, 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.
99	Appendix F, Section 5.1	Hydrogeological Investigation SAP	6	3	2	There needs to be a discussion on project objectives and potential hazards with project personnel.	Refer to Section 2.0 - Objectives for a discussion on hydrogeological investigation objectives associated with monitoring well installation. Refer to Section 3.0 - Health and Safety: potential hazards for project personnel will be addressed in the site-specific Health and Safety Plan that will be prepared prior to initiating field activities at the Plant.
100	Appendix F, Section 5.2	Hydrogeological Investigation SAP	6	1	2	The elevation of the top of casing shall be correlated to Mean Sea Level, allowing river levels to be easily corrrelated.	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. This reference has been added to the text.
101	Appendix F, Section 5.2.1	Hydrogeological Investigation SAP	6	1	1	Since the wells will be installed using rotosonic drilling techniques, TVA shall store the soil cores that are archived in core boxes, allowing further review of soil borings should questions on composition arise.	Soil cores from monitoring wells, installed by rotosonic drilling techniques, will be stored in core boxes and archived for future visual observation, if needed. These soil cores will be stored until one year from the date of the initial submittal of the EAR, after which point they may be properly disposed of.
102	Appendix F, Section 5.2.1	Hydrogeological Investigation SAP	6	1	3	Drilling oversight and sampling/logging activities will be performed by a TN Professional Geologist.	See response to comment 4.
103	Appendix F, Section .2.15	Hydrogeological Investigation SAP	6	2	1	A TN Professional Geologist will prepare the boring and monitoring well installation logs.	See response to comment 4.
104	Appendix F, Section 5.2.5	Hydrogeological Investigation SAP	8	1	5	Since rotosonic will be the method utilized and there is typically a large volume of drilling water produced, it will need to be containerized and processed as CCR contaminated water or labeled and stored in accordance with appropriate regulation pending analysis.	Comment is acknowledged. Waste generated during drilling activities will be properly handled and disposed according to the applicable TI and the Plant's requirements.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
105	Appendix F, Section 5.2.5	Hydrogeological Investigation SAP	9	1	1	Distribution of cuttings and discharge of water should will be performed in a manner as to not create a safety hazard.	Comment is acknowledged. "Should" will be replaced with "will." Separate ongoing investigation activities are in progress to characterize the site-specific hydrogeology at the site. The results of the ongoing activities will be included in the EAR.
106	Appendix F, Section 5.2.6.1	Hydrogeological Investigation SAP	10	1	5	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.
107	Appendix F, Section 5.2.6.2	Hydrogeological Investigation SAP	10	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.
108	Appendix F, Section 5.2.6.2	Hydrogeological Investigation SAP	10	1	12	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.
109	Appendix F, Attachment A	Hydrogeological Investigation SAP		Figure 2		The well pump inlet should be at the midpoint of the screen, if the screen is fully submerged, otherwise the pump inlet 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 saturated screen.
110	Appendix F, Attachment A	Hydrogeological Investigation SAP		Figure 2		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.
111	Appendix F, Attachment A	Hydrogeological Investigation SAP		Figure 2		The sand filter pack will extend a minimum of two feet above the screen	Comment is acknowledged. The SAP indicates the filter pack will extend "...a minimum of two feet above..." the screen, when site conditions allow.
112	Appendix F	Attachment A - Figure 1	290	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.
113	Appendix H	All	All	All	All	Based on a review of historic aerials, background soil sample location KIF-BG-08 is within or in close proximity to the historic ash release impact area. TVA shall relocate this sampling point to an area that is outside potential impacts from the historic ash release.	Comment is acknowledged, and the corresponding change has been made in the document.
114	Appendix H, Section 3.0	Background Soil SAP	3	1	4	Field teams shall include (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.
115	Appendix H, Section 5.2.1.1	Background Soil SAP	7	3	11	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?	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.
116	Appendix H, Section 5.2.1.1	Background Soil SAP	7	3	16	Grab samples only. The collection of composite soil samples is not acceptable to determine if CCR constituents are present because the evidence of a release may be diluted.	Comment is acknowledged and the corresponding change has been made in the document. The purpose of the Background Soil SAP is to sample background soil that has not been affected by CCR.
117	Appendix H, Section 5.2.1.1	Background Soil SAP	8	1	1	Boreholes shall 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.
118	Appendix H, Section 5.2.1.2	Background Soil SAP	8	1	3	The color of the soil shall be determined using the Munsell color chart and shall be described while the soil is still at or near the in-situ moisture condition. It should be noted if the Munsell Color Charts are not used for soil color descriptions.	Comment is acknowledged, and the requested change has been made in the applicable SAPs.
119	Appendix H, 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	Comment is acknowledged and the corresponding change has been made in the document. Soils will be logged using ASTM Standard D2488.
120	Appendix H, Section 5.2.1.2	Background Soil SAP	8	1	5	Soil will 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.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
121	Appendix H, Section 5.2.5	Background Soil SAP	13	Table 4		A pH field test kit will be employed to measure soil pH and to determine if soil pH promotes mobilization of CCR contaminants in the environment (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 increases the likelihood that soil pH will not be determined within the 15 min holding time, please consider a field method measurement of pH for comparison.	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 per QAPP Section 11. It should be remembered that 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.
122	Appendix H, Section 5.2.7	Background Soil SAP	14	41	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 changes have been made in the document.
123	Appendix H	Attachment A - Figure 1	331	All	All	Provide proposed background soil sample locations overlaying a USDA soil map.	Comment is acknowledged, and the corresponding change has been made in the document.
124	Appendix I	All	All	All	All	Any geotechnical data that may have been affected (directly or indirectly) by the 2008 dredge cell failure will be excluded from the EIP process.	Existing geotechnical data collected in materials impacted by the 2008 failure, which are not representative of materials within the Study Area, will not be used to evaluate the CCR units in the Study Area.
125	Appendix I, Section 3.8.1	Field Activities	19	2	All	Please provide additional justification and explanation for the exclusion of the indicated CCR material at STN-50	The requested additional justification and explanation will be added to this section.
126	Appendix I	Attachment A - Figure 1	406	All	All	Confirm that the perimeter wall is continuous along the KRP Ash Landfill and the Stilling Pond interface.	The perimeter wall is not continuous but rather a series of shear walls designed to meet technical objectives related to seismic performance and structural stability. The linework on the figure illustrates the approximate location of these series of walls and is diagrammatic only. The legend will be clarified accordingly.
127	Appendix K, Figure 1 and Data Tables	All	All	All	All	Data indicates exceedances for monitor wells 2, 9, 13, 10, and 6. Of particular concern are the exceedances associated with the now capped Interim Ash Staging Area and Sluice Trench/Ball Field East of Sluice Trench Area. TVA install additional wells near these historic exceedances to evaluate current water quality with regards to CCR constituents.	Monitoring wells 2, 9 and 13 were installed in ash within the Interim Ash Staging Area unit. The hydrogeological investigation monitoring well network is designed to evaluate groundwater quality at background and downgradient locations for the Study Area CCR units and not porewater within the CCR units. Additional downgradient monitoring wells will be installed in the previous locations of monitoring wells 6 and 10 to evaluate current groundwater quality for CCR parameters downgradient of the Stilling Pond and Sluice Trench/Ballfield East, respectively. The new wells will be installed and sampled according to the procedures described in the Hydrogoelogical Investigation and Groundwater Investigation SAPs.
128	Appendix K	Figure 1	444	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.
129	Appendix K	Table 1A	445	All	All	Provide groundwater chemical data for wells 27A, 27B, 22, and 22B.	Historical groundwater chemical data associated with wells 27A, 27B, 22 and 22B was not included in the table because this data is not part of the Study Area investigation. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation.
130	Appendix K	Table 1B	458	All	All	Provide groundwater physical data for wells 27A, 27B, 22, and 22B.	See response to comment 129.
131	Appendix K	Table 1C	466	All	All	Provide groundwater elevation data for wells 27A, 27B, and 22B.	See response to comment 129.
132	Appendix K	Table 1C	466	All	All	Why are the well depths variable at the same locations over multiple sampling events?	Historical well depth measurements were obtained from a groundwater database. The differences in well depths at the same location over time could potentially be related to well repairs and re-surveying the location, obstructions in the well, conversion of units and/or human error. Well depths for existing wells will be confirmed during the investigation and provided in interim monthly reports and the EAR.

Table TVA Kingston EIP Rev 1
Summary of TDEC Comments & TVA Responses
March 2, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)
133	Appendix K	All	All	All	All	Please include a summary table for all existing well construction details	A summary table for existing wells AD-1, AD-2, AD-3, 6AR, 22, 22B, 27A, 27B and GW-2 has been included in the Appendix.

Robert Wilkinson, P.G., CHMM CCR Technical Manager
2nd Floor TN Tower, W.R. Snodgrass Building
312 Rosa L. Parks Avenue
Nashville, TN 37243
Office: (615) 253-0689
e-mail: Robert.S.Wilkinson@tn.gov

Shari Meghreblian, Ph.D.
Commissioner

Bill Haslam
Governor

May 2, 2018

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

RE: TDEC Commissioner's Order OGC 15-1077
TVA Kingston 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.

Kingston CCR Site EIP Revision 2 Comments

TVA submitted the EIP Revision 2 (EIP Rev 2) for TVA Kingston Coal Fired Fossil Power Plant (TVA KIF) on March 2, 2018. TDEC has completed its review of EIP Rev 2 and is providing comments listed in the attached **Table 1 TVA Kingston 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 **June 15, 2018**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA KIF 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, P.G., CHMM

CC:	Chuck Head	Britton Dotson	James Clark
	Pat Flood	Caleb Nelson	Rob Burnette
	Jennifer Dodd	Angela Adams	Joseph E. Sanders
	Revendra Awasthi	Peter Lemiszki	Paula Plont
	Patrick Mulligan	Shawn Rudder	Bryan Wells

Table TVA Kingston EIP Rev 2
Summary of TDEC Comments

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)
New	4.1.2	A.2 TDEC Site Information Request No. 2	34	All	All			TVA will conduct 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 from each investigation area. Samples should be run for total concentrations of CCR parameters, TCLP CCR parameters, and SPLP CCR parameters.
New	Appendix N, Stability SAP	All	All	All	All			Provide rational for determining the acceptable (tolerable) displacement performance criteria. Provide documentation that justify the stated correlation of 3 feet to a factor of safety of 1.0.
New	Appendix N - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	766/818	Phase 1	All			Explain the use of Newmark's analysis if FSpseudo > 1.0.
New	Appendix N - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	768/818	Phase 4	All			Work with TDEC to define acceptable performance will need to be established as part of the of Phase 1 Assessment.
New	Appendix N - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	769/818	Table 2	All			Work with TDEC to define acceptable criteria in Phase 1 of the Assessment. Reference comment above.
New	Appendix N - Stability SAP	5.1.3 Basis for Load Cases and Acceptance Criteria	770/818	NA	All			TVA embankment dam design guidance (TVA 2016) should be removed from the list of documents used to determine acceptable criteria.
New	Appendix N - Stability SAP	5.1.3.1 Static Loading	771/818	NA	All			Flood loading should be considered for CCR units located in the flood plain.
New	Appendix P, Seep SAP	All	All	All	All			TVA shall sample the previously documented active seeps (Appendix O, Historic Seep Summary) at the Engineered Wetlands in compliance with the Seep SAP.
24	3.1.2	TDEC Site Specific Request No. 2	All	All	All	TVA will continue to sample groundwater at GW-2 and 22 during the EIP process.	Groundwater level measurements will be collected from wells GW-2 and 22 for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from well 22 as part of other ongoing programs associated with the KRP Ash Landfill. Wells GW-2 and 22 are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the QAPP will be utilized in the EAR.	TVA will collect groundwater samples from GW-2 as well. TDEC does not agree that these wells are outside the "Study Area". The Commissioner's Order applies to all "CCR disposal areas" at KIF. The KRP Ash Landfill has the potential to influence groundwater flow and quality at KIF. TVA will utilize the data from these wells to further define groundwater quality and flow at KIF. Although GW-2 and GW-22 are outside the limits of the individual units being investigated through the Order, that does not preclude information from these wells as being integral to the understanding of groundwater movement and concentration levels through the investigated area. GW-2 appears to be potentially upgradient of both units and should be sampled (for CCR parameters) to provide information on upgradient (potentially background) water quality as well as to provide water level information for a better understanding of groundwater flow. This same rational also includes GW-22 which could potentially be an upgradient or side gradient well to the stilling pond. Having a massive landfill between the two investigative units makes a determination of actual groundwater flow very difficult. In order to understand the site specific intricacies information from beyond the boundary of the Order sites may be required so as to not artificially bias the information.TVA has agreed to conduct an environmental investigation at the TVA KIF 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.
25	3.1.2	TDEC Site Specific Request No. 2	12	3	3	Based on exhibit #2 it appears that near the ballfield and sluice trench there are only 2 downgradient monitoring wells. At a minimum there should be three downgradient wells. TDEC would like TVA to evaluate potentially placing the third downgradient well southeast of AD-2.	A third monitoring well downgradient of the ballfield and sluice trench and northeast of well AD-2 has been added to the proposed monitoring well network for the investigation as shown on Exhibit No. 2. Monitoring well installation and sampling procedures for the additional well are included in the updated Hydrogeological Investigation and Groundwater Investigation SAPs, respectively.	TDEC requested a well to the southeast of AD-2, TVA shall install the requested well. TVA has agreed to conduct an environmental investigation at the TVA KIF 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.
28	3.1.2	TDEC Site Specific Request No. 2	18	3	2	Wells 27A, 27B, 22, And 22B will be added to the Study Area monitoring network.	Groundwater level measurements will be collected from wells 22, 22B, 27A and 27B for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from wells 22, 22B, 27A and 27B as part of other ongoing programs associated with the KRP Ash Landfill. These wells are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. In addition, wells 27B and 22B are screened within the bedrock and not within the saturated overburden, which is targeted for this investigation. . TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the QAPP will be utilized in the EAR.	TDEC does not agree that these wells are outside the "Study Area". The Order applies to all "CCR disposal areas" at KIF. The KRP Ash Landfill has the potential to influence groundwater flow and quality at KIF. TVA will utilize the data from these wells to further define groundwater quality and flow at KIF. TDEC Is not aware of any vertical limitations on the vertical extents of the Study Area. Use of data in the Order Investigation will depend on the results of the data. TVA has agreed to conduct an environmental investigation at the TVA KIF 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.
34	3.2.1	TDEC	25	NA	NA	TVA must submit a report to TDEC characterizing the nature of the groundwater mounding beneath the ash disposal areas.	Piezometers with vibrating wire transducers have been installed within the ash disposal areas 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 instrumentation is proposed to be installed within the units. Under the TDEC Order investigation along with other CCR compliance programs, TVA is gathering information in several targeted areas including but not limited to groundwater flow direction. TVA feels the current investigative actions will characterize the ground water in and around each CCR unit at Cumberland. As the investigation progresses, TVA will communicate with TDEC and jointly determine if additional investigative actions are needed.	This investigation is for the Kingston site, not Cumberland. Please correct your response.
37	3.4.1	TDEC Ground Water Monitoring Information Request No. 4	28	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.

Table TVA Kingston EIP Rev 2
Summary of TDEC Comments

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)
38	3.5.1	TDEC Ground Water Monitoring Information Request No. 2	All	All	All	Please provide TDEC with documentation and justification for the reinstallation of MW-22. Please provide documentation demonstrating that the well is screened in ash (boring log, stratigraphy, water levels, etc..). the new MW-22 and existing MW-22 be sampled simultaneously to determine if there is a difference in concentration of CCR constituents and groundwater quality.	TVA will provide the well construction logs showing well 22 screened in ash. TVA will sample well 22 and the new well 22C simultaneously for a minimum of four independent events.	The log indicates a 0.2 ft layer at a depth of 26.6 ft over the coarse of a 32-35ft screen (boring log indicated 17-49 [32ft], while installation record indicates 35ft). Is it TVA's contention that the intervals of no recovery are also ash? Long screen length wells are inappropriate in most cases, what is the target depth and screen interval for the replacement well?
39	3.5.1	GW -Chem Properties	23	2	7	The replacement well location for MW KIF-22 must be authorized by TDEC's CCR Technical team before placement. TDEC's authorization shall include any other wells placed under this EIP. Are the proposed location identified in Appendix D still accurate?	Comment acknowledged. The location of new well 22C is included in Appendix D. Proposed monitoring well locations in Appendix D are still accurate.	There is no well 22C depicted on Exhibit 2
41	3.5.2	TDEC Ground Water Chemical and Physical Properties Request No. 2	24			*"TVA plans to address the arsenic concentrations observed in well 22 under the current Ash Disposal Area monitoring program by replacing well 22 with a new well in the same area to obtain data representative of groundwater conditions downgradient of the Ash Disposal Area."* Replacing Well 22 with a new well does not "address" the arsenic concentration at that location. The historic arsenic detection must be characterized or otherwise explained.	Refer to Section 3.5.1 for discussion of the rationale for installing replacement well 22C. Representative groundwater samples cannot be obtained from wells screened in ash.	Replacing the well does not mitigate the arsenic impact or the fact that there is ash in the dike Based on the boring log and assuming it is actually a 35 ft screen (and not a 32 ft screen) less than 1% of the well screen is in ash. Are there notes from the driller/geologist indicting that the HSA cuttings resembled significant deposits of ash in the no recovery intervals?
46	4.1	CCR Material Characteristics	30	All	All	TVA will conduct 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 from each investigation area. Samples should be run for total concentrations of CCR parameters, TCLP CCR parameters, and SPLP CCR parameters.	TVA will include historical leachability testing data gathered at the KIF site. Based on this data, a new CCR Material Characteristics SAP does not need to be developed at this time. Upon review of the existing data, TDEC and TVA will jointly determine a path forward.	TVA has not adequately responded to the comment. TVA shall propose the requested study. TVA has agreed to conduct an environmental investigation at the TVA KIF 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.
74	Appendix D	Exhibit 3	232	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.
82	Appendix E, Section 4.0	Groundwater Investigation SAP, Sampling Scope	4	2	1	Please include well 27 in water level gauging and sampling. Also wells AD-1, AD-2, AD-3, 6AR, 22, 27 need to be sampled for CCR related constituents listed in 40 CFR 257, Appendices III and IV as well as Appendix I of TN Rule 0400-11-01-.04 along with the proposed wells (KIF-102, KIF-103, KIF-104).	Groundwater quality samples and levels will be collected from existing wells AD-1, AD-2, AD-3 and 6AR and proposed wells KIF-102, KIF-103 and KIF-104 for the investigation. Groundwater levels will also be collected from wells 22, 27A and 27B for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from wells 22, 27A and 27B as part of other ongoing programs associated with the KRP Ash Landfill. These wells are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the requirements of the QAPP will be utilized in the EAR.	See response to comment 28.
93	Appendix E	Attachment A - Figure 1	269	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.
112	Appendix F	Attachment A - Figure 1	290	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.
128	Appendix K	Figure 1	444	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.
129	Appendix K	Table 1A	445	All	All	Provide groundwater chemical data for wells 27A, 27B, 22, and 22B.	Historical groundwater chemical data associated with wells 27A, 27B, 22 and 22B was not included in the table because this data is not part of the Study Area investigation. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation.	See response to comment 28.
130	Appendix K	Table 1B	458	All	All	Provide groundwater physical data for wells 27A, 27B, 22, and 22B.	See response to comment 129.	See response to comment 28.
131	Appendix K	Table 1C	466	All	All	Provide groundwater elevation data for wells 27A, 27B, and 22B.	See response to comment 129.	See response to comment 28.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
1A	4.1.2	A.2 TDEC Site Information Request No. 2	34	All	All			TVA will conduct 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 from each investigation area. Samples should be run for total concentrations of CCR parameters, TCLP CCR parameters, and SPLP CCR parameters.	In November 2017, three CCR/ash and pore water samples were collected from the base of the KIF Stilling Pond. The CCR/ash samples were analyzed for total CCR Parameters, total organic carbon (TOC), and SPLP. The unfiltered and filtered pore water samples were analyzed for the CCR Parameter concentrations for total and dissolved pore water samples, total and dissolved iron and manganese, and TOC. In addition arsenic speciation was conducted on both the total and dissolved pore water samples to determine concentrations of arsenate and arsenite. Details of the sampling and field testing work plan are provided in (Stantec, 2017b). Since the Stilling Pond was recently characterized for leachability of the CCR parameters by collecting and analyzing pore water samples, and collecting and analyzing CCR material after application of the SPLP method, additional leachability characterization shall be continued for the remaining locations of the study area (i.e., SluiceTrench and Ballfield East of the ST, and the Interim Ash Staging Area). A CCR Material Characteristics SAP shall be developed to address these areas. Samples of CCR material will be collected from temporary wells, during their installation, from both saturated and unsaturated zones in the CCR unit. 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. Filtered and unfiltered pore water samples will be collected from the phreatic zone at the base of the unit to obtain in-situ leaching information for the material.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
2A	Appendix N, Stability SAP	All	All	All	All			Provide rational for determining the acceptable (tolerable) displacement performance criteria. Provide documentation that justify the stated correlation of 3 feet to a factor of safety of 1.0.	Text will be added in Section 5.1.3.2.1 of the Stability SAP to explain the technical basis for this correlation.
3A	Appendix N - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	766/818	Phase 1	All			Explain the use of Newmark's analysis if FSpseudo > 1.0.	As noted in Section 5.1.3.2.1 of the Stability SAP, TVA has developed a method whereby the pseudostatic coefficient is correlated to a site-specific tolerable displacement. This correlation is developed by performing a series of Newmark displacement analyses. This methodology is consistent with that used in TVA's CCR Rule demonstrations for seismic slope stability.
4A	Appendix N - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	768/818	Phase 4	All			Work with TDEC to define acceptable performance will need to be established as part of the of Phase 1 Assessment.	During the Phase 1 stability assessment, TVA will work with TDEC to define criteria for acceptable performance that would be utilized during a potential Phase 4 (the final phase) of the proposed phased stability assessment. The factors that contribute to defining acceptable performance will be site-specific and related to the consequences of the predicted deformations. As more site-specific information becomes available after Phase 1, TVA and TDEC may need to revisit the acceptable performance criteria in light of the additional information.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
5A	Appendix N - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	769/818	Table 2	All			Work with TDEC to define acceptable criteria in Phase 1 of the Assessment. Reference comment above.	During the Phase 1 stability assessment, TVA will work with TDEC to define criteria for acceptable performance that would be utilized during a potential Phase 4 (the final phase) of the proposed phased stability assessment. The factors that contribute to defining acceptable performance will be site-specific and related to the consequences of the predicted deformations. As more site-specific information becomes available after Phase 1, TVA and TDEC may need to revisit the acceptable performance criteria in light of the additional information.
6A	Appendix N - Stability SAP	5.1.3 Basis for Load Cases and Acceptance Criteria	770/818	NA	All			TVA embankment dam design guidance (TVA 2016) should be removed from the list of documents used to determine acceptable criteria.	TVA has a significant portfolio of embankment dams, and its design guidance is one of several relevant industry standards that were considered to help inform the proposed load cases and acceptance criteria. The proposed criteria in the Stability SAP do not rely solely on the TVA guidance document. Further, the TVA analysis load cases and acceptance criteria are based upon and generally consistent with other industry standards, such as the dam safety criteria of the U.S. Army Corps of Engineers and the Federal Energy Regulatory Commission. The text will be clarified to emphasize these similarities.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
7A	Appendix N - Stability SAP	5.1.3.1 Static Loading	771/818	NA	All			Flood loading should be considered for CCR units located in the flood plain.	For existing landfills or surface impoundments that no longer impound water, a flood event would only influence units with outboard slopes along the adjacent river/reservoir. For KIF, this would include the Stilling Pond and the Sluice Trench and Ballfield East of Sluice Trench. However, the temporarily elevated river levels during a flood only provide additional stabilizing (i.e., resisting) force with respect to slope stability. Such a load case would have a higher factor of safety than the static, long-term case that is already being considered. Therefore, separate consideration of a flood load case is not necessary.
8A	Appendix P, Seep SAP	All	ll	All	All			TVA shall sample the previously documented active seeps (Appendix O, Historic Seep Summary) at the Engineered Wetlands in compliance with the Seep SAP.	TVA will sample the previously documented active seeps in addition to active seeps identified during the seep investigation in accordance with the Seep SAP.

24	3.1.2	TDEC Site Specific Request No. 2	All	All	All	TVA will continue to sample groundwater at GW-2 and 22 during the EIP process.	Groundwater level measurements will be collected from wells GW-2 and 22 for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from well 22 as part of other ongoing programs associated with the KRP Ash Landfill. Wells GW-2 and 22 are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the QAPP will be utilized in the EAR.	TVA will collect groundwater samples from GW-2 as well. TDEC does not agree that these wells are outside the "Study Area". The Commissioner's Order applies to all "CCR disposal areas" at KIF. The KRP Ash Landfill has the potential to influence groundwater flow and quality at KIF. TVA will utilize the data from these wells to further define groundwater quality and flow at KIF. Although GW-2 and GW-22 are outside the limits of the individual units being investigated through the Order, that does not preclude information from these wells as being integral to the understanding of groundwater movement and concentration levels through the investigated area. GW-2 appears to be potentially upgradient of both units and should be sampled (for CCR parameters) to provide information on upgradient (potentially background) water quality as well as to provide water level information for a better understanding of groundwater flow. This same rational also includes GW-22 which could potentially be an upgradient or side gradient well to the stilling pond. Having a massive landfill between the two investigative units makes a determination of actual groundwater flow very difficult. In order to understand the site specific intricacies information from beyond the boundary of the Order sites may be required so as to not artificially bias the information.TVA has agreed to conduct an environmental investigation at the TVA KIF 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.	Groundwater samples will be collected from GW-2 and analyzed for CCR Parameters as part of the EI. The collected samples will be evaluated by TDEC and TVA in order to determine the viability of continuing to sample well GW-2. Groundwater quality samples are currently being collected from well 22 as part of the KRP Ash Landfill program. The analytical results from groundwater samples collected from well 22 will be provided in the EAR.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
25	3.1.2	TDEC Site Specific Request No. 2	12	3	3	Based on exhibit #2 it appears that near the ballfield and sluice trench there are only 2 downgradient monitoring wells. At a minimum there should be three downgradient wells. TDEC would like TVA to evaluate potentially placing the third downgradient well southeast of AD-2.	A third monitoring well downgradient of the ballfield and sluice trench and northeast of well AD-2 has been added to the proposed monitoring well network for the investigation as shown on Exhibit No. 2. Monitoring well installation and sampling procedures for the additional well are included in the updated Hydrogeological Investigation and Groundwater Investigation SAPs, respectively.	TDEC requested a well to the southeast of AD-2, TVA shall install the requested well. TVA has agreed to conduct an environmental investigation at the TVA KIF 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.	After receiving additional clarification from TDEC, one monitoring well will be installed southwest of AD-2 in the unconsolidated materials above bedrock to satisfy this request.
28	3.1.2	TDEC Site Specific Request No. 2	18	3	2	Wells 27A, 27B, 22, And 22B will be added to the Study Area monitoring network.	Groundwater level measurements will be collected from wells 22, 22B, 27A and 27B for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from wells 22, 22B, 27A and 27B as part of other ongoing programs associated with the KRP Ash Landfill. These wells are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. In addition, wells 27B and 22B are screened within the bedrock and not within the saturated overburden, which is targeted for this investigation. . TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the QAPP will be utilized in the EAR.	TDEC does not agree that these wells are outside the "Study Area". The Order applies to all "CCR disposal areas" at KIF. The KRP Ash Landfill has the potential to influence groundwater flow and quality at KIF. TVA will utilize the data from these wells to further define groundwater quality and flow at KIF. TDEC Is not aware of any vertical limitations on the vertical extents of the Study Area. Use of data in the Order Investigation will depend on the results of the data. TVA has agreed to conduct an environmental investigation at the TVA KIF 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 ` activities as specified by TDEC.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
34	3.2.1	TDEC	25	NA	NA	TVA must submit a report to TDEC characterizing the nature of the groundwater mounding beneath the ash disposal areas.	Piezometers with vibrating wire transducers have been installed within the ash disposal areas 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 instrumentation is proposed to be installed within the units. Under the TDEC Order investigation along with other CCR compliance programs, TVA is gathering information in several targeted areas including but not limited to groundwater flow direction. TVA feels the current investigative actions will characterize the ground water in and around each CCR unit at Cumberland. As the investigation progresses, TVA will communicate with TDEC and jointly determine if additional investigative actions are needed.	This investigation is for the Kingston site, not Cumberland. Please correct your response.	Piezometers with vibrating wire transducers have been installed within the ash disposal areas 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 instrumentation is proposed to be installed within the units. Under the TDEC Order investigation along with other CCR compliance programs, TVA is gathering information in several targeted areas including but not limited to groundwater flow direction. TVA feels the current investigative actions will characterize the ground water in and around each CCR unit at **Kingston**. As the investigation progresses, TVA will communicate with TDEC and jointly determine if additional investigative actions are needed.
37	3.4.1	TDEC Ground Water Monitoring Information Request No. 4	28	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
38	3.5.1	TDEC Ground Water Monitoring Information Request No. 2	All	All	All	Please provide TDEC with documentation and justification for the reinstallation of MW-22. Please provide documentation demonstrating that the well is screened in ash (boring log, stratigraphy, water levels, etc..). the new MW-22 and existing MW-22 be sampled	TVA will provide the well construction logs showing well 22 screened in ash. TVA will sample well 22 and the new well 22C simultaneously for a minimum of four independent events.	The log indicates a 0.2 ft layer at a depth of 26.6 ft over the coarse of a 32-35ft screen (boring log indicated 17-49 [32ft], while installation record indicates 35ft). Is it TVA's contention that the intervals of no recovery are also ash? Long screen length wells are inappropriate in most cases, what is the target depth and screen interval for the replacement well?	TVA is not contending that the interval with no recovery is ash. The replacement well is screened from 34 to 44 feet below ground surface.
39	3.5.1	GW -Chem Properties	23	2	7	The replacement well location for MW KIF-22 must be authorized by TDEC's CCR Technical team before placement. TDEC's authorization shall include any other wells placed under this EIP. Are the proposed location identified in Appendix D still accurate?	Comment acknowledged. The location of new well 22C is included in Appendix D. Proposed monitoring well locations in Appendix D are still accurate.	There is no well 22C depicted on Exhibit 2	Well 22C has been added to Exhibit 2.
41	3.5.2	TDEC Ground Water Chemical and Physical Properties Request No. 2	24			"TVA plans to address the arsenic concentrations observed in well 22 under the current Ash Disposal Area monitoring program by replacing well 22 with a new well in the same area to obtain data representative of groundwater conditions downgradient of the Ash Disposal Area." Replacing Well 22 with a new well does not "address" the arsenic concentration at that location. The historic arsenic detection must be characterized or otherwise explained.	Refer to Section 3.5.1 for discussion of the rationale for installing replacement well 22C. Representative groundwater samples cannot be obtained from wells screened in ash.	Replacing the well does not mitigate the arsenic impact or the fact that there is ash in the dike. Based on the boring log and assuming it is actually a 35 ft screen (and not a 32 ft screen) less than 1% of the well screen is in ash. Are there notes from the driller/geologist indicting that the HSA cuttings resembled significant deposits of ash in the no recovery intervals?	Because Well 22 is part of the network for the KRP landfill and is monitored within a state compliance monitoring program, the results, including potential mitigation associated with that well, will be evaluated and conducted within the compliance program. The results from Well 22 will be reviewed as part of the EAR and incorporated into the evaluation to the extent that they are pertinent to the goals of the EI and affect conclusions regarding the Stilling Pond.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
46	4.1	CCR Material Characteristics	30	All	All	TVA will conduct 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 from each investigation area. Samples should be run for total concentrations of CCR parameters, TCLP CCR parameters, and SPLP CCR parameters.	TVA will include historical leachability testing data gathered at the KIF site. Based on this data, a new CCR Material Characteristics SAP does not need to be developed at this time. Upon review of the existing data, TDEC and TVA will jointly determine a path forward.	TVA has not adequately responded to the comment. TVA shall propose the requested study. TVA has agreed to conduct an environmental investigation at the TVA KIF 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.	See response to new comment 1A regarding Section 4.1.2.
74	Appendix D	Exhibit 3	232	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
82	Appendix E, Section 4.0	Groundwater Investigation SAP, Sampling Scope	4	2	1	Please include well 27 in water level gauging and sampling. Also wells AD-1, AD-2, AD-3, 6AR, 22, 27 need to be sampled for CCR related constituents listed in 40 CFR 257, Appendices III and IV as well as Appendix I of TN Rule 0400-11-01-.04 along with the proposed wells (KIF-102, KIF-103, KIF-104).	Groundwater quality samples and levels will be collected from existing wells AD-1, AD-2, AD-3 and 6AR and proposed wells KIF-102, KIF-103 and KIF-104 for the investigation. Groundwater levels will also be collected from wells 22, 27A and 27B for the investigation to provide additional groundwater elevation data to evaluate groundwater flow direction for the Study Area. Groundwater quality samples will be collected from wells 22, 27A and 27B as part of other ongoing programs associated with the KRP Ash Landfill. These wells are also outside of the Study Area and groundwater quality data collected from these wells would be more representative of conditions at the Landfill than at the Study Area. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation. Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the requirements of the QAPP will be utilized in the EAR.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.
93	Appendix E	Attachment A - Figure 1	269	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.
112	Appendix F	Attachment A - Figure 1	290	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
128	Appendix K	Figure 1	444	All	All	Wells 27A, 27B, 22, And 22B should be added to the Study Area monitoring network.	See response to comment 28.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.
129	Appendix K	Table 1A	445	All	All	Provide groundwater chemical data for wells 27A, 27B, 22, and 22B.	Historical groundwater chemical data associated with wells 27A, 27B, 22 and 22B was not included in the table because this data is not part of the Study Area investigation. TVA will include this data in the EAR. TVA also requests further clarification on how this data will be used in the Order investigation.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.
130	Appendix K	Table 1B	458	All	All	Provide groundwater physical data for wells 27A, 27B, 22, and 22B.	See response to comment 129.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.

Table TVA Kingston EIP
TDEC Comments (May 4, 2018)

Comment Number	Section Number	Section Title	Page	Paragraph	Line	TDEC Comment (December 8, 2017)	TVA Response (March 2, 2018)	TDEC Comment (May 4, 2018)	TVA Response (June 15, 2018)
131	Appendix K	Table 1C	466	All	All	Provide groundwater elevation data for wells 27A, 27B, and 22B.	See response to comment 129.	See response to comment 28.	In TVA's response to TDEC's initial comment, TVA agreed to use data from monitoring wells that are part of other regulatory programs in the EAR. TVA defined the term "Study Area" to collectively describe the CCR units included in the Order.

Robert Wilkinson, P.G., CHMM CCR Technical Manager
2nd Floor TN Tower, W.R. Snodgrass Building
312 Rosa L. Parks Avenue
Nashville, TN 37243
Office: (615) 253-0689
e-mail: Robert.S.Wilkinson@tn.gov

Shari Meghreblian, Ph.D.
Commissioner

Bill Haslam
Governor

June 29, 2018

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

RE: TDEC Commissioner's Order OGC 15-1077
TVA Kingston Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Revision 3

Dear Ms. Smelley:

Tennessee Valley Authority (TVA) submitted the Environmental Investigation Plan (EIP) Revision 3 for the TVA Kingston Coal Fired Fossil Power Plant (TVA KIF) on June 15, 2018. The Tennessee Department of Environment and Conservation (TDEC) has completed its review of the submittal and found it to be acceptable.

TDEC added an additional opportunity for public involvement in a letter dated September 28, 2015 from TDEC to the Southern Alliance for Clean Energy (SACE). TDEC intends to schedule an All Interested Parties (AIP) meeting to discuss the TVA KIF EIP Revision 3 within 30 days of this letter. Copies of TVA KIF EIP Revision 3 will be provided to attendees of the AIP meeting prior to the meeting date.

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, P.G., CHMM

CC: Chuck Head, Pat Flood, Tisha Calabrese Benton, Caleb Nelson, Britton Dotson, Jennifer Dodd, Angela Adams, Peter Lemiszki, James Clark, Rob Burnette, Joseph E. Sanders, Bryan Wells, Patrick Mulligan, Revendra Awasthi, Paula Plont, Shawn Rudder

Robert Wilkinson, P.G., CHMM CCR Technical Manager
2nd Floor TN Tower, W.R. Snodgrass Building
312 Rosa L. Parks Avenue
Nashville, TN 37243
Office: (615) 253-0689
e-mail: Robert.S.Wilkinson@tn.gov

Shari Meghreblian, Ph.D.
Commissioner

Bill Haslam
Governor

July 3, 2018

Amanda Garcia
Southern Environmental Law Center
2021 21st Avenue South, Ste. C-400
Nashville, TN 37212

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

Dear Ms. Garcia:

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.

On June 15, 2018, TVA submitted the Environmental Investigation Plan (EIP) Revision 3 for the TVA Kingston Coal Fired Fossil Power Plant (TVA KIF) located near Harriman, TN. 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.

TDEC will hold an All Interested Parties (AIP) meeting to discuss the TVA KIF EIP Revision 3 on July 30, 2018, 1:00 PM EST at the TDEC Oak Ridge Office located at 761 Emory Valley Road Oak Ridge, TN 37830.

If your organization will be attending the AIP meeting, please respond no later than July 20, 2018. TDEC requests that each organization limit attendees to 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 KIF 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, P.G., CHMM
TDEC CCR Technical Program Manager

CC:	Shari Meghreblian	Chuck Head	James Clark
	Tisha Calabrese-Benton	Jennifer Dodd	Pat Flood
	Brooke Barrett	Britton Dotson	Rob Burnette
	Jenny Howard	Angela Adams	Joseph E. Sanders
	Bryan Wells	Susan Smelley	Shawn Rudder

KIF Boring Location Revision Justification

Location ID	Issue Identified	Technical Objective	Changes
KIF-TW04	The initial boring location was located under a pipe rack; therefore, the location was not accessible for drilling.	Obtain CCR samples for CCR Parameters and SPLP analyses and install a temporary well to sample pore water.	The proposed temporary well location has been moved approximately 100 feet to the northeast to avoid the pipe rack. The technical objectives can still be met at the alternate location.
KIF-102	Based on the National Environmental Policy Act, Categorical Exclusion evaluation, the initial background monitoring well location was not in a cultural survey area.	Install a background monitoring well and also collect background soil samples from the well screen interval. After installation of the well, groundwater level measurements and samples will be collected. Groundwater samples will be analyzed for CCR Parameters.	The proposed background monitoring well was moved approximately 240 feet northwest of the initial location to be cleared of potential cultural areas. The technical objectives can still be met at this alternate location.
KIF-103	The initial downgradient monitoring well location was in 10 feet of riprap.	Install a monitoring well downgradient of the Stilling Pond to collect groundwater level measurements and groundwater samples. Groundwater samples will be analyzed for CCR Parameters.	The proposed downgradient monitoring well was moved approximately 50 feet north of the initial location to be outside of the riprap and in an accessible location. The technical objectives can still be met at this alternate location.
KIF-105	The initial downgradient monitoring well location was near utilities identified by the utility locating service.	Install a monitoring well downgradient of the Interim Ash Staging Area and Sluice Trench and Ballfield East of Sluice Trench to collect groundwater level measurements and groundwater samples. Groundwater samples will be analyzed for CCR Parameters. This well will also be installed to evaluate groundwater quality for CCR Parameters near the former location of closed well 10.	The proposed downgradient monitoring well was moved approximately 20 feet west of the initial location area to prevent contact with the identified utilities. The technical objectives can still be met at this alternate location.
KIF-106	The initial downgradient monitoring well location was near utilities identified by the utility locating service.	Install a monitoring well downgradient of the Interim Ash Staging Area and Sluice Trench and Ballfield East of Sluice Trench to collect groundwater level measurements and groundwater samples. Groundwater samples will be analyzed for CCR Parameters.	The proposed downgradient monitoring well was moved approximately 60 feet southeast of the initial location to prevent contact with the identified utilities. The technical objectives can still be met at this alternate location.
BG-01	- Proposed location was located in an area lacking required cultural and archeological surveys.	- To meet a spatial distribution of BGS locations	- Moved boring location approximately 190 feet north to an area inside the existing cultural survey area. - The new proposed location is in the same geologic formation and USDA soil type as the original location.
BG-02	- Proposed location was located in an area lacking required cultural and archeological surveys.	- To meet a spatial distribution of BGS locations	- Moved boring location approximately 320 feet northeast to an area inside the existing cultural survey area. - The new proposed location is in the same geologic formation and USDA soil type as the original location.
BG-03	- Proposed location was located in front of a 9/11 memorial, TVA requested that it be relocated slightly to the area behind the memorial	- To meet a spatial distribution of BGS locations	- Moved boring location approximately 200 feet west to an area behind the 9/11 memorial monument. - The new proposed location is in the same geologic formation and USDA soil type as the original location.
BG-04	- This background soil location needs to be collocated with permanent well KIF-102. KIF-102 was moved from this location due to lack of cultural and archeological survey covering the drilling area. KIF-102 is scheduled to be installed in October 2018.	- To meet a spatial distribution of BGS locations	- Moved boring location northwest approximately 175 feet to the same area as KIF-102. - The new proposed location is in the same geologic formation and USDA soil type as the original location.

KIF Boring Location Revision Justification

Location ID	Issue Identified	Technical Objective	Changes
BG-06	- Dense vegetation and terrain make this location inaccessible moved location to BG-06 Alt	- To meet a spatial distribution of BGS locations	- Moved boring location approximatley 1,020 feet to the southwest for better access and terrain - The new proposed location is in the same geologic formation and depositional environment.
BG-07	- Dense vegetation and terrain make this location inaccessible	- To meet a spatial distribution of BGS locations	- Relocated for better access and terrain. - The new proposed location is in the same geologic formation and USDA soil type as the original location.
BG-09	- Property appears to be leased and is fenced. Field team was unable to confirm access to the leased property during field staking activities area was determined in the field to be inaccessible.	- To meet a spatial distribution of BGS locations	- Relocated boring to an area of known accessibility approximately 1,600 feet to the west of the original location. - The new proposed location is in the same geologic formation and depositional environment.
BG-10	- Property is owned by TVA but is currently used by the adjacent landowner to pasture horses which makes this location more difficult to access. Requiring the horses to be relocated will be take	- To meet a spatial distribution of BGS locations	- Relocated boring approximately 600 feet south to a property owned by TVA and currently used as a park. - The new proposed location is in the same geologic formation and USDA soil type as the original location.
BG-11	- Dense vegetation and terrain make this location inaccessible	- To meet a spatial distribution of BGS locations	- Relocated for better access and terrain. - The new proposed location is in the same geologic formation and USDA soil type as the original location.
BG-12	- Dense vegetation and terrain make this location inaccessible	- To meet a spatial distribution of BGS locations	- Relocated for better access and terrain. - The new proposed location is in the same geologic formation and similar USDA soil type and depositional environment as the original location.

Figure No.
1

DRAFT

Title
Proposed Temporary Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant
TDEC Commissioner's Order Phase 2 Environmental Investigation

Project Location
Roane County, Tennessee

175668043
Prepared by LMB on 2018-10-19
Technical Review by EM on 2018-10-19

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Alternate Proposed Boring/Temporary Well Location (Screened Interval)
- EIP Rev.3 Proposed Boring/Temporary Well Location (Screened Interval)
- Revised EIP Rev.3 Proposed Boring/Temporary Well Location (Screened Interval)
- 50-ft Buffer
- Proposed Laydown Area
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec
TVA

V:\1269-01\shared_projects\TVA-EIP\175668043_KIF_Phase2\gis\mxd\KIF_Proposed_TW_NonEIP_Redline.mxd Revised: 2018-10-19 By: TRink

Figure No.
2

DRAFT

Title
Proposed Groundwater Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-23
Technical Review by LP on 2018-10-23

0 200 400 600 800
Feet
1:3,600 (At original document size of 22x34)

Legend

- Alternate Proposed Monitoring Well Locations
- EIP Rev. 3 Proposed Groundwater Monitoring Well for Study Area
- EIP Rev. 3 Proposed Groundwater Monitoring Well for Study Area
- Surface Water Gauging Station For Study Area
- TVA Property Boundary (Approximate)
- Proposed Well Area
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec
TVA

Figure No.
3

DRAFT

Title
Proposed Groundwater Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-24
Technical Review by LP on 2018-10-24

0 200 400 600 800 Feet
1:3,600 (At original document size of 22x34)

Legend

- Alternate Proposed Monitoring Well Locations
- EIP Rev. 3 Proposed Groundwater Monitoring Well for Study Area
- EIP Rev. 3 Proposed Groundwater Monitoring Well for Study Area
- Surface Water Gauging Station For Study Area
- TVA Property Boundary (Approximate)
- Proposed Well Area
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Geologic Formations

- Ordovician/Cambrian Knox Group
- Ordovician Chickamauga Group
- Cambrian Maynardville Limestone
- Cambrian Conasauga Shale
- Cambrian Rome Formation

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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TVA

Figure No.
4

DRAFT

Title

Proposed Background Soil Sampling Locations

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant
TDEC Commissioner's Order Phase 2 Environmental Investigation

Project Location

Roane County, Tennessee

175668043

Prepared by LMB on 2018-11-02
Technical Review by EM on 2018-11-02

0 750 1,500 2,250 3,000 Feet

1:9,000 (At original document size of 22x34)

Legend

- 50-ft Buffer
- Alternate Proposed Background Soil Sample Location
- Revised EIP Rev. 3 Proposed Background Soil Sample Location
- EIP Rev. 3 Proposed Background Soil Sample Location
- Proposed Decontamination Area
- Proposed Laydown Area
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary
- TVA Property Boundary (Approximate)
- 100 Year
- 500 Year

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by ESRI
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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TVA

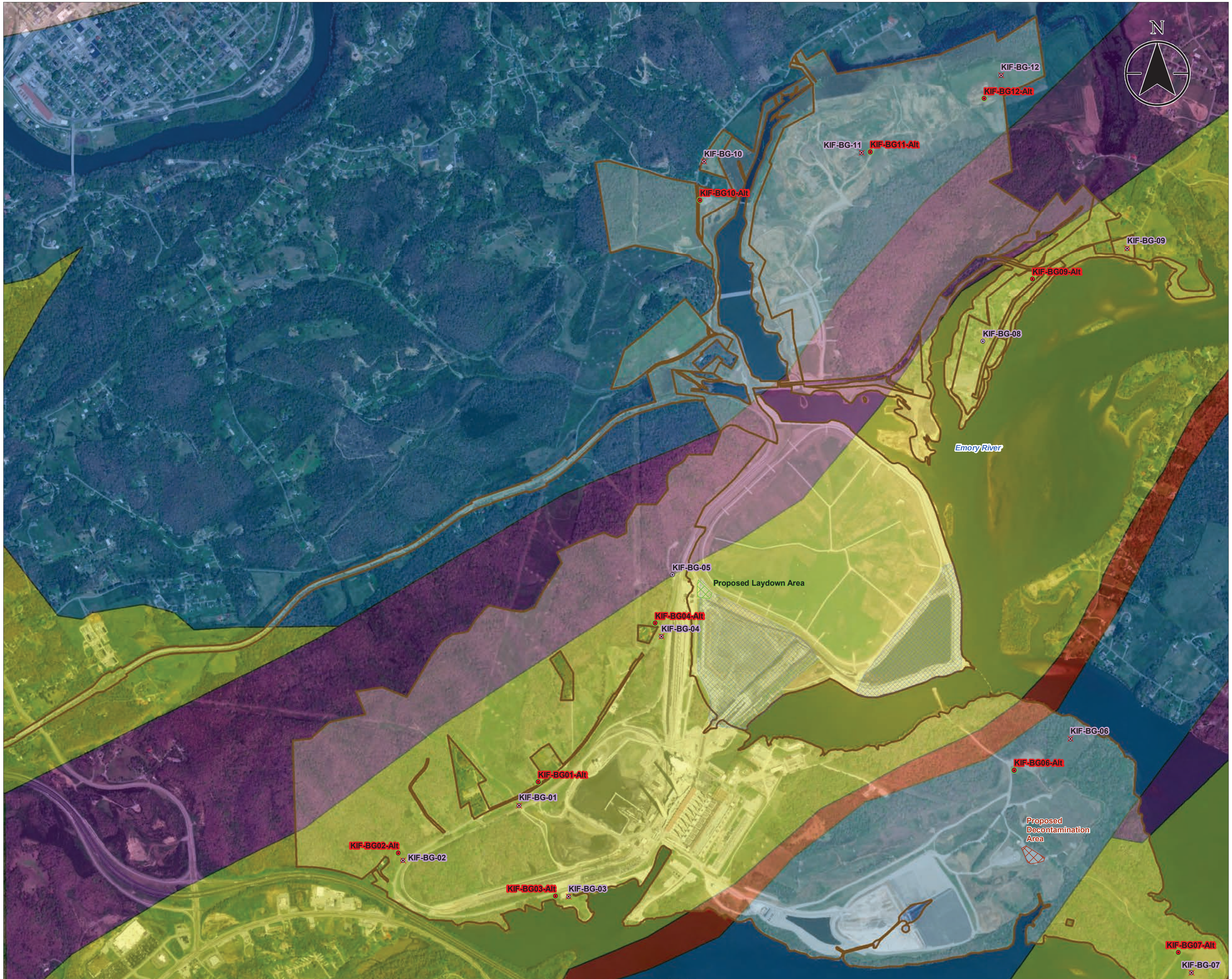


Figure No.
5

DRAFT

Title
Proposed Background Soil Sampling Locations and Geologic Units

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant
TDEC Commissioner's Order Phase 2 Environmental Investigation

175668043

Project Location
Roane County, Tennessee

Prepared by LMB on 2018-11-02
Technical Review by EM on 2018-11-02

0 750 1,500 2,250 3,000 Feet
1:9,000 (At original document size of 22x34)

Legend

- 50-ft Buffer
- Alternate Proposed Background Soil Sample Location
- Revised EIP Rev. 3 Proposed Background Soil Sample Location
- EIP Rev. 3 Proposed Background Soil Sample Location
- Proposed Decontamination Area
- Proposed Laydown Area
- KIF Study Area Boundary
- TVA Property Boundary (Approximate)

Geologic Formations

- Ordovician/Cambrian Knox Group
- Ordovician Chickamauga Group
- Cambrian Maynardville Limestone
- Cambrian Conasauga Shale
- Cambrian Rome Formation

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by ESRI
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.
4. Geological formations based on the Geological Map of Tennessee East -Central Sheet (1966)

Stantec TVA

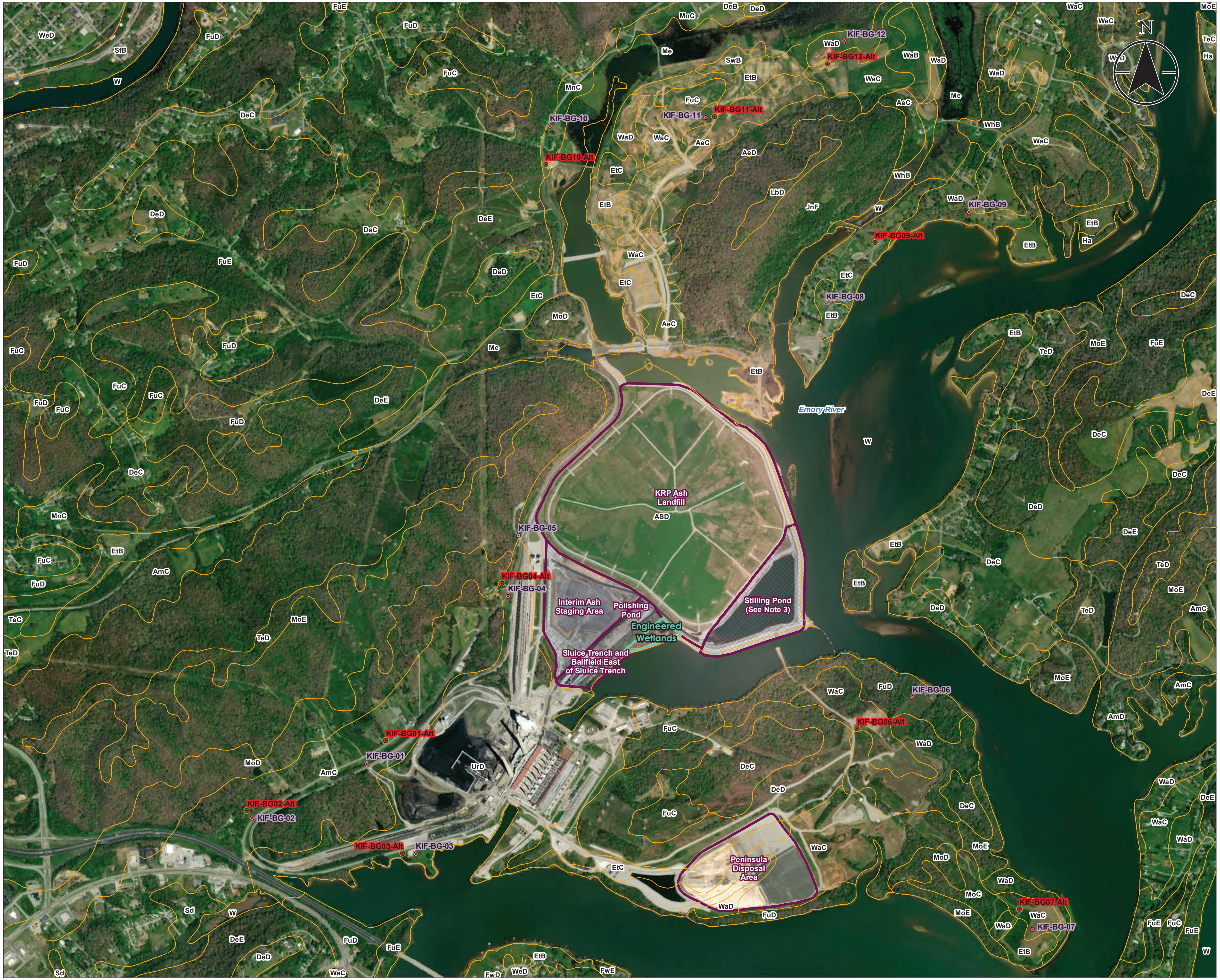


Figure No.
6

DRAFT

Title
Proposed Background Soil Sampling Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-11-02
Technical Review by ES on 2018-11-02

0 750 1,500 2,250 3,000 Feet
1:9,000 (At original document size of 22x34)

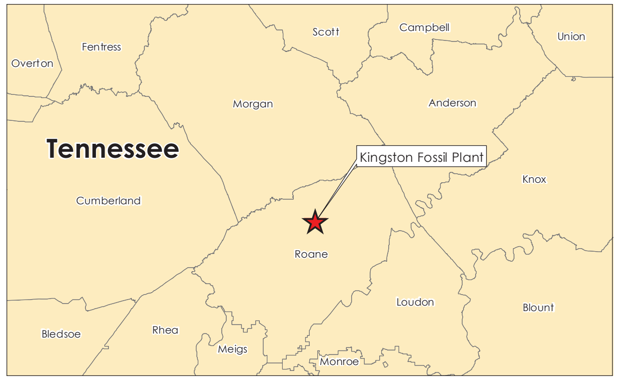
Legend

- 50-ft Buffer
- Alternate Proposed Background Soil Sample Location
- Revised EIP Rev. 3 Proposed Background Soil Sample Location
- EIP Rev. 3 Proposed Background Soil Sample Location
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Soil Unit	Soil Map Unit Name
AeC	Allen loam, 5 to 12 percent slopes
AeD	Allen loam, 12 to 20 percent slopes
AmC	Armuchee silt loam, 5 to 12 percent slopes
AmD	Armuchee silt loam, 12 to 20 percent slopes
ASD	Ash disposal area
DeB	Dewey silt loam, 2 to 6 percent slopes
DeC	Dewey silt loam, 6 to 15 percent slopes
DeD	Dewey silt loam, 15 to 25 percent slopes
DeE	Dewey silt loam, 20 to 45 percent slopes
EtB	Etowah loam, 2 to 6 percent slopes
EtC	Etowah silt loam, 6 to 12 percent slopes
FuC	Fullerton-Pailo complex, 5 to 12 percent slopes
FuD	Fullerton-Pailo complex, 12 to 20 percent slopes
FuE	Fullerton-Pailo complex, 20 to 35 percent slopes
FwE	Fullerton-Dewey-Urban land complex, 20 to 35 percent slopes
Ha	Hamblen silt loam, 0 to 3 percent slopes, occasionally flooded, hydric minor component
JnF	Jefferson cobbly loam, 20 to 50 percent slopes
LbD	Lily loam, 12 to 20 percent slopes
Me	Melvin silt loam, 0 to 2 percent slopes, frequently flooded, warm
MnC	Minvale gravelly silt loam, 5 to 12 percent slopes
MoC	Montevallo channery silt loam, 5 to 12 percent slopes
MoD	Montevallo channery silt loam, 12 to 20 percent slopes
MoE	Montevallo channery silt loam, 20 to 35 percent slopes
Sd	Shady loam, occasionally flooded
SfB	Shady-Swafford-Urban land complex, 2 to 5 percent slopes
SwB	Swafford loam, 2 to 5 percent slopes
TeC	Townley silt loam, 5 to 12 percent slopes
TeD	Townley silt loam, 12 to 20 percent slopes
UrD	Urban land, 5 to 20 percent slopes
W	Water
WaB	Waynesboro loam, 2 to 6 percent slopes
WaC	Waynesboro loam, 6 to 15 percent slopes
WaD	Waynesboro loam, 15 to 25 percent slopes
WeD	Waynesboro-Etowah-Urban land complex, 5 to 20 percent slopes
WhB	Whitwell loam, 1 to 4 percent slopes, occasionally flooded

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by ESRI
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.
4. Soil Map Unit data was obtained from U.S. Department of Agriculture



Stantec

TVA

Master Log of Changes to KIF EIP General Document											
Item No.	**Plant**	**Date**	**TDEC Comment No.**	**Section No.**	**Section Title**	**Page**	**Para**	**Line**	**TDEC Comment**	**TVA Response**	**Proposed Update to KIF EIP Rev 4 Final**
1	KIF	November 6, 2018	NA	NA	NA	NA	NA	NA	NA	NA	Programmatic revisions including updating timeline dates in Section 1.

Master Log of Changes to KIF EIP
Background Soil SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to KIF EIP Rev 4 Final
1	All	NA	NA	SAP 5.1	Preparation For Field Activities	5	5th Bullet	Last	NA	NA	Add the following language to Section 5.1 of Background Soil SAP: "If a proposed boring location is discovered to have accessibility restrictions related to agricultural, cultural, biological, or other such limiting factors, then a replacement boring will be proposed at a location that will meet the study's goals with approval from TDEC"
2	All	NA	NA	SAP 5.0	Sample Collection and Field Activity Procedures	4	2nd	Last	NA	NA	Correct typo in reference to ENV-TI-0.5.80.01 Planning Sampling Events. Currently referenced TI-08.80.01, should be TI-05.80.01
3	All	NA	NA	SAP 5.0	Sample Collection and Field Activity Procedures	4	2nd	Last	NA	NA	Correct typo in reference to ENV-TI-0.5.80.50 Soil and Sediment Sampling. Currently referenced TI-08.80.50, should be TI-05.80.50
4	All	NA	NA	SAP 5.2	Sampling Methods and Protocol	6	1st	Last	NA	NA	Correct typo in reference to ENV-TI-0.5.80.50 Soil and Sediment Sampling. Currently referenced TI-08.80.50, should be TI-05.80.50
5	All	NA	NA	EIP 4.1.1	A.1 TDEC Site Information Request No. 1	35	Last	Last	NA	NA	Add the following language: "If a proposed boring location is discovered to have accessibility restrictions related to agricultural, cultural, biological, or other such limiting factors, then a replacement boring will be proposed at a location that will meet the study's goals with approval from TDEC"

Master Log of Changes to KIF EIP
CCR Material Characteristics SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to KIF EIP Rev 4 Final
1	ALF	October 3, 2017	87	Appendix J, Section 5.2.2	Groundwater Investigation SAP, Well Purging				Indicate if specific conductance is measured in mS/cm or μS/cm.	Specific conductance will be measured and recorded in μS/cm in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017).	Acknowledged; amend language in section 5.2.1.2 second bullet item.
2	All	May 7, 2018	NA	General Administrative	CCR Mat Char SAP				NA	NA	Correct error in document numbering in section 5.0 for TVA TI ENV-TI-05.80.01 .
3	All	May 7, 2018	NA	General Administrative	CCR Mat Char SAP				NA	NA	Correct error in document numbering in sections 5.0 and 5.2 for TVA TI ENV-TI-05.80.50.
4	All	NA	NA	NA	NA				NA	NA	Add “ENV-TI-.05.80.01 Planning Sampling Events” to bullet list in Section 5.2
5	All	NA	NA	NA	NA				NA	NA	Clarify language on analyzing CCR material for totals, as well as leachability, in Sections 5.2.1 and 5.2.6
6	All	NA	NA	NA	NA				NA	NA	Correct error in document numbering in Section 5.2.4.2 for TVA TI ENV-TI-05.80.50.
7	All	NA	NA	NA	NA				NA	NA	Change “groundwater” to “pore water” for clarification in Table 6 footnote.
8	All	NA	NA	NA	NA				NA	NA	Clarify that rinsate blanks are to be collected for every 20 samples or once per sampling event, in lieu of each sampling event, in Section 6.2
9	KIF	November 6, 2018	NA	NA	NA				NA	NA	Remove arsenic speciation for all media from text and Table 6. Analytical Methods, Preservatives, Containers, and Holding Times in Section 5.

Master Log of Changes to KIF EIP Exploratory Drilling SAP											
Item No.	**Plant**	**Date**	**TDEC Comment No.**	**Section No.**	**Section Title**	**Page**	**Paragraph**	**Line**	**TDEC Comment**	**TVA Response**	**Proposed Update to KIF EIP Rev 4 Final**
1	CUF	September 13, 2018	n/a	5.2.7	Equipment Decontamination Procedures	14	First (new)	n/a	n/a	n/a	Add new first paragraph to Section 5.2.7: The decontamination procedures below apply to drilling and sampling in borings for temporary wells. For drilling and sampling in all other borings, as well as for all cone penetration testing, decontamination (per procedures listed in TVA TI ENV-05.80.05, Field Sampling Equipment Cleaning and Decontamination) will only occur before the first boring/CPT and after the last boring/CPT.
2	KIF	October 3, 2018	Email from Luisa to TVA re. Hydrogeological Investigation SAP and Exploratory Drilling SAP Deviation regarding placement of bentonite pellets and filter packs during well installation.	5.4.2.1	Materials and Installation	17	3rd	n/a	n/a	n/a	Replace 3rd paragraph with this text: It should be noted that the grout will be placed by tremie method through one-inch (minimum) diameter PVC pipe. The grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process. In open (uncased) boreholes, the sand filter zones and bentonite pellets will be placed by tremie method through one-inch (minimum) diameter PVC. In cased boreholes (i.e., through hollow-stem augers or temporary casing), the sand filter zones and bentonite pellets may be placed by tremie method or may be poured slowly into the annular space of the drill tooling to prevent bridging.

Master Log of Changes to KIF EIP Groundwater Investigation SAP											
Item No.	**Plant**	**Date**	**TDEC Comment No.**	**Section No.**	**Section Title**	**Page**	**Paragraph**	**Line**	**TDEC Comment**	**TVA Response**	**Proposed Update to KIF EIP Rev 4 Final**
1	ALF	October 3, 2017	87	Appendix J, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm.	Specific conductance will be measured and recorded in µS/cm in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017).	Specify units in Groundwater Investigation SAP

Master Log of Changes to KIF EIP Hydrogeological Investigation SAP											
Item No.	**Plant**	**Date**	**TDEC Comment No.**	**Section No.**	**Section Title**	**Page**	**Paragraph**	**Line**	**TDEC Comment**	**TVA Response**	**Proposed Update to KIF EIP Rev 4 Final**
	KIF	October 3, 2018	Email from Luisa to TVA re. Hydrogeological Investigation SAP and Exploratory Drilling SAP Deviation regarding placement of bentonite pellets and filter packs during well installation.	5.3.1	Materials and Installation	12	5	all lines	NA	NA	Replace 5th paragraph with this text: It should be noted that the grout will be placed by tremie method through one-inch (minimum) diameter PVC pipe. The grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process. In open (uncased) boreholes, the sand filter zones and bentonite pellets will be placed by tremie method through one-inch (minimum) diameter PVC. In cased boreholes (i.e., through hollow-stem augers or temporary casing), the sand filter zones and bentonite pellets may be placed by tremie method or may be poured slowly into the annular space of the drill tooling to prevent bridging.

Master Log of Changes to KIF EIP Material Quantity SAP											
Item No.	**Plant**	**Date**	**TDEC Comment No.**	**Section No.**	**Section Title**	**Page**	**Paragraph**	**Line**	**TDEC Comment**	**TVA Response**	**Proposed Update to KIF EIP Rev 4 Final**
											No updates needed.

Master Log of Changes to KIF EIP Seep SAP											
Item No.	**Plant**	**Date**	**TDEC Comment No.**	**Section No.**	**Section Title**	**Page**	**Paragraph**	**Line**	**TDEC Comment**	**TVA Response**	**Proposed Update to KIF EIP Rev 4 Final**
1	All	10/5/2018	NA	General Administrative	Seep SAP				NA	NA	Correct error in document numbering in section 5.0 for TVA TI ENV-TI-05.80.01 .
2	All	10/5/2018	NA	General Administrative	Seep SAP				NA	NA	Correct error in document numbering in sections 5.3 for TVA TI ENV-TI-05.80.50.
3	All	10/5/2018	NA	General Administrative	Seep SAP				NA	NA	Add TVA TI ENV-TI-05.80.01 to Section 5.3 and References list.
4	All	10/5/2018	NA	General Administrative	Seep SAP				NA	NA	Add TVA TI ENV-TI-05.80.50 to References list.

Master Log of Changes to KIF EIP Stability SAP											
Item No.	**Plant**	**Date**	**TDEC Comment No.**	**Section No.**	**Section Title**	**Page**	**Paragraph**	**Line**	**TDEC Comment**	**TVA Response**	**Proposed Update to KIF EIP Rev 4 Final**
											No updates needed.

Master Log of Changes to KIF EIP
Water Use Survey SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to KIF EIP Rev 4 Final
1	ALF	October 3, 2017	87	Appendix J, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm.	Specific conductance will be measured and recorded in µS/cm in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017).	Specify units in Water Use Survey SAP
2	KIF	November 6, 2018	NA	NA	NA	NA	NA	NA	NA	NA	Replace SW-846 analyses with EIP numbered methods for drinking water in Table 5. Analytical Methods, Preservatives, Containers, and Holding Times in Section 5 to match the analyses in the QAPP.

Master Log of Changes to KIF EIP
Quality Assurance Project Plan

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to KIF EIP Rev 4 Final
1	KIF	NA	NA	2.2.4	Analytical Laboratories	6	Table 2-1	NA	NA	NA	Change PM for both TestAmerica Facilities as Gail Lage
2	KIF	NA	NA	2.2.4	Analytical Laboratories	6	Table 2-1	NA	NA	NA	Update primary TestAmerica facility to Nashville, TN and identify Pittsburgh and St. Louis as support facilities
2	KIF	NA	NA	2.2.4	Analytical Laboratories	6	Table 2-1	NA	NA	NA	Remove reference to arsenic speciation analyses and remove reference to TestAmerica Denver facility.
3	KIF	NA	NA	11.2	Field and Laboratory Quality Control Samples	28	Table 11-1	NA	NA	NA	Clarify field blank frequency to "1 per day of sampling activity per sampling team"
4	KIF	NA	NA	11.2	Field and Laboratory Quality Control Samples	28	Table 11-1	NA	NA	NA	Clarify filter blank collection frequency to "1 per sampling event per lot of filters used (when dissolved parameters are collected)"
5	KIF	NA	NA	19.1	Precision	50	3	NA	NA	NA	Add language defining RER equation
6	KIF	NA	NA	All attachments	Various	Various	Various	NA	NA	NA	Update analyte lists for consistency with updates to SAPs.
7	KIF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-2	Table E-1	NA	NA	NA	Update container type to 16-oz glass for radiological parameters
8	KIF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-2	Table E-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
9	KIF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-3	Table E-2	NA	NA	NA	Update RLs to match current laboratory reporting limits
				Attachment I	Investigation-Specific Quality Control Requirements – CCR Material Characteristics	Various	Various	NA	NA	NA	Remove references to arsenic speciation for CCR Material Characteristics Investigation
10	KIF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – CCR Material Characteristics	I-2	Table I-1	NA	NA	NA	Update container type to 16-oz glass for radiological parameters for CCR Material.
11	KIF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – CCR Material Characteristics	I-2	Table I-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
12	KIF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – CCR Material Characteristics	I-8	Table I-5	NA	NA	NA	Remove surrogate requirement for radiological parameters
13	KIF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – CCR Material Characteristics	I-2	Table I-1	NA	NA	NA	Add equipment blank requirements for CCR material
14	KIF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – CCR Material Characteristics	I-2	Table I-2	NA	NA	NA	Remove thermal preservation required for radiological parameters
16	KIF	NA	NA	Attachment G	Investigation-Specific Quality Control Requirements – Water Use Survey Sampling	G-2	Table G-1	NA	NA	NA	Remove thermal preservation required for radiological parameters

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to KIF EIP Rev 4 Final
20	KIF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Seep Sampling	H-2	Table H-1	NA	NA	NA	Update container type to 16-oz glass for radiological parameters for seep soil
21	KIF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Seep Sampling	H-2	Table H-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
22	KIF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Seep Sampling	H-3	Table H-2	NA	NA	NA	Update RLs to match current laboratory reporting limits
23	KIF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – Groundwater	F-2	Table F-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
24	All	NA	NA	NA	NA	NA	NA	NA	NA	NA	Edit document to remove "Investigation Consultant"

APPENDIX C
QUALITY ASSURANCE PROJECT PLAN

ENVIRONMENTAL STANDARDS
Setting the Standards for Innovative Environmental Solutions

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

Revision 3

November 2018

Prepared by:

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

Prepared for:

TENNESSEE VALLEY AUTHORITY
1101 Market Street
Chattanooga, TN 34702-2801

1.0 TABLE OF CONTENTS

Figures

Tables

Attachments

2.0 QUALITY ASSURANCE PROJECT PLAN DESCRIPTION

2.1 Background

The primary goal of this Tennessee Valley Authority (TVA) Kingston Fossil Plant (KIF) Environmental Investigation Quality Assurance Project Plan (KIF QAPP) is to confirm that the KIF 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 Kingston Fossil Plant Environmental Investigation Plan*, *Revision 4* (KIF EIP, Revision 4; November 2018) and provides QA procedures and quality control (QC) measures to be applied to associated sampling and monitoring activities. This KIF QAPP will govern the quality aspects of the investigation-specific Sampling and Analysis Plans (SAPs).

This KIF QAPP describes the QA implementation for the KIF 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 KIF 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 KIF QAPP describes the generation and use of environmental data associated with the KIF EIP and is applicable to current sampling and monitoring programs associated with the project. Data generated under the KIF 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

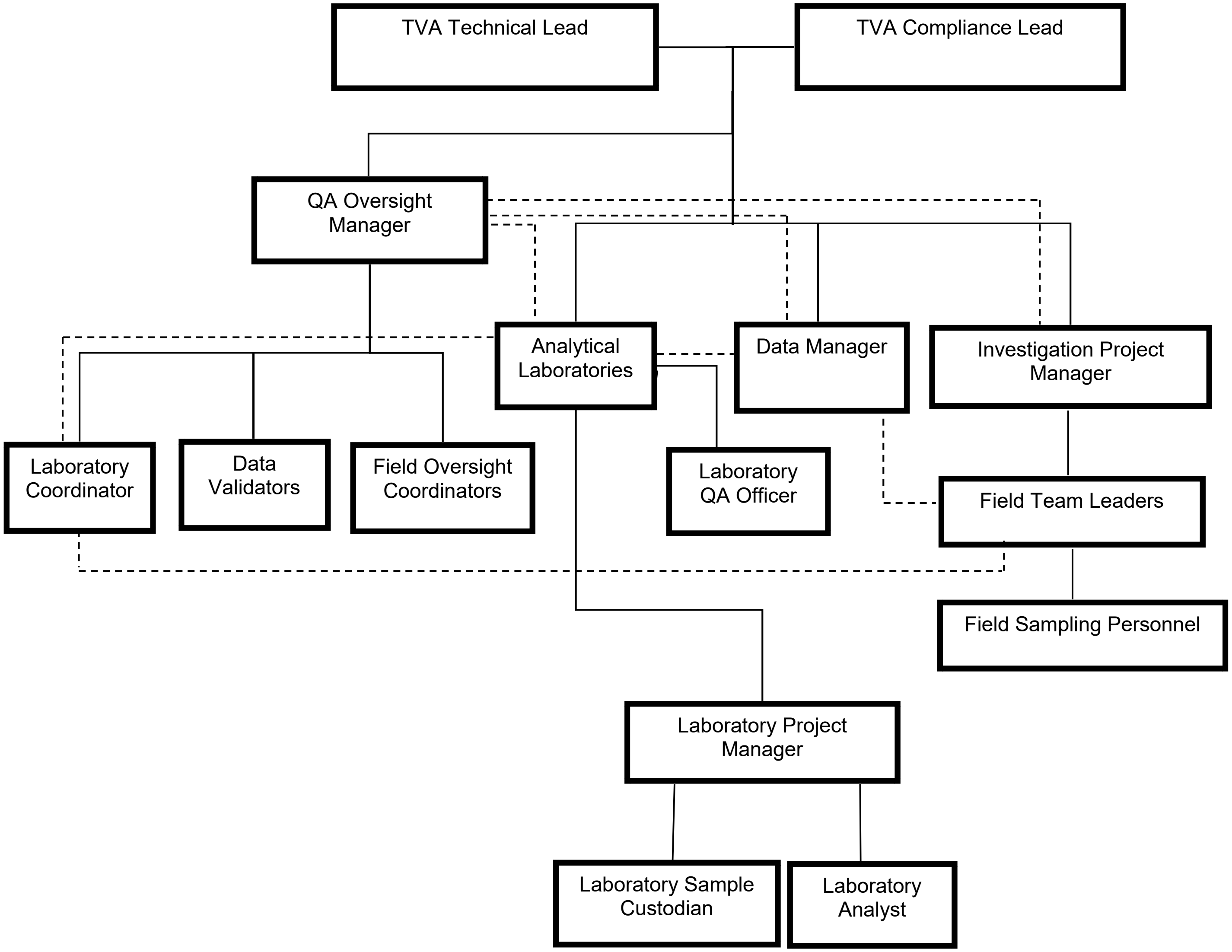
Successful implementation of a QA Program requires clear lines of reporting and authority, along with defined responsibilities for key individuals implementing and administrating the QA Program. This section describes the organizational structure, lines of authority, and responsibilities of key individuals accountable for the implementation and administration of the KIF 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 subsection of the overall organizational structure for the project as directly related to implementation of the KIF 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 KIF EIP



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

2.2.1 TVA Compliance Lead

The TVA Compliance Lead is responsible for the coordination and direction of the KIF EIP. The TVA Compliance Lead is ultimately responsible for design and implementation of the KIF 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 KIF EIP strategy.
- Reviewing and approving KIF 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 KIF EIP. The TVA Technical Lead directs the Investigation Project Manager and independent QA Oversight Manager and is ultimately responsible for design and implementation of the KIF 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 KIF EIP strategy.
- Developing and reviewing KIF 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 Project Manager

The Investigation Project Manager plans, coordinates, and oversees the performance of all investigation and sample collection activities.

Investigation 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 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 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 personnel, 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 KIF 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 actions.
- 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 to 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 KIF 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 KIF EIP are presented on Table 2-1.

Table 2-1. Analytical Laboratories for KIF EIP

Parameter/ Sample Type	Laboratory	Facility Address	Laboratory Contact
Metals, General Chemistry Parameters	TestAmerica Laboratories, Inc.	2960 Foster Creighton Drive Nashville, TN 37204[1]	Ms. Gail Lage (gail.lage@testamericainc.com)
		301 Alpha Drive Pittsburgh, PA 15237[2]	
Radiological Parameters		13715 Rider Trail North Earth City, MO 63045[2]	
Percent Ash	R.J. Lee Group	50 Hochberg Road, Monroeville, PA 15146	Ms. Monica Carse (MCarse@rjleegroup.com)
Geotechnical Characteristics	Stantec Consulting Services, Inc.	3052 Beaumont Centre Circle Lexington, KY 40513-1703	Ms. Ryan Jones (ryan.jones@stantec.com)

NOTES:

1 Primary analytical laboratory.
2 Support analytical laboratory.

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 KIF 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 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 KIF 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 KIF 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 KIF 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 KIF 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 KIF 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 KIF 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 Field Team Leaders, and historical data of known quality used as part of the KIF EIP. The Data Manager is the main point-of-contact for data-related issues. The Data Manager is responsible for ensuring compliance with the KIF 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 Field Team Leader 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, TDEC issued Commissioner's Order, No. OGC15-0177 (TDEC 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 Order. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at KIF on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the EIP. On September 16, 2016, TVA submitted the KIF EIP Revision 0.

On June 22, 2017, TDEC issued a letter to TVA regarding the TDEC Order and attached to the letter were environmental investigation comments for the TVA KIF site. According to this letter and subsequent discussions between TVA and TDEC, the specific questions and tasks found in the June 22, 2017 TDEC were to supersede the original specific questions and tasks found in TDEC's June 14, 2016, letter. On September 8, 2017, TVA submitted Rev 1 of the EIP to TDEC. On December 8, 2017, TDEC issued a letter to TVA regarding their review of the KIF Rev 1 EIP and attached to the letter were environmental investigation comments. TVA submitted Rev 2 on March 2, 2018, which addressed those TDEC comments. The KIF Rev 3 EIP addressed the TDEC Rev 2 review comments received on May 2, 2018. This KIF EIP Rev 4 addresses applicable programmatic revisions identified since finalization of the KIF EIP Rev 3.

The purpose of the KIF EIP is to characterize the hydrology and geology of the KIF, identify the extent of soil, surface water, and groundwater impact by CCR, and assess the quantities and characteristics of CCR materials currently onsite. 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 KIF.

To support the KIF EIP 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 KIF QAPP. The requirements of the KIF QAPP are applicable to project environmental personnel, support staff, consultants, and subcontractors.

3.1 Purpose and Scope

The KIF QAPP is intended to establish an overall environmental QA framework for the KIF EIP and to provide quantitative quality objectives for analytical data generated under the KIF 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 KIF EIP and provide the appropriate QA procedures and QC measures to be applied to the associated sampling and monitoring activities. The KIF 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 I of this KIF 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 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 KIF 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 KIF QAPP Distribution and Revision

The KIF 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 KIF 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 KIF QAPP will identify the KIF QAPP 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 personnel considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts at the KIF 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 Project Manager, 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 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 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 investigation-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 QA Officer or her/his designee to conduct the various laboratory analyses described in the KIF 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 KIF QAPP and in the program-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 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 KIF 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 complete 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

Chemical 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 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 45 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 are expressed in terms of weight per unit weight of sample (such as milligrams per kilogram [mg/kg]) 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 KIF 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 analytical data (historical and investigatory) to be used as part of the KIF EIP. To maintain uniformity and consistency among analytical laboratories, the EDD format for the transfer of data associated with the KIF 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 KIF EIP will also be stored in the EQuIS Project Database. A simple EDD specification will be utilized by the 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 KIF 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 and solid samples may be collected in association with the KIF EIP. These samples will be subject to a variety of chemical, radiological, and physical analyses to support the objectives outlined in the KIF 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 KIF 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 KIF 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 SAP 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 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, Field 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. 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 I to this KIF 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 KIF 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 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 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 Team 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 Field Sampling Personnel) 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 Sampling Personnel 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.

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 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 I of this KIF 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 KIF 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 KIF 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 I of this KIF 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 KIF EIP, the collected samples will be tested for the methods, constituents, and reporting limits presented in Attachments E through I of this KIF 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 KIF 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 I of this KIF 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 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 KIF EIP. Specific quantitative QA objectives for each investigation are presented in Attachments E through I of this KIF 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 KIF EIP are presented in Attachments E through I of this KIF 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 precision and accuracy may be found in Section 19.0 of the KIF QAPP. In addition, specific requirements for representativeness, comparability, and completeness of field and laboratory QC samples may be found in Section 19.0 of the KIF 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 and solid samples associated with the KIF 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
Equipment Rinsate Blank	1 per sampling event	1 per 20 field samples
Field Blank	1 per day of sampling activity per sampling team	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
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
Filter Blank[c]	1 per sampling event per lot of filters used when dissolved parameters are collected [c]	N/A

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.

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 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 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 from within the same core, whichever is more appropriate for the type of sample/sampling technique (surface or subsurface sediment sample). 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 laboratory duplicate (LD) sample is obtained by splitting a field sample into two separate aliquots and performing separate preparation and analysis on the respective aliquots if a field collected sample is not designated as a LD sample. 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 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 KIF 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 Field Team Leader and will be subject to audit by the Field Oversight Coordinator or designee. The 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 Field Team Leader will inspect equipment to ensure its proper working condition. If equipment is not in the proper working condition, the 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 KIF 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 KIF 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 KIF 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 EIP cannot be substantiated, the data may not be suitable the support certain aspects of the investigation, and new data may be collected to supplement the historical/legacy data.

TVA, QA oversight, and investigation personnel 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 will be 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 project 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 KIF 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 KIF QAPP includes systems and performance audits to ensure that established QA procedures are properly implemented.

The KIF 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 KIF 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 KIF QAPP will identify the KIF QAPP 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 KIF 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 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 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 KIF 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 Officer 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 KIF 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, and solid samples associated with the KIF 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 KIF 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 KIF 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 KIF 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 Field Sampling Personnel, 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 KIF 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 Sampling Personnel by the TVA Technical Lead, QA Oversight Manager, and/or Investigation 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 Field Team Leader is responsible for verifying that QC procedures are followed. This responsibility requires the 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 Field Team Leader will notify the TVA Technical Lead and QA Oversight Manager. An appropriate corrective action will then be determined and implemented. The 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, and to provide a “defense” in the event that field procedures are called into question. 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.

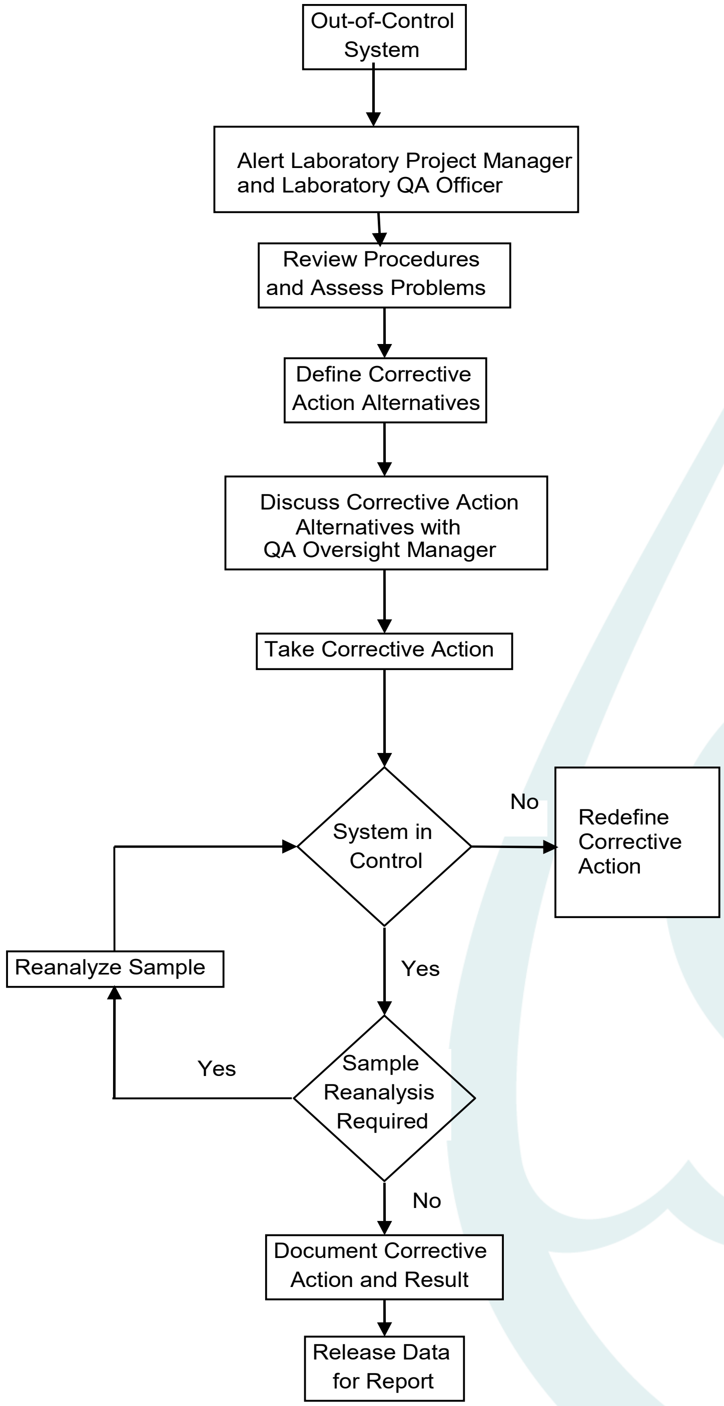
If the assessment reveals that the QC acceptance criteria are not met, the laboratory must immediately evaluate the analytical system and correct the problem. The Laboratory Analyst will notify the Laboratory Project Manager and Laboratory QA Officer of the problem and, if possible, will identify potential 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 KIF EIP samples will be monitored by the TVA Technical Lead and the QA Oversight Manager.

Communication among TVA, QA personnel, the Field Team Leader, 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 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 CLP National Functional Guidelines (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 EI. 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 Data Validators 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.
RL	Positive result reported between the MDL and QL.
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.

Reason Code	Explanation
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 project 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 KIF 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 KIF 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 KIF EIP are presented in Attachments E through I of this KIF 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 for non-radiological parameters is calculated by expressing, as a percentage, the RPD between results of analyses of 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.

Analytical precision for radiological analyses is calculated as the relative error ratio (RER) using the following formula:

$$RER = abs\left[\frac{ACT_s - ACT_d}{\sqrt{(TPU_s)^2 + (TPU_d)^2}}\right]$$

Where:
Abs = Absolute Value
ACT_s = Sample Activity
ACT_d = Duplicate Activity
TPU_s = Total Propagated Uncertainty of Sample
TPU_d = Total Propagated Uncertainty of Duplicate

Specific precision and difference objectives for field duplicate samples and laboratory duplicate samples (including MSDs) are presented in Attachments E through I of this KIF 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 I of this KIF 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 will 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 KIF 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 KIF 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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US EPA. *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review,* EPA-540-R-08-01, June 2008.

US EPA. *Data Quality Objectives Process for Superfund, Interim Final Guidance,* EPA540-R-93-071, September 1993.

US EPA Region 4. *Data Validation Standard Operating Procedures for Contract Laboratory Program Inorganic Data by Inductively Coupled Plasma – Atomic Emission Spectroscopy and Inductively Coupled Plasma – Mass Spectroscopy*. SOP No: QAS-SOP-12; September 2011.

US EPA Region 4. *Data Validation Standard Operating Procedures for Contract Laboratory Program Mercury Data by Cold Vapor Atomic Absorption.* SOP No: QAS-SOP-13; September 2011.

US EPA Region 4. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual,* November 2001.

US EPA Region 4. *Field pH Measurement,* SESDRPOC-100-R3, January 2013.

US EPA. *National Functional Guidelines for Inorganic Data Review,* October 2004.

US EPA. *QA Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations – Chemical Evaluations,* 1995.

US EPA. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, 3rd Edition including Final Update IV, November 2000.

US EPA. 40 CFR Part 136, *Final Methods Update Rule*, March 2008.

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 should 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
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 Summary: 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 concentration (MDC). The sample-specific MDC 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 MDC 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)
- concentration 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 MDC 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 MDC observed in the original sample aliquot
- observed activity, uncertainty, and MDC 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	F
Preparation Logs	A.2.8	X
Traceability Documents	A.2.9	X

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 KIF EIP 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**
EMA-TI-05.80.40	*Surface Water Sampling*
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 Measurements Using a Multi-Parameter Sonde*

ATTACHMENT C

EXAMPLE CHAIN OF CUSTODY RECORD

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

Required Ship to Lab:		Required Project Information:		Required Sampler Information:	
Lab Name:		Site ID #:		Sampler	
Address:	#N/A	Project #	#N/A	Sampling Company	
				Address:	
		Site Address	#N/A	City/State	Phone #:
Lab PM:	#N/A	City #N/A	State, Zip #N/A	Reimbursement project?	Non-reimbursement / Mark one
Phone/Fax:	#N/A	Site PM Name	#N/A	Send EDD to	
Lab PM email	#N/A	Phone/Fax:		CC Hardcopy report to	
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:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME

Sample Receipt Conditions			
Temp In 0C	Samples on Ice?	Sample Intact?	Trip Blank?
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N

SHIPPING METHOD: (mark as appropriate)		SAMPLER NAME AND SIGNATURE	
UPS	COURIER \ FEDEX	PRINT Name of SAMPLER:	
US MAIL		SIGNATURE of SAMPLER:	

ATTACHMENT D

TDEC ORDER SAMPLE NAMING CONVENTIONS

KINGSTON FOSSIL PLANT

Table A: TVA - TDEC Order Sample Naming Conventions - Kingston Fossil Plant

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Matrix Sample Type Acronym	Location	Location ID	Depth Interval (If Applicable)	Quality Assurance/Quality Control Sample Type	QA/QC Sample Type Acronym	Date of Sample	Example
Kingston Fossil Plant	KIF	Background Soil	BS	Soil Boring or Monitoring Well Number	BGXX MWXX	Feet/Feet	Equipment Rinsate Blank	EBXX	Year/Month/Day	KIF-BS-BGXX-6.0/8.0-20180524 KIF-BS-MWXX-6.0/8.0-20180524 KIF-BS-EBXX-20180524 KIF-BS-FBXX-20180524 KIF-BS-DUPXX-20180524
		Coal Combustion Residuals	CCR	Temporary Well Number	TWXX	Feet/Feet	Field Blank	FBXX	Year/Month/Day	KIF-CCR-TWXX-6.0/8.0-20180524 KIF-CCR-EBXX-20180524 KIF-CCR-FBXX-20180524 KIF-CCR-DUPXX-20180524
		Groundwater	GW	Monitoring Well Number	MWXX or Existing Name	Feet Below Top of Casing	Field Blank	FBXX	Year/Month/Day	KIF-GW-MWXX-35-20180524 KIF-GW-KIFXX-35-20180524 KIF-GW-EBXX-20180524 KIF-GW-FBXX-20180524 KIF-GW-FLBXX-20180524 KIF-GW-DUPXX-20180524
		Pore Water	PW	Temporary Well Number	TWXX	Feet Below Top of Casing	Field Duplicate	DUPXX	Year/Month/Day	KIF-PW-TWXX-20180524 KIF-PW-EBXX-20180524 KIF-PW-FBXX-20180524 KIF-PW-FLBXX-20180524 KIF-PW-DUPXX-20180524
		Seep Soil	SES	Seep Number	XX	NA	Field Duplicate	DUPXX	Year/Month/Day	KIF-SES-XX-20180524 KIF-SES-EBXX-20180524 KIF-SES-FBXX-20180524 KIF-SES-DUPXX-20180524
		Seep Water	SEW	Seep Number	XX	NA	Filter Blank	FLBXX	Year/Month/Day	KIF-SEW-XX-20180524 KIF-SEW-EBXX-20180524 KIF-SEW-FBXX-20180524 KIF-SEW-FLBXX-20180524 KIF-SEW-DUPXX-20180524
		Water Supply	WS	Well ID # or Property Owner Name	State or USGS Well # or Property Owner Name	NA	Matrix Spike/Matrix Spike Duplicate *Note applicable sample on COC	MS/MSD	Year/Month/Day	KIF-WS-TN0001-20180524 KIF-WS-JOHNDOE-20180524 KIF-WS-EBXX-20180524 KIF-WS-FBXX-20180524 KIF-WS-FLBXX-20180524 KIF-WS-DUPXX-20180524

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
Solid	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	16-oz glass	20 g	NA	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	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	8.0	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	7440-47-3	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	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	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Anions	SW-846 9056A Modified	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
Percent Ash	R.J. Lee SOP OPT23.02	< RL	NA	NA	NA	NA	±10%	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified (laboratory-based definitive analysis	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

GROUNDWATER INVESTIGATION 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
Groundwater	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 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	180 days
	Total Dissolved Solids (TDS)	250-mL HDPE	100 mL	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 F-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
pH	pH	SW-846 Method 9040C	0.100	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	10.00	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	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)	7440-47-3	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	1.00	µg/L
Potassium (Total and Dissolved)	7440-09-7	SW-846 6020A	500	µg/L
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

Parameter	CAS No.	Method	Reporting Limit	Units
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
µg/L	-	micrograms per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation.

Table F-3: Quantitative QA Objectives – Groundwater

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Filter 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
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

ATTACHMENT G

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

WATER USE SURVEY SAMPLING

Table G-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Water Supply Well Samples	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	180 days
	Total Dissolved Solids (TDS)	250-mL HDPE	100 mL	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 G-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
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	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)	7440-47-3	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	EPA 200.8	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	100	µg/L
Potassium (Total and Dissolved)	7440-09-7	EPA 200.8	500	µg/L
Selenium (Total and Dissolved)	7782-49-2	EPA 200.8	5.00	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
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	1.0	pCi/L
Radium-228	15262-20-1	EPA 904.0	1.0	pCi/L
Radium-226+228	RA226/228	CALC	1.0	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
µg/L	-	micrograms per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation.

Table G-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)	EPA 200.8	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury (Total and Dissolved)	EPA 245.1	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)	EPA 300.0	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
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < 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
RER	-	Relative Error
RL	-	Reporting Limit
%R	-	Percent Recovery

ATTACHMENT H

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

SEEP SAMPLING

Table H-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation[1]	Holding Time
Seep 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 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	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)	1-L HDPE	1000 mL	Cool to < 6°C	7 days
Seep Soil	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	16-oz glass	20 g	NA	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	28 days
	pH				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 H-2: Analytes, Methods, and Reporting Limits – Seep 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	7440-47-3	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 7471c	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
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 H-3: Analytes, Methods, and Reporting Limits – Seep Water 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	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	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)	7440-47-3	SW-846 6020A	2.00	µg/L
Cobalt (Total and Dissolved)	7440-48-4	SW-846 6020A	0.5	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

Parameter	CAS No.	Method	Reporting Limit	Units
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	µg/L
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

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 H-4: Quantitative QA Objectives – Seep Soil Samples

Analyte/ Parameter Group	Method	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	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Anions	SW-846 9056A Modified	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified (laboratory-based definitive analysis)	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 H-5: Quantitative QA Objectives – Seep Water 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 (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
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 I

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

CCR MATERIAL CHARACTERISTIC SAMPLING

Table I-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	16-oz glass	20 g	NA	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	21 days
	pH				NA*
	Total Organic Carbon	4-oz glass	10 g	Cool to < 6°C	28 days
	SPLP	16-oz glass	100 g MINIMUM	Cool to <6°C	28 days
SPLP Leachates	Metals	NA	NA; generated in laboratory	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters			NA	180 days
	Anions (Chloride, Fluoride, and Sulfate)			Cool to < 6°C	28 days
	pH				NA*
Pore 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 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	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

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation[1]	Holding Time
Aqueous Equipment Blanks	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 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	180 days
	Total Dissolved Solids (TDS)[2]	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Total Organic Carbon	250-mL Amber Glass	250-mL	Cool to ≤ 6°C H_2SO_4 to pH < 2	28 days

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.

* 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 I-2: Analytes, Methods, and Reporting Limits – CCR Material

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	8.0	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	7440-47-3	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
Iron	7439-89-6	SW-846 6020A	5.00	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
Manganese	7439-96-5	SW-846 6020A	0.500	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
Total Organic Carbon	7440-44-0	Lloyd Kahn or SW-846 9060A	1000	mg/kg
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 (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 I-3: Analytes, Methods, and Reporting Limits – SPLP Leachates

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	0.0100	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	7440-47-3	SW-846 6020A	2.00	µg/L
Cobalt	7440-48-4	SW-846 6020A	0.500	µg/L
Copper	7440-50-8	SW-846 6020A	2.00	µg/L
Iron	7439-89-6	SW-846 6020A	50.0	µg/L
Lead	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium	7439-93-2	SW-846 6020A	5.00	µg/L
Manganese	7439-96-5	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	10.00	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
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	1.00	mg/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 I-4: Analytes, Methods, and Reporting Limits – Pore Water 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
pH	pH	SW-846 Method 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)	7440-47-3	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
Iron (Total and Dissolved)	7439-89-6	SW-846 6020A	50.0	µg/L
Lead (Total and Dissolved)	7439-92-1	SW-846 6020A	1.00	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Lithium (Total and Dissolved)	7439-93-2	SW-846 6020A	5.00	µg/L
Manganese (Total and Dissolved)	7439-96-5	SW-846 6020A	5.00	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
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
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
Total Organic Carbon	7440-44-0	SM 5310C	1.00	mg/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 I-5: Quantitative QA Objectives – CCR Material

Analyte/ Parameter Group	Method	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	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	< RL	75-125	NA	RER<2	NA	RER<2	RER<2
Radium-228	EPA 901.1	< RL	75-125	NA	RER<2	NA	RER<2	RER<2
Total Organic Carbon	Lloyd Kahn or SW-846 9060A	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified	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
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
RER - Relative Error

Table I-6: Quantitative QA Objectives – SPLP Leachates

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	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 Method 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

Table I-7: Quantitative QA Objectives – Pore Water

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
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	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 Method 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

APPENDIX D
DATA MANAGEMENT PLAN

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402-2801

March 8, 2018

Mr. Chuck Head
Assistant Commissioner
Tennessee Department of Environment
and Conservation (TDEC)
Tennessee Tower William R. Snodgrass Building
312 Rosa L Parks Avenue
Nashville, Tennessee 37243-1548

Dear Mr. Head:

TENNESSEE VALLEY AUTHORITY (TVA) – DATA MANAGEMENT PLAN (DMP) – COMMISSIONER'S ORDER NUMBER OGC15-0177

Enclosed is the DMP for the above mentioned order. This DMP Revision 1 responds to comments provided by TDEC in an email dated February 7, 2018.

If you have questions regarding this information, please contact Bryan Wells at (423) 751-7393 or by email at wbwells@tva.gov. You may also contact me at (423) 751-3304 or by email at sstidwell@tva.gov.

Sincerely,

M. Susan Smelley

M. Susan Smelley
Director
Environmental Compliance & Operations

Enclosure

cc (w/o Enclosure):

Ms. Angela Adams
CCR Environmental Consultant
TDEC Division of Water Resources
761 Emory Valley Road
Oak Ridge, Tennessee 37830

Mr. Robert Burnette, P.E.
Tennessee Department of Environment
and Conservation
1301 Riverfront Parkway, Suite 206
Chattanooga, Tennessee 37402

Mr. James Clark
Chief Geologist
TDEC Columbia Field Office
1421 Hampshire Road
Columbia, Tennessee 38401

Mr. Britton Dotson
Environmental Fellow
Tennessee Department of Environment
and Conservation
William R. Snodgrass TN Tower
312 Rosa L Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1548

Ms. Jenny Howard
General Council
Tennessee Department of Environment
and Conservation
William R. Snodgrass TN Tower
312 Rosa L Parks Avenue, 2nd Floor
Nashville, Tennessee 37243-1548

Ms. Shari Meghreblian, Ph.D.
Deputy Commissioner, Bureau of Environment
Tennessee Department of Environment
and Conservation
William R. Snodgrass TN Tower
312 Rosa L Parks Avenue, 2nd Floor
Nashville, Tennessee 37243-1548

Mr. Robert S. Wilkinson
Coal Combustion Residual Technical Manager
Tennessee Department of Environment
and Conservation
William R. Snodgrass TN Tower
312 Rosa L Parks Avenue
Nashville, Tennessee 37243-1548

WBW:SMF
cc (Electronic Distribution):

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ECM, ENVrecords

TENNESSEE VALLEY AUTHORITY

MULTI-SITE ORDER ENVIRONMENTAL INVESTIGATIONS

DATA MANAGEMENT PLAN

Revision 1

March 2018

Prepared by

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

Prepared for

TENNESSEE VALLEY AUTHORITY
1101 Market Street
Chattanooga, TN 34702-2801

Revision Log MULTI-SITE ORDER ENVIRONMENTAL INVESTIGATIONS DATA MANAGEMENT PLAN (TVA EI DMP)		
Revision and Date	Section Reference	Revision Description
Revision 0, November 2017	n/a	Issued for TDEC Review
Revision 1, March 2018	2.1.2	Updated responsibilities to align with QA Program definitions.
Revision 1, March 2018	2.1.2.1	Updated responsibilities to align with QA Program definitions.

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (Multi-Site 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 response to the Multi-Site Order, TVA is initiating Environmental Investigations (EIs) at each of the TVA facilities in Tennessee addressed in the Multi-Site Order. The primary goal of this TVA EI Data Management Plan (TVA EI DMP) is to address the logistics and technical challenges of managing analytical data generated by environmental laboratories and Field Sampling Personnel in support of activities intended to address the requirements set forth in the Multi-Site Order. This TVA EI DMP is intended to 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 completeness, data usability, and most importantly, defensibility of the analytical data.

Typical environmental Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), and Data Management Plans (DMPs) predominately focus on analytical chemistry data from the environmental investigations of various media (air/vapors, soil, sediment, surface water, and groundwater) and receptors (ecological and human). Due to the comprehensive nature of the Coal Combustion Residuals (CCR) Rule and the Multi-Site Order, the over-arching disciplines requiring data management are:

- Civil/Mapping;
- Environmental/Surface Water;
- Geotechnical; and
- Hydrogeology.

The work products of these disciplines will produce a wide-range of data and deliverables needing management. In addition, the Multi-Site Order requires a timely distribution of information to TDEC as well as public involvement.

TVA has decided that the best way to support the wide-array of data management needs related to the Multi-Site Order, is to build a SharePoint-based knowledge management portal (KMP) where data and deliverables will be housed and accessible. The KMP will integrate the EarthSoft® EQuIS™ (EQuIS) database for analytical chemistry and field parameter data, geographic information system (GIS) database for geospatial data, and various other databases for historical and current deliverables. The KMP will thus serve as the central access point for the Environmental Investigation Plans (EIPs), the EI data, and other data necessary for the Corrective Action/Risk Assessment (CARA).

To support the TVA Multi-Site Order response objectives, a Quality Assurance (QA) program has been implemented to verify that environmental data generated for use in decision-making is of high quality and is legally defensible. The QA program is documented in the QAPPs developed as part of each site-specific EIP. The sampling design and execution for monitoring activities associated with each EI are described in the site-specific EIP and investigation-specific SAPs.

Environmental data have been and will continue to be used for purposes such as, but not limited to, operational decisions, ecological and human health risk assessments; delineation of the extent of contamination and ash transport; and to demonstrate the achievement of project objectives. Accordingly, it is imperative that the data are subjected to a formal data management process.

On behalf of TVA, Environmental Standards, an independent QA firm, has prepared this TVA EI DMP. The requirements of the TVA EI DMP are applicable to TVA environmental personnel, TVA information technologies personnel, support staff, contractors, and analytical laboratories.

1.1 Historical and Recent Data

Environmental data associated with surface water, groundwater, sediment, biological, CCR, and soil samples have been collected by TVA during previous operational periods. For the purpose of this TVA EI DMP, “historical” data on this project is defined as analytical data collected by TVA or its contractors prior to the institution of this data management plan. Historical analytical data sets intended for use under the TVA Multi-Site Order response will be included in TVA's project database as requested by TVA. Historical data migration efforts will be detailed in one or more separate Data Migration Plans, at such time that the scope of the migration has been developed. TVA will conduct environmental sampling under the EIPs developed in response to the Multi-Site Order, resulting in the generation of a significant amount of environmental analytical and related field data; these data are referred to as “Recent” data in this TVA EI DMP.

1.2 Existing Project Database General Structure

TVA and its designated contractors will use an existing EQuIS database (TVA EI database) to store recent data, as well as any historical data requiring migration. The TVA EI database will be separated into distinct facilities to store data associated with each site-specific EIP. The database will use common valid values, data qualifier definitions, and management processes across all TVA facilities. Reference value files (RVF) containing lists of valid values used in the database will be provided to analytical laboratories, Field Team Leaders, and other appropriate parties, as needed.

1.3 Objectives

The major objectives for the TVA Multi-Site Order Data Management Program are to:

- Maintain data control, consistency, reliability, and reproducibility throughout the life of the EIs;
- Establish the framework for consistent documentation of the quality and validity of field and laboratory data compiled during investigations;
- Describe in detail the data management procedures for EI-related data;
- Include procedures and timelines for sharing data with stakeholders as well as procedures for providing both electronic and hardcopies to specified recipients of each type of data; and
- Enable the use of EI data in a consistent and easily shared format among appropriate parties.

2.0 DATA MANAGEMENT TEAM

This section describes the key roles and responsibilities associated with the Data Management Program and processes for managing data.

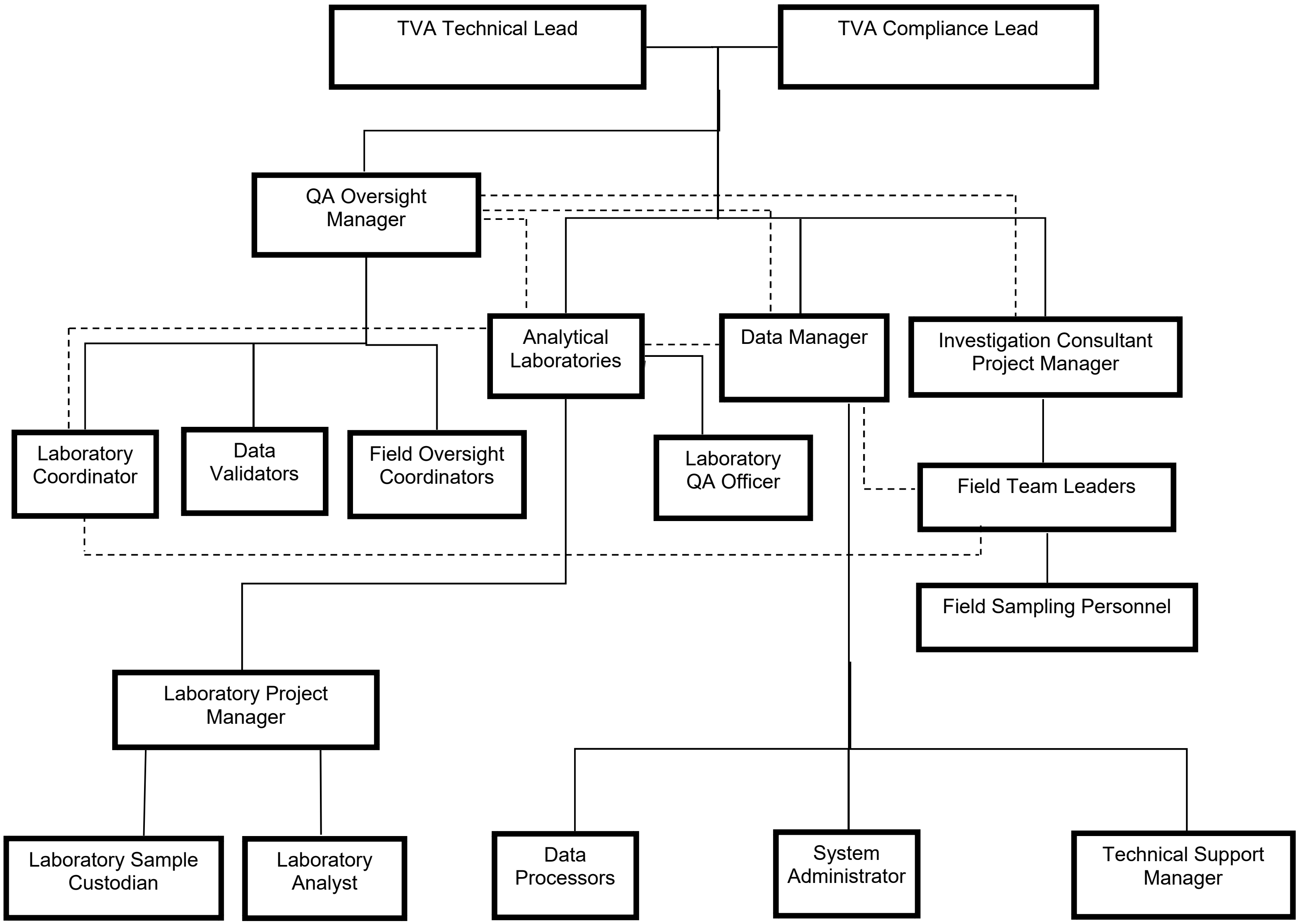
Users of the EQuIS Quality and Data Management System (EQDMS) primarily consist of technical and project staff that are assumed to have a general understanding of the environmental data and the EIs being conducted at each TVA facility. Some users are also required to have an advanced understanding of the EQDMS and relational database architecture.

The data management team consists of the following positions.

- Data Manager
- Data Processors
- Technical Support Manager
- System Administrator
- Data Analysts and Other Data Users
- Field Team Leaders
- Field Sampling Personnel
- Laboratory Coordinator

The organization chart for the TVA EI Data Management Program is presented in Figure 2-1. The Data Management Team is a component of the overall QA Program for each plant-specific EI. The roles and responsibilities for the TVA Technical Lead, TVA Compliance Lead, Investigation Consultant Project Manager and subordinate roles, Analytical Laboratory and subordinate roles, and QA Oversight Manager and subordinate roles are detailed in the QAPP developed for each of the plant-specific EIs. The relationship between the TVA Technical Lead and the TVA Compliance Lead is reflected in Part VII.F of the Multi-Site Order. Descriptions of data management personnel roles and responsibilities, and additional responsibilities of project personnel specific to the data management program, are provided in the sections below.

Figure 2-1. Organization Chart and Lines of Communication for TVA Multi-Site Order EI Data Management



2.1 Data Managers

Data Managers are 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 that is intended for use under the TVA Multi-Site Order. The Data Manager acts as the single point of contact for TVA for data management and for data-related issues. Data Managers are responsible for ensuring compliance with the plant-specific EI QAPP and the TVA EI DMP. Data Managers make certain that adequate Data Management Team members are available and properly trained, and that adequate software and hardware are available. Data Managers perform periodic audits on components of the data management system including access and security controls, system documentation, and data backup procedures. Data Managers have an intimate knowledge of the data management process, relational database concepts, and the architecture of the EQDMS.

Data Managers are typically the most knowledgeable and active user of the EQDMS and performs or directs the majority of the data updates or changes. A Data Manager or designee receives electronic data deliverables (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 a Data Manager from the Field Team Leaders utilizing field EDDs and is loaded and managed in the project database. Data Managers work directly with the Investigation Consultant Project Managers and field staff members to perform checks that the data are complete and accurate, as well as with data analysts, and other data users to provide queries, tables, graphs, and data exports. Data Managers are responsible for updating and implementing the TVA EI DMP and other quality documentation pertaining to data management.

2.1.1 Data Processors

Data Processors log in and load data delivered to the system. Data Processors are responsible for first-level activities and report any exceptions encountered in a standard process to the Data Manager for review and action. Data Processors are responsible for deliverable tracking, standard data loading, and providing standard EQDMS reports. Data Processors update or modify data in the database at the direction of the Data Manager in support of QA activities.

2.1.2 Technical Support Manager

The Technical Support Manager is responsible for any programming or database schema change required to support the operation of the EQDMS for this project. The Technical Support Manager is typically involved in the planning and implementation phases of the project and, once the system is operational, acts primarily as a technical advisor to the project team for any contemplated change in functionality. The Technical Support Manager sets user authentication and controls access to the data, maintains data tables necessary for the EQDMS to run, and generally manages EQDMS usage. The Technical Support Manager has a strong background in information systems and relational database hardware, software design and programming, detailed understanding of the EQDMS architecture, and familiarity with the data management business process.

2.1.3 System Administrator

The System Administrator will be responsible for the operation and maintenance of the EQDMS. The System Administrator will back up the data and confirm that the system is available for users. The System Administrator has a strong background in network support, information systems, and hardware and software maintenance.

2.2 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 personnel and subcontractors.
- Provide coordination of field sampling and calibration activities.
- Submit analytical requests to the Laboratory Coordinator.
- Verify 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

Field Team Leaders are responsible for implementing the investigation-specific SAPs that describe data collection requirements and activities to be conducted. Field Team Leaders are responsible for overall coordination between field activities and the data management process. Field Team Leaders understand the data management process and interactions between field and data management staff.

2.2.1 Field Sampling Personnel

Field Sampling Personnel are responsible for the performance of field activities as required by the investigation-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.

2.3 Laboratory Coordinator

The Laboratory Coordinator serves as a liaison between Field Team Leaders and the analytical laboratories. 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 Chain of Custody (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.

2.4 Data Analysts and Other Data Users

Data analysts and other data users may be any project team members who require access to analytical data for reporting, interpretation, or decision-making. Data analysts and other data users use the EQDMS to evaluate data that have completed the verification/validation process. Analysts and Users can run standard reports in EQDMS and do not update or modify data in the database.

3.0 DATA MANAGEMENT PROCESS

Optimal control of data is enforced by rigorous pre-planning of sampling activities. The EQDMS provides the functionality to support the creation of COC forms and bottle labels, auto loading of laboratory-generated analytical chemistry data, automated correctness checking, detailed completeness checking, data verification, support for data validation reporting and editing, and technical data reporting and presentation. This functionality exists so that the stages of data management are efficient and performed as accurately as possible. Appendix A presents workflow diagrams illustrating the overall data management process and the detailed data verification/validation process.

3.1 Planning

The data management process starts with preparation of the investigation-specific SAP. This planning phase gives consideration for appropriate levels of documentation specific to the individual data collection process and details any appropriate field measurements and/or other event-related data. Based on the field-planning document, the Data Manager configures the EQDMS for the investigation to support the data collected on the required COC forms. Configuration of the system may involve defining Method Analyte Groups (MAGs) in the database that include the methods used by laboratories to analyze samples and the analytes to be reported by those methods, as well as setting up standard forms and reports to meet the needs of the project team. The EQDMS supports storage of the information on the COC form, including the laboratory, shipping information, sample identifications (IDs), type and quantity of containers, preservatives, analytical tests, sample date, and sampler. At the time of sample collection, the Field Sampling Personnel fill out the remaining information including the sampler's initials, sample collection date, and time, shipping information and sample IDs. Some deviation from this approach may be acceptable if it is fully documented and approved in investigation-specific SAPs.

3.2 Field Measurements and Sample Collection

The process continues with Field Sampling Personnel collecting environmental samples and field measurements, and documenting field activities. Field documents must be recorded and stored electronically in accordance with project requirements. The EQDMS provides the functionality to create the electronic COCs (eCOCs), or COCs may be manually populated by the Field Sampling Personnel, at the discretion of TVA and its designated contractor(s). The COC form, whether generated as an eCOC or hand-written, will serve as the legal document of sample handling and transfer. The COC form is provided to the Data Project Manager to enter technical data into the EQDMS and could possibly include additional sampling event information, coordinate data and field measurements. The details for the specific data to be collected during sampling or other activities are contained in investigation-specific SAPs and related TIs.

3.3 Sample Tracking

Sample tracking begins when the COC is created. Events tracked in the EQDMS include: sample shipment, laboratory sample receipt, data package receipt, EDD receipt, and any rejection or resubmission dates, as needed.

Data Processors update the sample tracking records in EQDMS upon receiving a deliverable. The laboratory receives and evaluates the samples for proper COC procedures and sample handling. The laboratory assigns unique laboratory sample IDs and a Sample Delivery Group (SDG) number. To confirm that samples were received and that the correct analyses will be performed, the laboratory then provides the Data Processors with a sample receipt confirmation (SRC) that specifies the following.

- Sample receipt quantities and condition of containers (such as broken/leaking, temperature, hold time, custody maintained).
- Sample preparation (such as compositing and filtration) and analyses to be conducted.
- Date that analyses will be completed.
- Laboratory sample IDs and SDG number.

A copy of the SRC is provided to Data Processors who update the database with the sample receipt information and continue to track sample/data reporting progress until all data are delivered and review completed.

3.4 Laboratory Analysis and Reporting

The laboratory personnel analyze the samples as specified on the COC Record and according to the published method and project-specific requirements outlined in the associated plant-specific EI QAPP. Once the samples are analyzed, an electronic copy of the laboratory data package and an EDD are produced and forwarded to an electronic mailbox established specifically for the project. A Data Processor monitors the project mailbox for deliverables received and processes the data for testing against project specifications as described in the following sections.

3.5 Data Loading and Review

Data are assigned status values based on progression through the data loading and review process. There are currently three status levels for data that have been reviewed. These status levels are “VERIFIED”, “FINAL-VERIFIED”, and “VALIDATED”. Data are automatically unclassified and assigned no status upon initial load to the database. After an automated chemistry data verification and second-level review, data are manually assigned a state of “VERIFIED” by a Data Processor. If automated verification is the only level of review required, the Data Processor sets the data to a stage of “FINAL-VERIFIED”. Upon completion of data validation inclusive of senior reviews, data are assigned a status of “VALIDATED” by a Data Processor.

3.5.1 Initial Data Loading

EDDs are received in an electronic mailbox established specifically for the project. EDDs are loaded by a Data Processor and data are automatically unclassified. The first test of the EDD is for correctness against the project specifications. Correctness testing is a review of the EDD format against structural rules. Correctness determines if data are delivered using the correct file layout, data types, and adherence to project specific values. The full list of requirements can be found in the EDD specification in Appendix B. When an error is identified during testing for correctness, an e-mail containing a report of the deficiency is created and reviewed by a Data Manager and sent to the laboratory with the request for resubmission. Typical problems found in this review are missing or incorrect valid values, incorrectly formatted data, duplicate rows, and missing Parent/Child sample relationships.

After successfully passing the correctness testing and subsequent loading to the database, data completeness is checked by comparing the planned sampling data associated with the COC form to the actual sample, analytical method and analyte delivered by the laboratory. When an error is identified during testing for completeness, an e-mail containing a report of the deficiency is created and reviewed by the Data Manager and sent to the laboratory requesting resubmission, with a copy to the QA Oversight Manager.

Once data have passed correctness and completeness processing, the data are ready for automated data verification processing.

3.5.2 VERIFIED Status

Automated electronic data verification is only performed on data that has been deemed to be correct and complete. A verification report is produced for review by the Data Validator. Data verification activities are conducted according to the associated plant-specific QAPP. The criteria used to assess accuracy and precision of the data are detailed in the associated plant-specific QAPP. The data are reviewed from a usability perspective using screening software; the qualification assigned by the screening software are subsequently reviewed by a Data Validator. A Data Processor will make any needed edits identified by the Data Validator. All edits are reviewed by the initial Data Validator, as well as peer reviewed by the QA Oversight Manager. After review and approval of the data verification report and related results by the Data Validator, the data are assigned a status of “VERIFIED” by a Data Processor.

3.5.3 FINAL-VERIFIED Status

Data that are not going to be subjected to data validation are set to a status of “FINAL-VERIFIED” by a Data Processor once the verification process as detailed above is complete.

3.5.4 VALIDATED Status

Validation will occur after automated verification has been completed. The decision to perform data validation on any given data set will be determined based upon the data quality objectives for that data set. Data validation is supported by reporting and edit functionalities in the EQDMS. Data tables are provided to the Data Validator, who will manually annotate those tables with validation edits. A Data Processor will make any needed edits; edited data tables are returned to the initial Data Validator for review and approval. Once all edits have been confirmed, final validation tables will be prepared for inclusion in reports. All edits are reviewed by the initial Data Validator, as well as peer reviewed by the QA Oversight Manager. This stage also reveals and resolves any EDD to hardcopy data discrepancies. After review and approval of the final data validation tables by the QA Oversight Manager, the data are assigned a status of “VALIDATED” by a Data Processor.

The associated plant-specific QAPP and/or the investigation-specific SAPs detail the sample program specific goals for the timeline of activities such as validation.

3.6 EQuIS Reports

Reports are available to users through EQuIS Professional or EQuIS Enterprise. Standard EQuIS reports and a summary of their purposes are detailed in Appendix C.

3.7 Management of Historical Data

As indicated in Section 1.2, there have been prior sampling events at TVA facilities that generated historical data. Managing historical data from these investigations is complicated by the fact that the agencies and contractors performing the investigations used different methods for sampling and analysis. In addition, the historical data may not have complete laboratory reports that allow proper verification/validation of the data. To manage historical data in a manner that addresses the variety of types, sources, and formats, as well as concerns regarding data validation, the following procedures will be implemented.

Electronic data received from other consultants may be migrated to EQDMS. The migration steps include matching up the historical fields with the fields in EQDMS, appending the historical data into the previously determined EQDMS fields, and running error checks on the newly appended data. If questions arise, the previous consultants are contacted for data clarifications. The data migration steps, such as field matching and changes made, are documented for future reference.

If only hardcopy files exist for desired results, these files may be used to perform manual entry of data into EQDMS. Any data requiring manual entry are checked by a second person for correctness of the entry.

Depending on the source and reliability of the historical data, data will be marked reportable or non-reportable. Reportable data are data deemed appropriate for quantitative use. Non-reportable data are deemed to be of unknown quality and may be used for qualitative purposes only. Historical data will be reviewed and assessed for potential quantitative or qualitative use following the procedures described in Section 14.0 of the associated plant-specific QAPP. Data are loaded into the database with an unclassified status, and updated to a status of “FINAL-NOT QCd” or another relevant status based upon the data quality and review.

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 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. After undergoing the review process described in the plant-specific QAPP, the data are marked appropriately within the EQDMS (*i.e.*, data deemed appropriate for quantitative use are marked as reportable and data deemed of unknown quality and or appropriate for qualitative use only are marked as non-reportable. Non-reportable results remain in EQDMS and can be queried, but are not included in standard reports. Custom reports can be created for non-reportable historical data, but users are cautioned about the undetermined reliability of the data.

3.8 Documenting and Communicating Changes to Reported Data

3.8.1 Communication of Issue

Errors in reported data are typically found by the data user or an individual working as part of the data management team. It is the responsibility of the individual to correctly identify and report an error in data stored in the EQDMS. An individual on the project team (a stakeholder) who identifies a need to change data must send an e-mail to a Data Manager describing the requested data change and providing supporting documentation. Any individual requesting a changed to data in the EQDMS is referred to as the Data Change Requestor in the subsequent sections. The Data Change Request Workflow Diagram presented in Appendix D illustrates the process for managing changes to reported data.

3.8.2 Completion of the Data Change Request Form

A Data Manager is responsible for reviewing the request and initiating a Data Change Request Form. An example Data Change Request Form is presented in Appendix E. Completion of the Data Change Request Form is essential to ensuring that the appropriate procedures and approvals are in place prior to initiating any changes and/or updates to the data reported in the EQDMS. The form contains essential information pertaining to the request itself, the origin of the request, the solution applied, contact information and signatures upon the approval and completion of the task. The Data Change Request Form shall be completed by the Data Manager with information from the Data Change Requestor. Additionally, the Data Change Request Form requires signatures by the QA Oversight Manager, the Data Manager, and the Data Change Requestor.

The Data Manager shall complete the Data Change Request Form prior to the approval and initiation of any changes and/or updates to the data already loaded to the EQDMS. The following sections of the Data Change Request Form shall be completed in full:

- Date: Date of the request as initiated by the Data Change Requestor
- Proposed Completion Date: Tentative date of completion as identified by the Data Requestor

- Name: Data Change Requestor
- Company: Data Change Requestor’s company
- Phone/E-mail: Contact information of the Data Change Requestor
- Description of Request: A detailed summary outlining the request along with its origin and purpose
- Required Signatures: the printed name, signature and date signed of the:
    - Data Manager
    - QA Oversight Manager
    - Data Change Requestor

3.8.3 Communication and Approval Process for Data Change Request Form

The following steps are performed when communicating and approving the Data Change Request Form.

- The Data Manager complete the Data Change Request Form in its entirety as detailed above. A brief description of the resolution shall be provided in the section for use by the Data Project Manager.
- The Data Manager shall then request the review and confirmation of the Data Change Request Form by the Data Change Requestor.
- Upon approval of the Data Change Request Form, the Data Requestor will sign and date the form.
- The Data Manager will submit the Data Change Request Form to the QA Oversight Manager for review and signature.
- The Data Manager shall coordinate or perform the data change or update as requested. Upon resolution, the Data Manager shall sign and date the form.
- Once the Data Change Request Form is signed by all necessary parties, the Data Manager shall e-mail the approved Data Change Request Form, along with a report or query to confirm appropriate changes, to all stakeholders.
- Completed Data Change Request Forms will be posted on the KMP.

4.0 EQDMS DATA MANAGEMENT SYSTEM

This section provides an overview of the EQDMS and its components. This section also describes the specification for laboratory data submission and valid values.

4.1 EQDMS Overview

The EQDMS is composed of a commercially available environmental data management software suite, EQuIS, and can be supplemented and expanded using purpose-built QA Modules to work with the EQuIS software. The EQDMS has been configured to support project-specific requirements. The EQuIS software suite, which has been in use and continuously improved since 1994, is used on many environmental projects by industrial clients, consultants, and regulatory agencies at the state and federal levels. Functionality is provided on the internet for casual users and on the desktop for power users.

Software modules used on this project are described below.

4.1.1 EQuIS Enterprise Database

Analytical data, field data, and water level measurements are stored and hosted in a Microsoft® SQL database using the EQuIS Enterprise SQL server data schema. EQuIS connects to and accesses data using industry standard methodology. Security of the data is maintained using SQL server roles and assigning users appropriately.

4.1.2 COC Forms

COC forms for this project may be hand-written or generated utilizing an eCOC generator, if desired. The eCOC generator creates a unique COC ID and enables the Field Sampling Personnel to print COC forms. The eCOC is provided to the Data Project Manager to enter technical data into the EQDMS and could possibly include additional sampling event information, coordinate data and field measurements. The data generated from the eCOC are used to test analytical laboratory data for completeness and support status reports. The details for the specific data to be collected during sampling or other activities are detailed in investigation-specific SAPs, and related TIs.

4.1.3 EQuIS Enterprise Electronic Data Processor

The Enterprise electronic data processor (EDP) functionally enables loading of EDDs, testing against project specifications, and reporting the results of the testing to users. The rules and criteria built into the selected EDP Format are used to verify the correctness of EDDs.

4.1.4 Completeness Processor

The Completeness Processor assesses laboratory data within an SDG for the existence of project-specified data such as target analyte lists. Each SDG should represent a set of samples based on a COC form, each sample represents a set of analytical methods, and each analytical method represents a particular list of target analytes. MAGs are used to define required methods, analytes, fractions, and units. Completeness checks performed on data loaded into the EQDMS include:

- Confirming that all samples, analytical methods, and analytes requested on the COC/MAG are provided by the laboratory
- Confirming that no additional samples, analytical methods, or analytes are provided by the laboratory that were not planned
- Confirming that the following fields match identically between the planned and laboratory data:
  - Sample Names
  - Sample Matrix
  - Analytical Method
  - Fraction
  - Chemical Abstract Service (CAS) Registry Number
  - Result Units

4.1.5 Data Verification Module

The Environmental Standards Data Verification Module assesses loaded, correct, and complete data against project-specific QC limits for field and lab blank contamination, holding times, accuracy, precision, and surrogates. This functionality supports the project goals by automating a significant amount of manual effort in the quantitative assessment of analytical data.

4.1.6 EQuIS Enterprise

Enterprise is a web-based portal for visualization and generating pre-defined reports on demand. This function is ideally suited for casual users with a need to access project data in a simplified way and build simple reports. Users may run reports with defined parameters selected and save those settings for future uses as a “Pick Report.” Pick Reports can be scheduled for automated processing based on pre-defined triggers, the arrival of an EDD, or on a schedule such as a day of the week. Output from this reporting function can be a spreadsheet, a PDF, or a complex formatted deliverable such as an Excel® file that auto-formats based on selections.

4.1.7 EQuIS Professional

EQuIS Professional is a desktop application that is designed for more technical users. It has the capability to perform the same reporting functions as seen in Enterprise, but can additionally design, build, and publish Enterprise reports. This application enhances decision support by enabling links to analysis and visualization functions that can create crosstab tables, graphs, and statistical output. EQuIS Professional can also interface with third-party tools such as gINT®, Rockworks®, EVS®, Visual Modflow®, and Excel.

4.2 Electronic Data Deliverable Specification

The EQDMS can import EDDs in a wide variety of formats. The standard EQuIS EQEDD is used for submittal of all recent data by analytical laboratories. Laboratories are required to submit EDDs in accordance with the EQEDD Format provided in Appendix B.

5.0 SYSTEMS MANAGEMENT AND ADMINISTRATION

This section describes how the EQDMS is managed and administrated. Database Administration includes:

- Adding, altering, and deleting users, roles, and privileges; and
- Providing for routine backup of the database.

5.1 Access and Security

The EQDMS uses application-level and database-level security to limit access to system functionality. Users are required to log onto the system in order to gain entry into the application. The Data Management team has defined privileges based on roles while other users, such as data analysts and other data users have read-only privileges to the project data and read/write privileges to their personal reports. User accounts and privileges are maintained by the Technical Support Manager and approved by a Data Manager.

5.2 Data Backup

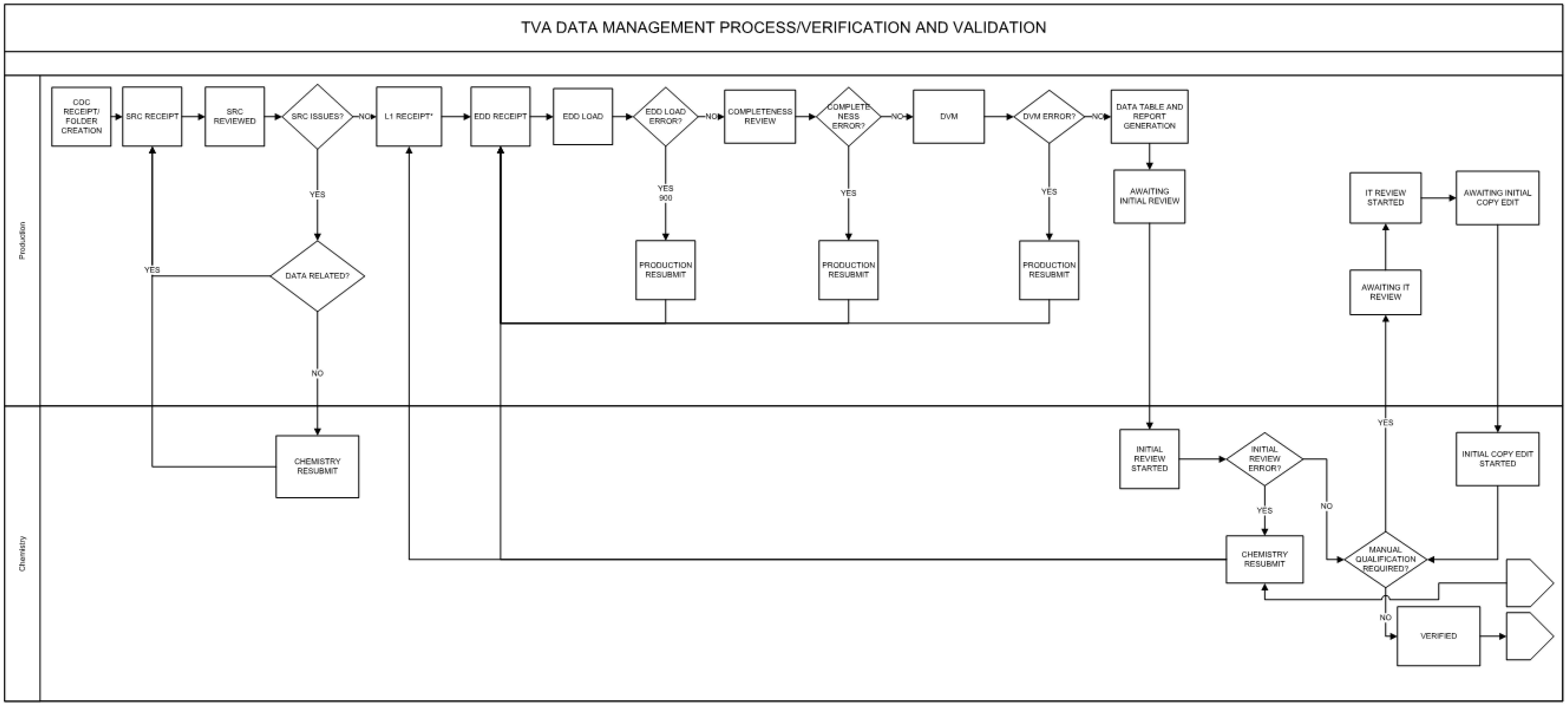
Automated full backups of the EQDMS are performed daily, and automated incremental backups of transactions are performed every 15 minutes to safeguard that any potential data loss is limited. An incremental daily backup is archived every night and retained for 30 days. A full weekly backup is archived and retained for 2 months. Monthly full backups are archived and retained for 40 years. Backups are written to digital tapes and are stored the next business day in an off-site environmentally controlled storage facility.

6.0 REFERENCES

- 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 05.80.06 Handling and Shipping of Samples

APPENDIX A

DATA MANAGEMENT WORKFLOW DIAGRAMS



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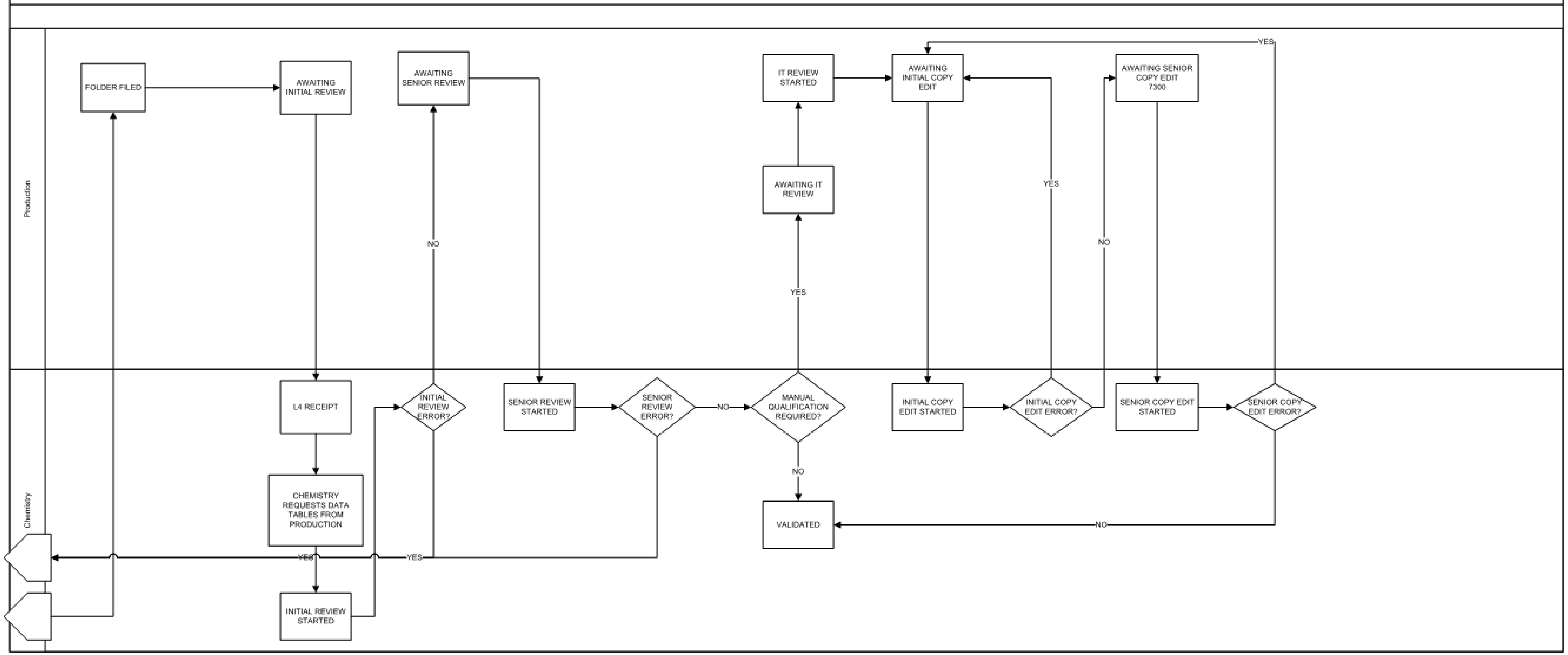
TVA DATA MANAGEMENT PROCESS/VERIFICATION AND VALIDATION (CONT)



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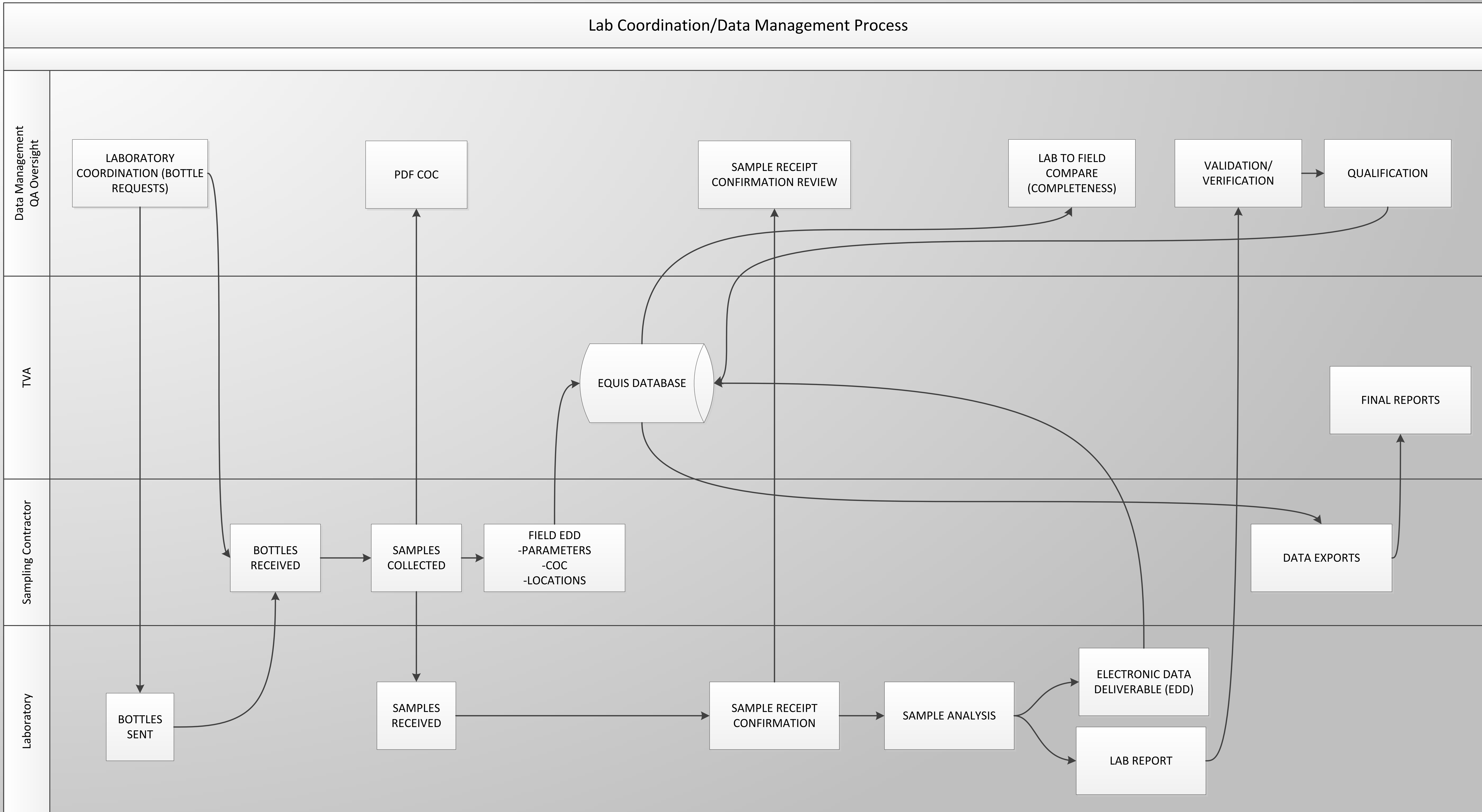

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APPENDIX B

EQUIS EDD SPECIFICATIONS

ENVIRONMENTAL STANDARDS

EQuIS EQEDD Laboratory EDD Specifications

November 2017

INTRODUCTION

The purpose of this document is to describe the processing of the laboratory data and provides the required specifications of the electronic data deliverable (EDD).

FILE FORMAT

All data from the field must be stored in an ASCII file using a tab-delimited standard format. Maximum length of text fields is indicated in the parentheses. If the information is less than the maximum length, do not pad the record with spaces.

Each record must be terminated with a carriage return/line feed (*i.e.,* standard DOS text file). The file can be produced using any software with the capability to create ASCII files. Date is reported as MM/DD/YYYY (month/day/year) and time as HH:MM (hour: minute). Time uses a 24-hour clock, thus 3:30 p.m. will be reported as 15:30.

Each record in an import file must have one or more fields with values that make the row unique. These fields are indicated in the “PRIMARY KEY?” column. Required fields are indicated in the “REQUIRED?” column.

NULL FORMAT

Some fields in the EDD are optional or only required “when applicable.” When a field is not listed as required, this means that a null or blank may be appropriate. However, the blank value must still be surrounded by tabs. In other words, the number of fields is always the same, whether or not the fields include data.

NAMING CONVENTION

The filename extensions are used to indicate the file type as follows:

Type of Rows	File Name
Lab Sample	LabSample._v1.txt
Test & Results	TestResultsQC_v1.txt
Test Batch	TestBatch_v1.txt

FILE DELIVERY

All EDD deliverables must be sent in a zip file containing the EDD files listed above. The zipped file must be named using the following naming convention:

- *SDG*.FACILITYCODE.EQEDD.zip

EDD SPECIFICATION

LabSample_v1

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	sys_sample_code	Text(40)	Y	PK		Unique sample identifier.
	sample_name	Text(50)				Additional sample identification information as necessary.
	sample_matrix_code	Text(10)	Y		RVF	Code which distinguishes between different of sample matrix types.
	sample_type_code	Text(20)	Y		RVF	Code which distinguishes between different types of samples.
	sample_source	Text(10)	Y		ENUM	This field identifies where the sample came from, either field or laboratory.
	parent_sample_code	Text(40)				The value of "sys_sample_code" that uniquely identifies the sample that was the source of this sample.
	sample_delivery_group	Text(20)				The sampling event with which the sample is associated.
	sample_date	DateTime	Y			Date and time sample was collected (in MM/DD/YYYY HH:MM format for EDD).
	sys_loc_code	Text(20)				Soil boring or well installation location.
	start_depth	Numeric				Beginning depth (top) of sample in feet below ground surface.

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	end_depth	Numeric				Ending depth (top) of sample in feet below ground surface.
	depth_unit	Text(15)			RVF	Unit of measurement for the sample begin and end depths.
	chain_of_custody	Text(40)				Chain-of-Custody identifier. A single sample may be assigned to only one Chain-of-Custody.
	sent_to_lab_date	DateTime				Date sample was sent to laboratory (in MM/DD/YYYY format for EDD).
	sample_receipt_date	DateTime				Date that sample was received at laboratory (in MM/DD/YYYY format for EDD).
	sampler	Text(50)				Name or initials of sampler.
	sampling_company_code	Text(40)	Y		RVF	Name or initials of sampling company (not controlled vocabulary).
	sampling_reason	Text(30)				
	sampling_method	Text(40)				Sampling method.
	task_code	Text(40)				Code used to identify the task under which the field sample was retrieved.
	collection_quarter	Text(5)				Format: YYQ# where YY is year and # is 1, 2, 3, or 4 representing the quarter.

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	composite_yn	Text(1)	Y		ENUM	Is sample a composite sample? 'Y' for yes or 'N' for no.
	composite_desc	Text(255)				Description of composite sample (if composite_yn is 'Yes').
	sample_class	Text(10)				Report as null.
	custom_field_1	Text(255)				Report as null.
	custom_field_2	Text(255)				Report as null.
	custom_field_3	Text(255)				Report as null.
	comment	Text(2000)				Comment.

TestResultsQC_v1

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	sys_sample_code	Text(40)	Y	PK		Unique sample identifier.
	lab_anl_method_name	Text(20)	Y	PK	RVF	Laboratory analytical method name or description.
	analysis_date	DateTime	Y	PK		Date and time of sample analysis in 'MM/DD/YYYY HH:MM' format.
	total_or_dissolved	Text(10)	Y	PK	RVF	Must be either 'D' for dissolved or filtered [metal] concentration, 'T' for total or undissolved, or "N" for everything else.
	column_number	Text(2)				Values include either '1C' for first-column analyses, '2C' for second-column analyses, or 'NA' for tests for which this distinction is not applicable.
	test_type	Text(10)	Y	PK	RVF	Type of test.
	lab_matrix_code	Text(10)			RVF	Code which distinguishes the type of sample matrix.
	analysis_location	Text(2)	Y		ENUM	Must be either 'FI' for field instrument or probe, 'FL' for mobile field laboratory analysis, or 'LB' for fixed based laboratory analysis.
	basis	Text(10)	Y		ENUM	Must be either 'Wet' for wet-weight basis reporting, 'Dry' for

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
						dry-weight basis reporting, or 'NA' for tests for which this distinction is not applicable.
	container_id	Text(30)				Report as null.
	dilution_factor	Numeric				Effective test dilution factor.
	prep_method	Text(20)			RVF	Laboratory sample preparation method name or description.
	prep_date	DateTime				Beginning date and time of sample preparation in 'MM/DD/YYYY HH:MM' format.
	leachate_method	Text(15)				Laboratory leachate generation method name or description.
	leachate_date	DateTime				Beginning date and time of leachate preparation in 'MM/DD/YYYY HH:MM' format.
	lab_name_code	Text(20)			RVF	Unique identifier of the laboratory.
	qc_level	Text(10)			ENUM	May be either 'screen' or 'quant'.
	lab_sample_id	Text(20)				Laboratory LIMS sample identifier.
	percent_moisture	Text(5)				Percent moisture of the sample portion used in this test.
	subsample_amount	Text(14)				Amount of sample used for test.
	subsample_amount_unit	Text(15)			RVF	Unit of measurement for

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
						subsample amount.
	analyst_name	Text(50)				
	instrument_id	Text(60)				Instrument identifier.
	comment	Text(2000)				Comments about the test.
	preservative	Text(20)			RVF	Sample preservative used.
	final_volume	Numeric				The final volume of the sample after sample preparation. Include all dilution factors.
	final_volume_unit	Text(15)			RVF	The unit of measure that corresponds to the final volume.
	cas_rn	Text(15)	Y	PK	RVF	Use values in analyte valid value table.
	chemical_name	Text(255)	Y			Use the name in the analyte valid value table.
	result_value	Numeric				Analytical result reported at an appropriate number of significant digits. May be blank for non-detects.
	result_error_delta	Text(20)				Error range applicable to the result value; typically used only for radiochemistry results.
	result_type_code	Text(10)	Y		RVF	Must be either 'TRG' for a target or regular result, 'TIC' for tentatively identified compounds, 'SUR' for surrogates, 'IS' for internal standards, or

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
						'SC' for spiked compounds.
	reportable_result	Text(10)	Y		ENUM	Must be either 'Yes' for results which are considered to be reportable, or 'No' for other results.
	detect_flag	Text(2)	Y		ENUM	May be either 'Y' for detected analytes, 'N' for non-detects or 'TR' for trace.
	lab_qualifiers	Text(20)				Qualifier flags assigned by the laboratory.
	validator_qualifiers	Text(20)				Qualifier flags assigned by the validation firm.
	interpreted_qualifiers	Text(20)			RVF	Qualifier flags assigned by the validation firm.
	organic_yn	Text(1)	Y		ENUM	Must be either 'Y' for organic constituents, or 'N' for inorganic constituents.
	method_detection_limit	Text(20)				Method detection limit.
	reporting_detection_limit	Numeric				Concentration level above which results can be quantified with confidence.
	quantitation_limit	Text(20)				Concentration level above which results can be quantified with confidence.
	result_unit	Text(15)			RVF	Unit of measurement for the result.
	detection_limit_unit	Text(15)			RVF	Unit of measurement for the detection limit(s).

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	tic_retention_time	Text(8)				Retention time in seconds for tentatively identified compounds.
	result_comment	Text(2000)				Result-specific comments.
	lab_sdg	Text(20)				Sample Delivery Group (SDG) identifier.
	qc_original_conc	Numeric				The concentration of the analyte in the original (un-spiked) sample.
	qc_spike_added	Numeric				The concentration of the analyte added to the original sample.
	qc_spike_measured	Numeric				The measured concentration of the analyte.
	qc_spike_recovery	Numeric				The percent recovery calculated as specified by the laboratory QC program.
	qc_dup_original_conc	Numeric				The concentration of the analyte in the original (un-spiked) sample.
	qc_dup_spike_added	Numeric				The concentration of the analyte added to the original sample.
	qc_dup_spike_measured	Numeric				The measured concentration of the analyte in the duplicate.
	qc_dup_spike_recovery	Numeric				The duplicate percent recovery calculated.
	qc_rpd	Text(8)				The relative percent difference calculated.

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	qc_spike_lcl	Text(8)				Lower control limit for spike recovery.
	qc_spike_ucl	Text(8)				Upper control limit for spike recovery.
	qc_rpd_cl	Text(8)				Relative percent difference control limit.
	qc_spike_status	Text(10)			ENUM	Used to indicate whether the spike recovery was within control limits.
	qc_dup_spike_status	Text(10)			ENUM	Used to indicate whether the duplicate spike recovery was within control limits.
	qc_rpd_status	Text(10)			ENUM	Used to indicate whether the relative percent difference was within control limits.

TestBatch_v1

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	sys_sample_code	Text(40)		PK		Unique sample identifier.
	lab_anl_method_name	Text(20)		PK	RVF	Laboratory analytical method name or description.
	analysis_date	DateTime		PK		Date and time of sample analysis in 'MM/DD/YYYY HH:MM' format.
	total_or_dissolved	Text(10)		PK	RVF	Must be either 'D' for dissolved or filtered [metal] concentration, 'T' for total or undissolved, or "N" for everything else.
	column_number	Text(2)				Values include either '1C' for first-column analyses, '2C' for second-column analyses, or 'NA' for tests for which this distinction is not applicable.
	test_type	Text(10)		PK	RVF	Type of test.
	test_batch_type	Text(10)	Y	PK	RVF	Laboratory batch type. Valid values include 'Prep', 'Analysis', and 'Leach'. This is a required field for all batches.
	test_batch_id	Text(20)	Y			Unique identifier for all laboratory batches.

“REQUIRED WHEN APPLICABLE” FIELDS

Some “Required When Applicable” fields are data driven and are, therefore, not listed below.

SAMPLE LEVEL

	BD	BS	EB	FB	FD	LB	LD	LR	MB	MS	N	RB	SD	TB
PARENT_SAMPLE_CODE	X				X		X	X		X			X	
SAMPLE_DATE			X	X	X					X	X	X	X	X
SAMPLE_TIME			X	X	X					X	X	X	X	X
SAMPLE_RECEIPT_DATE			X	X	X					X	X	X	X	X
SAMPLE_RECEIPT_TIME			X	X	X					X	X	X	X	X

RESULT LEVEL-TARGET & SPIKED RESULTS (TRG & SC)

	BD	BS	EB	FB	FD	LB	LD	LR	MB	MS	N	RB	SD	TB
QC_ORIGINAL_CONC		X			X			X		X				
QC_SPIKE_ADDED		X								X				
QC_SPIKE_MEASURED		X								X				
QC_SPIKE_RECOVERY		X								X				
QC_DUP_ORIGINAL_CONC													X	
QC_DUP_SPIKE_ADDED													X	
QC_DUP_SPIKE_MEASURED	X												X	
QC_DUP_SPIKE_RECOVERY	X												X	
QC_RPD	X							X					X	

RESULT LEVEL-SURROGATE RESULTS (SUR)

	BD	BS	EB	FB	FD	LB	LD	LR	MB	MS	N	RB	SD	TB
QC_SPIKE_ADDED		X	X	X		X		X	X	X	X	X		X
QC_SPIKE_MEASURED		X	X	X		X		X	X	X	X	X		X
QC_SPIKE_RECOVERY		X	X	X		X		X	X	X	X	X		X
QC_DUP_SPIKE_ADDED	X												X	
QC_DUP_SPIKE_MEASURED	X												X	
QC_DUP_SPIKE_RECOVERY	X												X	

APPENDIX C

EQUIS STANDARD REPORTS

EQuIS Standard Reports

Novemberr 2017

Introduction

The purpose of this document is to describe the standard reports provided with EQuIS version 6.6.

Action Level Reports

Action Level Exceedance

The Action Level Exceedance Report compares values from a saved Analytical Results Report against one or more action levels (*e.g.*, regulatory limits).

Action Level Exceedance (by EDD)

This version of the Action Level Exceedance Report is used for checking exceedances within an EDD (instead of within a saved report), and is commonly used as an Environmental Information Agent (EIA), or trigger, within EQuIS Enterprise

Analyte Exceedance (Over Time)

The Analyte Exceedance Report provides a simple way to find results for a chemical that exceeds a specified value.

Action Level Exceedance II by EDD

This version of the Action Level Exceedance II Report is used for checking exceedances within an EDD (instead of within a saved report), and is commonly used as an Environmental Information Agent (EIA), or trigger, within EQuIS Enterprise

Action Level Exceedance II by User Report

This report allows you to run an Action Level Exceedance Report by selecting a saved user report as well as the additional action level parameters.

Action Level Exceedance II - Percent Variance

The Action Level Exceedance II - Percent Variance Report is designed to flag analytical results within a given EDD that vary by more than the listed percentage from the historical average for each chemical and location

Action Level Exceedance II with Parameters

The Action Level Exceedance II with Parameters Report displays all of the parameters from the Analytical Results II Report, thus allowing you to create the Analytical Results Report and the Action Level Exceedance Report together (displayed once in the Action Level Exceedance format).

Action Level Exceedance Format I

The Action Level Exceedance Format I Report generates a report with or without action level exceedances. Its row headers are Constituent, action levels and units. Its column headers are

Location ID, Sample Date, Sample Time, Sampled Interval, Sample ID, Laboratory and Lab. Number. It can report up to a maximum of three action level codes. The units of action levels can be used as final units of the report. Checking results against summed action levels can be done in the report. It is a class report based on the Analytical Results II Report.

Action Level Exceedance Format III

The Action Level Exceedance Format III Report generates cross-tabbed analytic results with or without action level exceedances. The row headers are Analyte, Units, Limits, and action levels, if selected. Its column headers are Station ID, Sample ID, Matrix, and Sample Date. This allows you to add lab qualifiers after results and export RT_QUALIFIER.REMARK as a footnote. Two types of action level comparisons are possible.

ALE II Crosstab - Row-based

The report generates cross-tabbed analytic results with or without action level exceedances.

ALE II Crosstab - Column-based

The report generates cross-tabbed analytic results with or without action level exceedances

Analytical Results Reports

Analytical and Water Results

Analytical and Water Results runs the Analytical Results II* and Water Level (Extra Fields) reports, and combines the output rows so the water level data are reported as CAS_RN results. This enables direct comparison in crosstab reports.

Analytical Results by EDDs

The Analytical Results by EDDs Report is an advanced version of the Analytical Results II* Report. This report includes a new group of input parameters, "EDD." If the "Use EDD Date Range" input parameter is checked, the date range specified in the EDD input parameter group will override the date range specified in the Sample input parameter group. The EDD date range will query Analytical Results on the dates the results were loaded to EQuIS.

Analytical Results Crosstab (Chemicals by Location)

This report creates a Crosstab Report in Microsoft Excel that displays location, sample date and sample type as column headers, and chemicals as row headers.

Analytical Results (Extra Fields)

It provides "additional fields" for users to select extra fields, except for all the fields of the Analytical Results.

Analytical Results (QC)

This report is identical to the Analytical Results Report, except it also includes all of the DT_RESULT_QC fields in the output. The report is designed for users that need to report QC information.

Analytical Results with Sample Parameter (Table)

The Analytical Results with Sample Parameter (Table) Report combines the Analytical Results Report and the Sample Parameter Report

Analytical Results II

The core function for reporting analytical data in EQuIS Professional. You can execute this function standalone and also use it within several other reports.

Analytical Results II - No Sample Taken

The sample must still satisfy the defined parameters (date range, sample type, *etc*.). All of the other parameters are related to samples/test/results (date range, sample type, *etc*.). This report also includes sample data, even if that sample does not have any tests/results

Basic Results Profile

The Basic Results Profile is a result of cross tabbing the Basic Results Report so that the measured results of chemicals vs. their sampling dates and depths can easily be read. The results of each location are placed in their own Excel worksheet.

Basic Results II

In addition to reporting the content of DT_BASIC_RESULT, the Basic Results II Report also provides measured results with unit conversion, if users provide a unit over the user interface.

Gauging and Analytical Report

This report creates a Crosstab Report in Microsoft Excel. The columns include water level (i.e. gauging data) information, followed by the selected analytes.

Database Tables Tools

Client Metrics Report

The Client Metrics Report summarizes how many records are available in several main tables, and how many total records in DT_/AT_/RT_ tables of each facility listed in DT_FACILITY are in the EQuIS database, and the number of records in the tables without the FACILITY_ID field in DT_/AT_/RT_ tables

Database Diagnostics

Database Diagnostics Report provides information on the owner, type and CREATED_DATETIME of a selected object or the name, owner, and type of all objects in the database if you do not select a specific object.

EQuIS Data Audit

The report reports the questionable (location, sample, test, result and reference *etc.*) data information under the facilities and/or the locations that are involved in checking items.

EQuIS Enterprise Report Usage

The EQuIS Enterprise Report Usage Report generates a report on the information of users and the report names used during a range of date

Reference Values

A report that lists all the reference values with a status flag of “R” in all reference tables. This report exports all the reference tables to individual worksheets in Microsoft Excel. The worksheets are named for each reference table. You may select to export records with all or any specific individual status flags.

Table Row Counts

The Table Row Counts Report generates the total number of rows per table in the database (TOTAL_ROWS), the number of these rows in the current FACILITY_ID or facility group (IN_FACILITY), the number of reference values per reference table with STATUS_FLAG="A" and "R" (STATUS_FLAG_A and STATUS_FLAG_R, respectively).

EnviroInsite Reports

EnviroInsite Boring Log

This report creates a boring log in EnviroInsite according to the selected template file. The report queries the data in EQuIS, opens EnviroInsite and compiles the log

EnviroInsite Site Diagram

Site diagram report is an alternative report for the EnviroInsite Data Export. It is a simplified report that lets you automate steps in EnviroInsite to create tables, contours, etc.

EnviroInsite Spider Diagram

The EnviroInsite Spider Diagram Report allows you to create spider diagrams using EnviroInsite for data within EQuIS. Water Level and Analytical Results can be outputted as spider diagrams

Google Earth Reports

Google Earth 3D Action Levels

This report lets the user select a saved Analytical Results Report and an action level. The output of the report shows concentrations of each chemical represented as a vertical cylinder at each location. The height of the cylinder represents the amount of concentration (taller cylinders show greater amount of chemical).

Google Earth 3D Action Level Sample Parameters

This report lets you select a saved Sample Parameter Report, and an action level. The output of the report shows concentrations of each parameter represented as a vertical cylinder at each location. The height of the cylinder represents the parameter value (taller cylinders show greater value).

Google Earth 3D Analyte Aggregates

This report prompts you to select a saved Analytical Results Report. You then select whether you want to aggregate values by group or individual. You may also select the aggregate function you want to use (default is maximum). The report displays vertical cylinders representing the aggregate value at each location, along with a label showing the numeric value

Google Earth 3D Analytical Results (3D Cylinders)

This report prompts you to select a saved Analytical Results Report. The output of the report shows concentrations of each chemical represented as a vertical cylinder at each location. The height of the cylinder represents the amount of concentration (taller cylinders show greater amount of chemical). Each chemical is displayed in a different color. You can select which chemical to view by clicking in the circle next to the desired chemical name. This report includes data over the selected date range. You can drag the time slider, or press the Play button, to watch the values change over time

Google Earth 3D Basic Results (XYZ Plot)

This report is computationally intensive, and interpolates a unique grid for each parameter and date. For example, a site may have only 100 different records, but 25 different dates. In this case the report would interpolate 25 different grids, and potentially consume vast system resources. Please also note that there are limitations to the size and complexity of KML/KMZ files supported in Google Earth.

Google Earth Analytical Results (Aggregate) Pie Charts

The output of this report shows pie charts illustrating the sum of each of the chemicals. If you choose to aggregate by group, then the pie charts will show the sum of each group.

Google Earth Analytical Results (XYZ Plot)

This Google Earth Report uses a saved Analytical Results Pick Report as the primary input parameter. The Analytical Results output is exported into to a *.kmz, and separated by chemical with each sampling date. Multiple sampling dates can be displayed in animation using Google Earth's time animation bar.

Google Earth Location Parameter (XYZ Plot and Contour)

This report prompts you to select a date range and one (or more) location parameters. The output of this report shows values of each parameter represented as a three dimensional contour. The Places tree lists each parameter. Underneath each parameter there are folders for each of the days where values exist for that parameter. Values from each day are interpolated using a Nearest Neighbor algorithm. The interpolated values are then displayed using a color palette ranging from blue (low) to red (high). Each color in the palette is shown as a folder, so the user can check/uncheck that folder to show/hide values in that range.

Google Earth Locations

The purpose of this report is to show locations from an EQuIS facility in Google Earth. Each location is labeled with the DT_LOCATION.SYS_LOC_CODE. The Places tree in Google Earth groups each location by type (*i.e*. DT_LOCATION.LOC_TYPE). The report output can also include DT_LOCATION.LOC_DESC in the 'callout box' when a location is clicked

Google Earth Sample Parameters (3D Cylinders)

This report prompts you to select a saved Sample Parameter Report. The output of the report shows values of each parameter represented as a vertical cylinder at each sampling location. The height of the cylinder represents the parameter value (taller cylinders show greater values). Each parameter is displayed in a different color. You can select which parameter to view by clicking in the circle next to the desired parameter name.

This report includes data over the selected date range. You can drag the time slider or press the Play button to watch the values change over time.

Google Earth Water Levels (3D Cylinders)

This report prompts you to select a saved Water Level Report.

The output of the report shows the water level as a vertical cylinder at each location. The height of the cylinder represents the water level (taller cylinders show greater water elevation).

This report includes data over the selected date range. You can drag the time slider or press the Play button to watch the values change over time.

Google Earth Water Levels (XYZ Plot)

The output of this report shows the water level represented as a three dimensional contour. The Places tree contains folders for each of the days on which water level measurements exist. Values from each day are interpolated using a Nearest Neighbor algorithm. The interpolated values are then displayed using a color palette ranging from blue (low) to red (high). Each color in the palette is shown as a folder, so the user can check/uncheck that folder to show/hide values in that range.

In addition to the color palette, the elevation of each point (distance from the ground) represents the relative value to other points. For example, the lower valued points are close to the ground; whereas the higher valued points are farther above the ground. This relative distance from the ground makes it possible to view a 2D contour (by reducing the tilt in Google Earth to look straight down from above) or to view a 3D surface (by increasing the tilt in Google Earth to look from the side).

This report includes data over the selected date range. You can drag the time slider, or press the Play button, to watch the values change over time. The report provides the option to create Contours, Color grids, Dot Plots or Surface Plots.

Google Earth Weather - Wind Speed and Direction

This report creates an animated "wind sock" at each location. The sock (*i.e*. red line) points in the direction the wind is blowing and the length of the sock indicates the relative wind speed. This report includes data over the selected date range. You can drag the time slider, or press the Play button, to watch the values change over time.

Location Parameter Reports

Location Information

The Location Information Report is the class report based off of the database procedure Location Information Report. It provides metadata about sample locations (wells, boreholes, *etc.*), including the matrices by which locations have been sampled as well as the screened interval.

Location Parameter “Real Time” Ticker Charts

This report creates ticker charts based on location parameter data.
This report is deployed as a web page and requires EQuIS Enterprise.

Location Parameter Exceedance

The report compares PARAM_VALUE of DT_LOCATION_PARAMETER with a value provided over the user interface and generates an exceedance report. It calls the Location Parameters report

Location Parameters

Location Parameter Standard Report has been improved to fill non-numeric results as PARAM_TEXT in their respective outputs.

Location Parameters (Action Level Exceedance)

This report checks PARAM_VALUE of the Location Parameters report against the action levels of the Action Levels Report and then generates an Action Level Exceedance Report.

Location Parameters (Extra Fields)

The Location Parameters (Extra Fields) Report generates the location parameter information from DT_LOCATION_PARAMETER and other selectable fields from DT_FACILITY, DT_LOCATION_PARAMETER, DT_PRECIPITATION, VW_LOCATION and VW_WELL

Location Parameters (Most Recent)

The Location Parameters (Most Recent) Report compiles the PARAM_VALUES along with other parameters in DT_LOCATION_PARAMETER that are obtained most recently. It uses the Location Parameters Report

Location Parameters (Rollup)

The Location Parameters (Rollup) Report compiles the hourly, daily, weekly or monthly average values of PARAM_VALUES in DT_LOCATION_PARAMETER based on selected parameters. It uses the Location Parameters Report

Sample Parameter Reports

Analytical Results with Sample Parameter (Tables)

The Analytical Results with Sample Parameter (Table) Report combines the Analytical Results Report and the Sample Parameter Report.

Sample Parameters

This report queries data from the DT_SAMPLE_PARAMETER table. The Sample Parameter standard report has been improved to fill non-numeric results as PARAM_TEXT in their respective outputs

Sample Parameters (Action Level Exceedance)

The Sample Parameters (Action Level Exceedance) Report is similar to the Sample Parameters (Exceedance) Report with the exception that it uses a saved Sample Parameters Report, action levels from DT_ACTION_LEVEL and DT_ACTION_LEVEL_PARAMETER rather than a user-entered action level value over the user interface, and more output fields.

Sample Parameters (Exceedance)

The Sample Parameters (Exceedance) Report examines PARAM_VALUES of DT_SAMPLE_PARAMETER a user-entered action level value over the user interface and generates a report with exceedances.

Sample Parameters (Extra Fields)

This report adds the functionality of reporting more selective fields.

Sample Parameters (Most Recent)

Sample Parameters (Most Recent) II Report compiles the PARAM_VALUE along with other parameters in DT_SAMPLE_PARAMETER that are obtained most recently.
Sample Parameters (Most Recent) II

It compiles the PARAM_VALUE along with other parameters in DT_SAMPLE_PARAMETER that are obtained the most recently. It uses the Sample Parameters (Extra Fields) Report to get raw data.

Statistics Reports

Analytical Results – Statistics

The Analytical Results (Statistics) Report is a new report based from the standard Analytical Results (Aggregate) Report. It computes various statistical functions not found in the aggregate report, namely: minimum, maximum, mean, median, sum, standard deviation, variance, skewness, Mann-Kendall S, Sen slope, confidence (90%, 95%, 99%, and 95%) and 95% Student's-t UCL (UCL = mean + student_t *sd/n).

Analytical Results with Sample Calculations

The Analytical Results with Sample Calculations (Table) Report generates the results of the Analytical Results, and the results from the calculations of balance and summation of the results of the Analytical Results.

Analytical Statistics

This report allows you to compare results to historical data from the specified statistical date range. It includes the option to highlight exceedances and results that fall outside the range of the historical values as well as display the information in graphical form.

ChemStat Report

The ChemStat Report generates a table that presents a statistical analysis for the selected analytes. The report summarizes the entire dataset into a single table with the rows representing each analyte in the dataset, and the columns representing the summary statistics. It allows you to focus in on those analytes and use the spatial and temporal querying tools provided, to understand what is going on. It does not show the report by location or by sample, but allows you to easily identify what analytes exceed the LOD and Action Levels, and the statistics associated with these exceedances. It uses Analytical Results report to get source data

Facility Results II

Facility Results II provides a broad overview of the analytical result information for the selected locations, along with the sample depth and screened interval

Facility Samples (Summary by EDD Date)

For all facilities which the user is subscribed to, this report will return the date of the most recent sample entered, the number of samples within the date range, and the number of samples that have been loaded year-to-date

Flow Rate

The Flow Rate Report calculates the volumes and rates of instant flow and cumulative flow per selected time interval based on the data from DT_FLOW. It also compares flow rate (for Flow-Inst) or flow volume (for Flow-Daily etc.) to action levels, if action level data are provided.

Lithology Summary

The Lithology Summary Report generates a table that summarizes maximum depths, minimum depths, maximum thicknesses and minimum thicknesses of each GEO_UNIT_CODE1 of location groups

Location Analyte Review

This report creates a Crosstab Report in Microsoft Excel that displays summary information about which locations have been sampled for specific chemicals during the specified date range. The report also indicates whether the chemical was detected or not.

Relative Percent Difference

The Relative Percent Difference Report (RDP) determines the difference between analytical results reported in primary, duplicate, and triplicate samples

Relative Percent Difference II

Relative Percent Difference II Report (RDP) determines the difference between analytical results reported in primary, duplicate, and triplicate samples.

Relative Percent Difference III

The Relative Percent Difference III Report determines the difference between analytical results reported in primary, duplicate, and triplicate samples (SYS_SAMPLE_CODE) as defined by user selection.

Sample Summary by Analyte Group

The Sample Summary by Analyte Group Report generates analysis information of collected samples included in various groups of analytes. The analysis information is represented by a combination of x/X, e/E, s/S, t/T, a/A, z/Z, which marks a sample as detected/non-detected regular results as well as if the results use special leachate methods

Sanitas

The Sanitas Report generates necessary data used by the Sanitas statistics software

Statistics: Analytical Statistics (by Location)

The report generates the statistics information of Mean, UCL, Median, Standard Deviation, Coefficient of Variation, Skewness, Minimum, Maximum, Count (n), Mann-Kendall S, Trend analysis (at 80% confidence, 90% confidence, 95% confidence, 99% confidence) and Sen Slope based on a saved Analytical Results Report.

Statistics: Analyte by Sample (Lithology)

This report creates a Crosstab Report in Microsoft Excel that displays lithology samples down the side, and analytes across the top. Below the crosstab are summary statistics for each analyte. The report can also report action level violations if the Action Level input is selected.

Statistics: Samples, Statistics and Exceedances

This report creates a Crosstab Report in Microsoft Excel that displays samples down the side, and analytes across the top. Below the crosstab are summary statistics for each analyte. This report is similar to “Statistics: Analyte by Sample (Lithology)” with the exception that it does not have the information on the depths of lithology.

Statistics: Samples, Statistics and Exceedances of Each Location

The report lists sample values and calculates the statistics, such as the Number of Samples, the Number of Detects, Maximum, Mean, 95% UCL, and Minimum and Standard Deviation based on a saved Analytical Results Report. The report can also report action level exceedances, if the Action Level input is selected.

Water Level Reports

Water Level Report Basics

The Water Level Reports return the field measured water level elevations as stored directly in EQuIS or as calculated or estimated water level elevation based on user inputs if LNAPL thickness and density are stored in the database

Non-Detect Trend Report

The Non-Detect Trend Report produces an Excel spreadsheet that includes non-detects and detects as trend lines for multiple compounds

LNAPL Column Report

The LNAPL Column Report creates a visual display of daily LNAPL thickness and water levels in the selected wells. A series of wells are presented on a single MS Excel Column chart that displays the depth of air (white), LNAPL (brown), and water (blue). The vertical extent of each column represents the total depth of the well. The locations are organized in both alphanumeric and chronological order

Water Level Aggregate vs Location Plot (2d, 3d, or Bubble)

Water Level Aggregate vs. Location Plot (2d, 3d, or Bubble) generates surface 2d contours, surface 3d contours, and bubble charts of an aggregation (max, min, avg, or sum) of the water level vs locations.

Water Level Elevation Trend Plot

Water level Trend Plot Report generates charts of water level elevations. In addition, an analyte can be added to water level charts. It uses Water Levels report and Analytical Results report to retrieve source data

Water Level Information

The Water Level Info Report generates water level (DT_WATER_LEVEL.EXACT_ELEV) data of selected locations in the form of graphs, plus other location information such as well diameter, installation date, top of casing, depth, purpose and owner.

Water Levels

The Water Levels Report conveys information about water levels, LNAPLs, and DNAPLs stored in the DT_WATER_LEVEL table. This report uses specific logic for computing the corrected water level elevation based on input parameters selected by the user

Water Levels (Extra Fields)

The Water Levels (Extra Fields) Report generates water level information. It is an improved Class Report version of the Water Levels (EQuIS func) Report. The Water Levels Report conveys information about water levels, LNAPLs, and DNAPLs stored in the DT_WATER_LEVEL table. This report uses specific logic for computing the corrected water level elevation based on input parameters selected by the user.

Water Levels (Most Recent)

The Water Levels (Most Recent) Report uses the Water Levels report to show the most recent water level elevation for each location

Contact List Export

Export EQuIS st_user, dt_person, and rt_company information as a contact list suitable for import to eMail or Client Resource Management (CrM) system.

Downhole Point Parameters

This report converts the downwhole point parameter values into numeric values and allows you to plot the parameters in an x-y chart, and save a template

Execute Scheduled Report

The "Execute Scheduled Report" report allows you to run a scheduled EIA Report. You choose which scheduled EIA to run, then click the Go button. There is no output for the report, it simply tells workflow to start the scheduled report now instead of waiting for the scheduled time. The report will continue to run on the originally designated schedule.

Facility Detects by Chemical

This report uses Analytical Results as input and performs a crosstab that counts the number of detects for each chemical across the entire facility.

Facility Parameters

The Facility Parameters Report generates the facility parameter information from DT_FACILITY_PARAMETER and other selectable fields

License Use

The report allows users to investigate license uses in details or in a summary.

ProUCL_data

The EQuIS ProUCL Report export allows EQuIS users to export analytical data in a format that can be used in ProUCL (a third party statistical application developed by the US EPA)

Risk Assessment - SADA

Description: This is a report that will automatically interface with the University of Tennessee Knoxville's Spatial Analysis and Decision Assistance (SADA) Software

Sample Holding Time II

The Sample Holding Time II Report displays time spent from sampling to analyzing the samples plus other items, which can also be obtained in the Analytical Results II** Report

Service Provider Licensing - Usage Report

The Service Provider Licensing Usage Report reports on product usage and billing rate information for EarthSoft Resellers

Tag Cloud - Chemical Concentrations

This report creates a tag cloud, based on overall chemical concentrations for the current facility
Unsubscribed User Report

This report can be used to notify managers and admins of users not subscribed to facilities
VLA - PPU Usage and Billing Statement

Generate usage information for invoicing purposes. This report is only required for usage-based Viewer License Agreements.

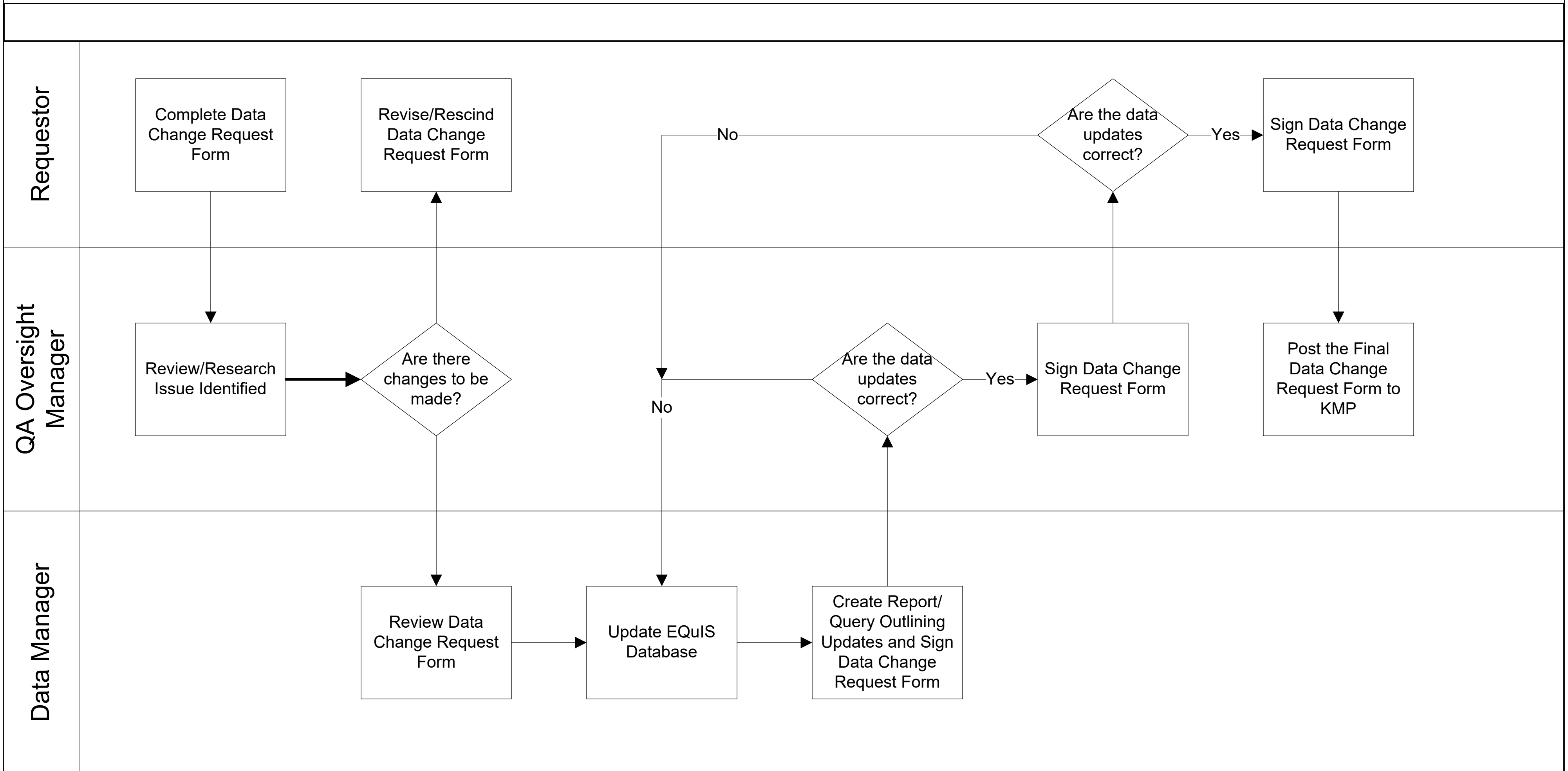
Well Construction

Well Construction Report is a class and Igrid Report that outputs well construction information from DT_WELL, DT_LOCATION, DT_COORDINATE, and DT_WELL_SEGMENT with default SEGMENT_TYPE='SCREEN'.

APPENDIX D

DATA CHANGE REQUEST WORKFLOW DIAGRAM

Data Change Request Process



APPENDIX E

TVA DATA CHANGE REQUEST FORM

Tennessee Valley Authority
Data Change Request Form

The Data Change Request Form will serve to document the data request and time-table for delivery.

Steps:

- Fill out Data Change Request Form and associated files to further explain the request.
- Attach the form and associated files in an e-mail to the Data Manager
- The subject of the e-mail should be- "**Data Change Request [Date].**"
- The Data Manager will be in contact to confirm information and delivery date.

Requestor Information		Data Manager use:
Date:		
Proposed Completion Date:		
Name:		
Company:	Phone:	
E-mail:		
Description of Request: (Below)	File Attached? Y N	
Summary: Proposed Solution:		Date Completed:

Data Manager/QA Oversight Manager

Signature ____________________________________ **Date:** _______________

Signature ____________________________________ **Date:** _______________

Data Change Requestor

Signature ____________________________________ **Date:** ______________

Stakeholders to Notify:

APPENDIX E
EXHIBITS

Exhibit No.
1

Title
Existing Borings

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location 175618610
Roane County, Tennessee
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

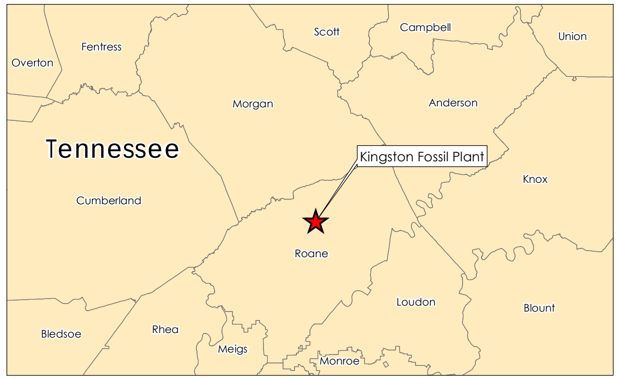
Legend

- ● Existing Boring
- ▲ Existing CPT

Boring Locations for Other Ongoing TVA Projects

- ✚ Closure Design Boring
- Perimeter Containment Alignment (Approximate)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.
4. During the construction of the Perimeter Containment Soil-Cement Stabilization, top of rock elevations were determined by a combination of predrilling (S&ME 2011) and trench excavations. This top of rock information is available for the entirety of the Stabilization alignment and the spacing between top of rock observations range from approximately 15 feet to 20 feet.



Stantec TVA

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Exhibit No.
2

Title

Existing Groundwater Wells for Study Area

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-06-11
Technical Review by LP on 2018-06-11

0 250 500 750 1,000 Feet
1:3,000 (At original document size of 22x34)

Legend

- Existing Wells Proposed As Observation Wells For Study Area
- Existing Wells For Study Area
- Surface Water Gauging Station For Study Area
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary
- TVA Property Boundary (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Exhibit No.
3

Title
Proposed Groundwater Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-31
Technical Review by LP on 2018-10-31

0 200 400 600 800 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Groundwater Monitoring Well for Study Area
- Existing Wells Proposed As Observation Wells For Study Area
- Existing Wells for Study Area
- Surface Water Gauging Station For Study Area
- TVA Property Boundary (Approximate)
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec
TVA

Revised: 2018-10-31 By: lblackman

Exhibit No.
4

Title
Proposed Temporary Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-31
Technical Review by EM on 2018-10-31

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe (Screened Interval)
- Existing Piezometer Vibrating Wire (Tip Interval)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- TVA Property Boundary (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec
TVA

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Exhibit No.
5

Title
Existing CCR Thickness Boring Data

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec

TVA

N

Exhibit No.
6

Title
Uppermost Foundation Soil Data

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800
Feet
1:2,400 (At original document size of 22x34)

Legend

- Clay
- Sand
- Silt
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec

TVA

V:\1756\active\175618610\gis\mxds\06_KIF_Uppermost_Foundation_Soils.mxd Revised: 2018-06-11 By: hink

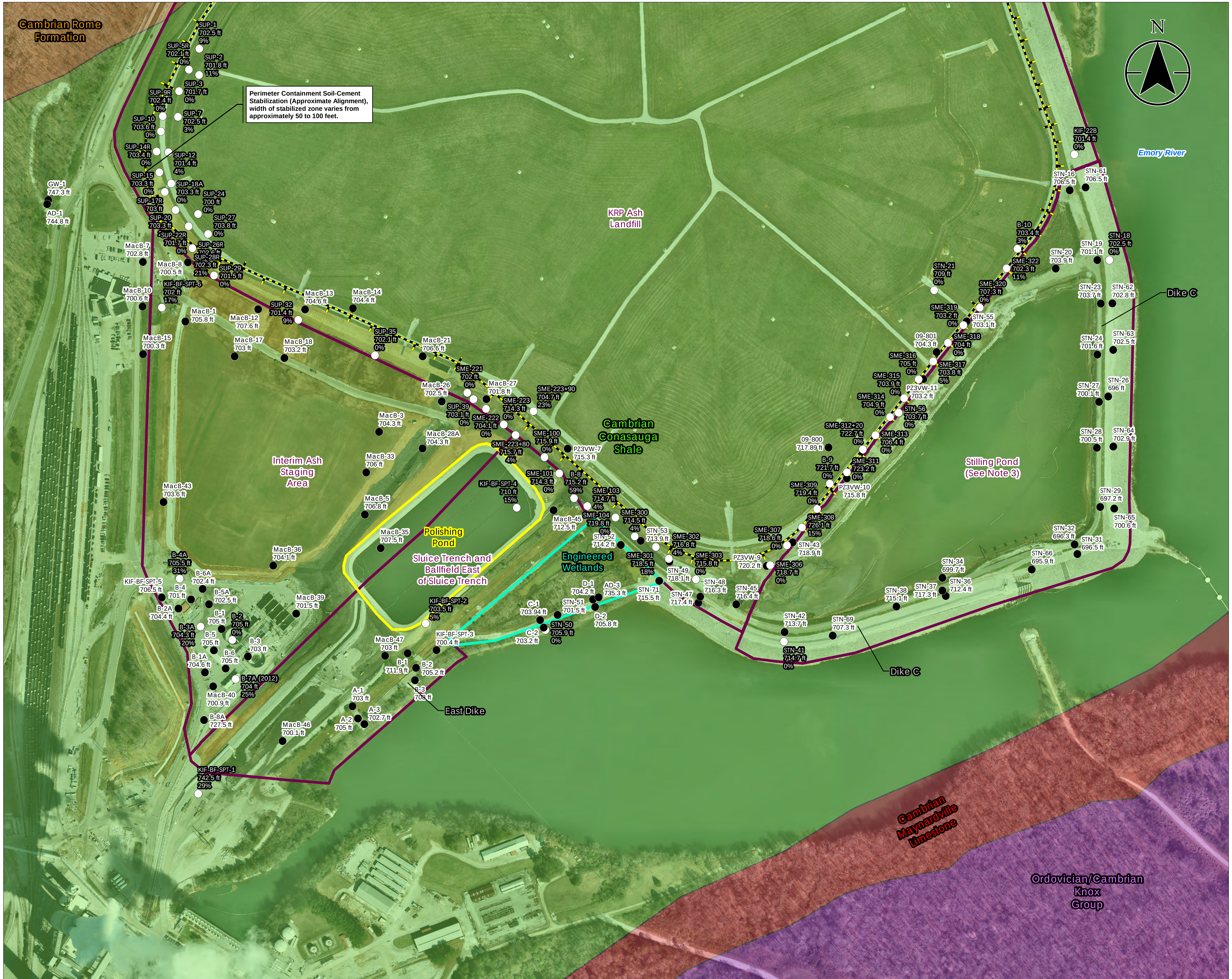

Exhibit No.
7

Title
Existing Top of Rock Elevation Boring Data

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location 175618610
Roane County, Tennessee
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Borings without Rock Core Data [ID & TOR Elevation]
- Borings with Rock Core Data [ID, TOR Elevation, RQD]
- Perimeter Containment Alignment (Approximate)
- Ordovician/Cambrian Knox Group
- Cambrian Maynardville Limestone
- Cambrian Conasauga Shale
- Cambrian Rome Formation
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.
4. During the construction of the Perimeter Containment Soil-Cement Stabilization, top of rock elevations were determined by a combination of predrilling (S&ME 2011) and trench excavations. This top of rock information is available for the entirety of the Stabilization alignment and the spacing between top of rock observations range from approximately 15 feet to 20 feet.
5. RQD value corresponds to upper 20 feet of rock core.
6. Geologic map corresponds to Moore, James L. et al (1993). "Geologic Map of The Harriman Quadrangle, Tennessee"

Stantec TVA

Exhibit No.
8

Title
Existing Instrumentation

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Existing Piezometer Open Standpipe (Screened Interval)
- Existing Piezometer Vibrating Wire (Tip Interval)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec TVA

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Exhibit No.
9

Title
KIF 1/2 Mile Radius Map

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

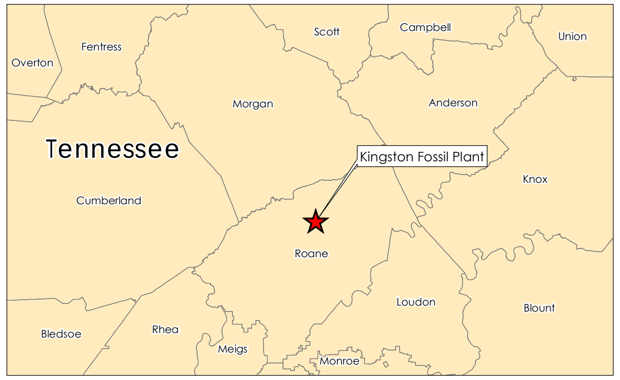
175618610
Prepared by LMB on 2018-06-11
Technical Review by JK on 2018-06-11

0 500 1,000 1,500 2,000 Feet
1:6,000 (At original document size of 22x34)

Legend

TVA Property 1/2 Mile Buffer
Approximate CCR Unit Area

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond.
The Stilling Pond has been closed since the imagery was collected.



Stantec
TVA

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CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Pseudostatic[1], Global	Pseudostatic[1], Veneer[2]	Post-EQ[3], Global
Interim Ash Staging Area (Closed Condition)	NR[4]	NR	NR	NR	NR
Sluice Trench (& Ballfield East of Sluice Trench) (Closed Condition)	A – A, Polishing Pond	Typ.[5]	A – A, Polishing Pond	Typ.	A – A, Polishing Pond
Stilling Pond (Closed Condition)	STA. 119+69, STA. 132+37	Typ.	STA. 132+37	Typ.	STA. 119+69, STA. 132+37

[1] Pseudostatic, but related to a site-specific tolerable displacement.
[2] Veneer stability is the slope stability of the final cover.
[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.
[4] NR = Not Required; Slope stability calculations not required to demonstrate performance of the closed Interim Ash Staging Area due to the higher surrounding grade, flat closure grading, and containment towards the east by the Polishing Pond
[5] Typical design section was analyzed.
Blue cells are completed analyses. Yellow cells are proposed analyses.

Exhibit No.
10

Title
Completed and Proposed Stability Analyses

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Stability Cross Section
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec
TVA

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Exhibit No.

11

Title

Geologic Map

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location

Roane County, Tennessee

175618610

Prepared by LMB on 2018-06-11
Technical Review by JK on 2018-06-11

0 200 400 600 800 Feet

1:2,400 (At original document size of 22x34)

Legend

- Ordovician/Cambrian Knox Group
- Cambrian Maynardville Limestone
- Cambrian Conasauga Shale
- Cambrian Rome Formation
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3.This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.
4. Geologic map corresponds to Moore, James L. et al (1993). "Geologic Map of The Harriman Quadrangle, Tennessee"

Stantec

TVA

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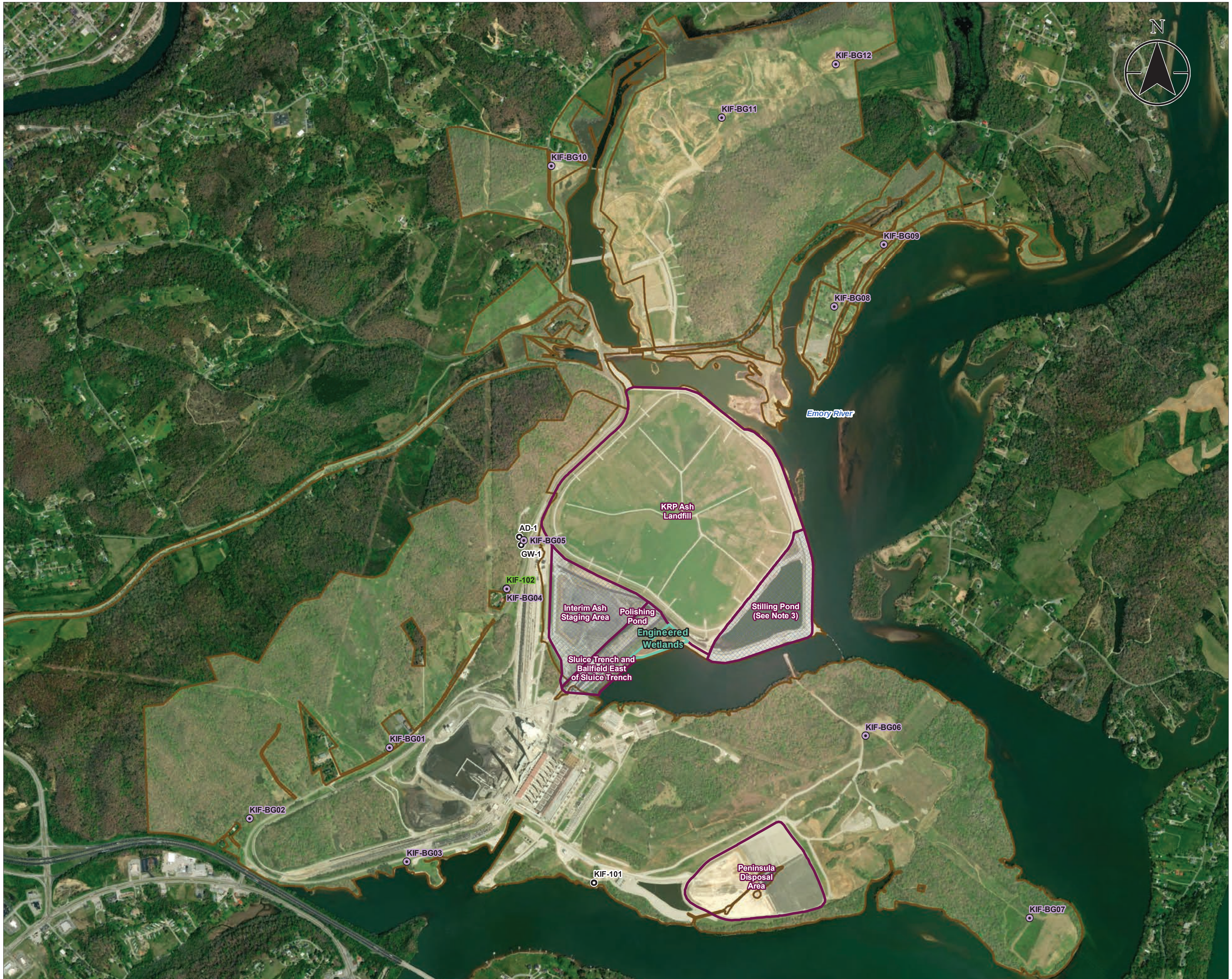


Exhibit No.
12

Title
Proposed Background Soil Sampling Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-11-06
Technical Review by EM on 2018-11-06

0 750 1,500 2,250 3,000 Feet
1:9,000 (At original document size of 22x34)

Legend

- Existing Background Monitoring Well Location
- Proposed Groundwater Well Location
- Proposed Background Soil Sample Location
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary
- TVA Property Boundary (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by ESRI
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec TVA

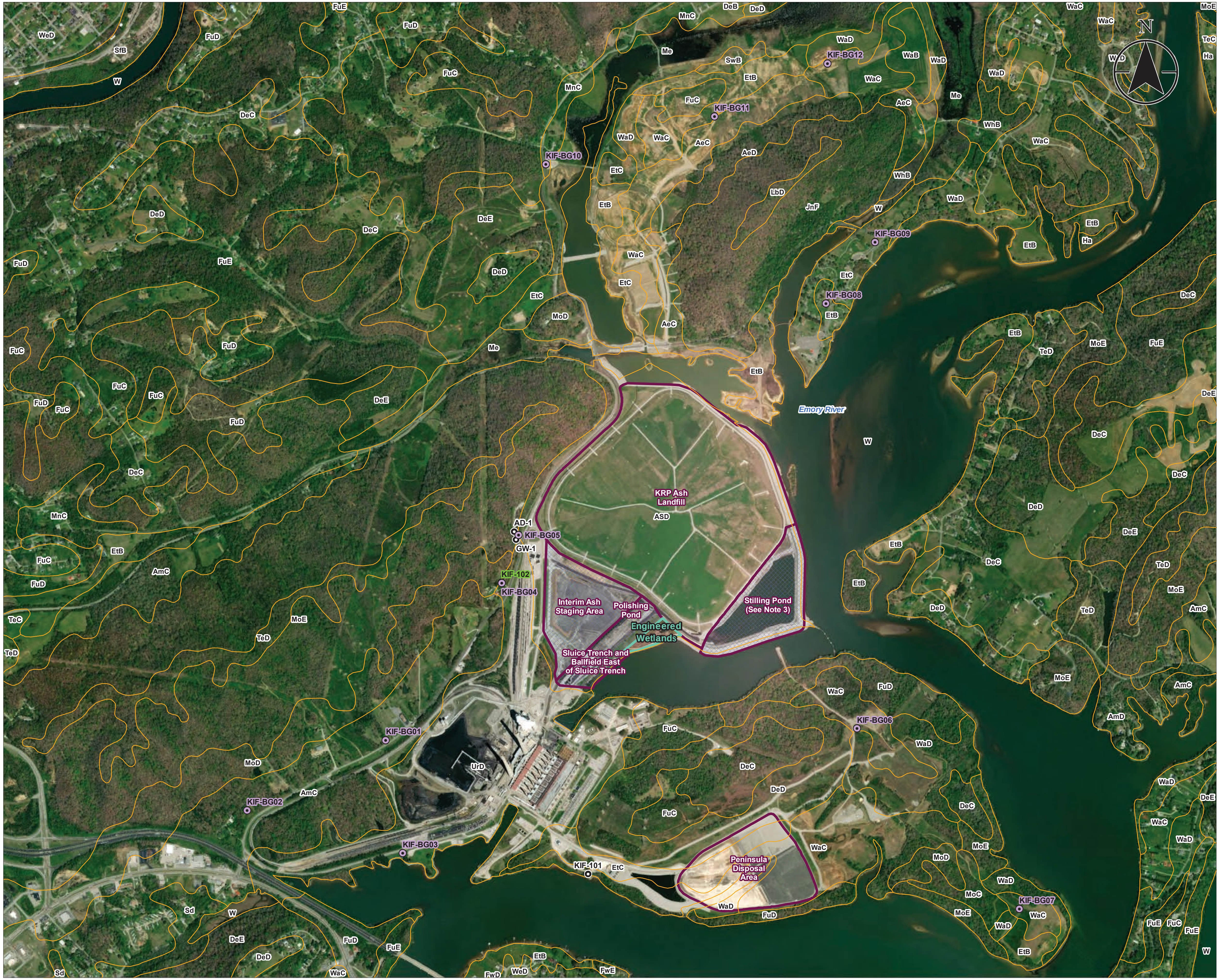


Exhibit No.
13

Title

Proposed Background Soil Sampling Locations

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location

Roane County, Tennessee

175618610

Prepared by DMB on 2018-11-06
Technical Review by EM on 2018-11-06

0 750 1,500 2,250 3,000 Feet

1:9,000 (At original document size of 22x34)

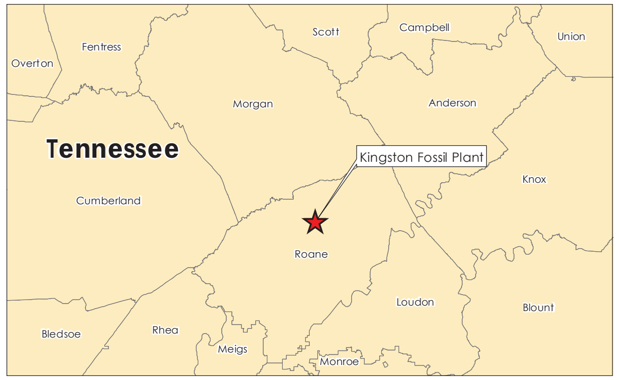
Legend

- Existing Background Monitoring Well Location
- Proposed Groundwater Well Location
- Proposed Background Soil Sample Location
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Soil Unit	Soil Map Unit Name
AeC	Allen loam, 5 to 12 percent slopes
AeD	Allen loam, 12 to 20 percent slopes
AmC	Armuchee silt loam, 5 to 12 percent slopes
AmD	Armuchee silt loam, 12 to 20 percent slopes
ASD	Ash disposal area
DeB	Dewey silt loam, 2 to 6 percent slopes
DeC	Dewey silt loam, 6 to 15 percent slopes
DeD	Dewey silt loam, 15 to 25 percent slopes
DeE	Dewey silt loam, 20 to 45 percent slopes
EtB	Etowah loam, 2 to 6 percent slopes
EtC	Etowah silt loam, 6 to 12 percent slopes
FuC	Fullerton-Pailo complex, 5 to 12 percent slopes
FuD	Fullerton-Pailo complex, 12 to 20 percent slopes
FuE	Fullerton-Pailo complex, 20 to 35 percent slopes
FwE	Fullerton-Dewey-Urban land complex, 20 to 35 percent slopes
Ha	Hamblen silt loam, 0 to 3 percent slopes, occasionally flooded, hydric minor component
JnF	Jefferson cobbly loam, 20 to 50 percent slopes
LbD	Lily loam, 12 to 20 percent slopes
Me	Melvin silt loam, 0 to 2 percent slopes, frequently flooded, warm
MnC	Minvale gravelly silt loam, 5 to 12 percent slopes
MoC	Montevallo channery silt loam, 5 to 12 percent slopes
MoD	Montevallo channery silt loam, 12 to 20 percent slopes
MoE	Montevallo channery silt loam, 20 to 35 percent slopes
Sd	Shady loam, occasionally flooded
SfB	Shady-Swafford-Urban land complex, 2 to 5 percent slopes
SwB	Swafford loam, 2 to 5 percent slopes
TeC	Townley silt loam, 5 to 12 percent slopes
TeD	Townley silt loam, 12 to 20 percent slopes
UrD	Urban land, 5 to 20 percent slopes
W	Water
WaB	Waynesboro loam, 2 to 6 percent slopes
WaC	Waynesboro loam, 6 to 15 percent slopes
WaD	Waynesboro loam, 15 to 25 percent slopes
WeD	Waynesboro-Etowah-Urban land complex, 5 to 20 percent slopes
WhB	Whitwell loam, 1 to 4 percent slopes, occasionally flooded

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by ESRI
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.
4. Soil Map Unit data was obtained from U.S. Department of Agriculture



Stantec TVA

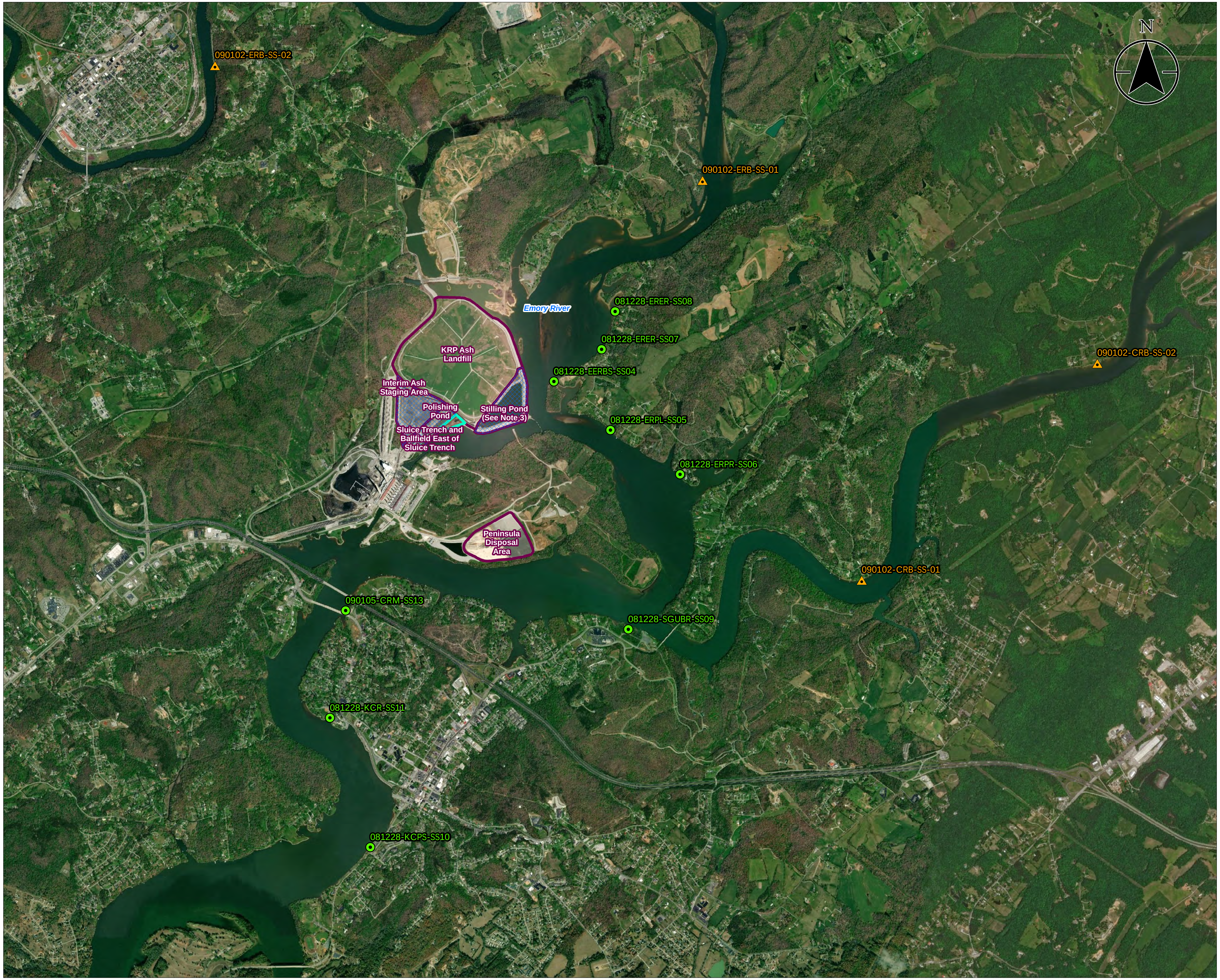


Exhibit No.
14

Title
Existing CERCLA Surficial Soil Sample Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

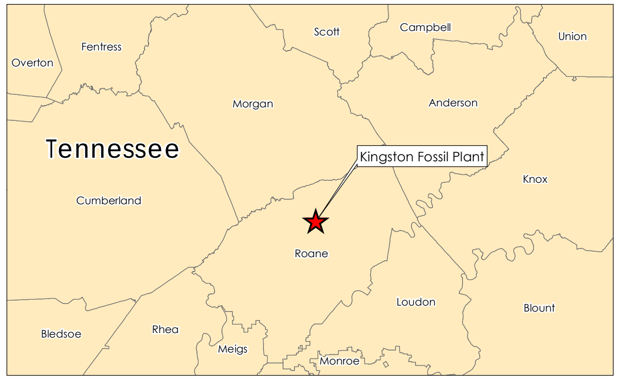
175618610
Prepared by LMB on 2018-06-11
Technical Review by ES on 2018-06-11

0 1,500 3,000 4,500 6,000 Feet
1:18,000 (At original document size of 22x34)

Legend

- Existing CERCLA Surficial Soil Sample Location Downstream
- Existing CERCLA Surficial Soil Sample Location Background
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by ESRI
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.



Stantec TVA

U:\TVA-EIP\175618610\gis\mxds\14_KIF_CERCLA_Surficial_Soil_Sample_Location.mxd Revised: 2018-06-11 By: lmk

Exhibit No.
15

Title

KIF - 1941 USGS Topographic Map

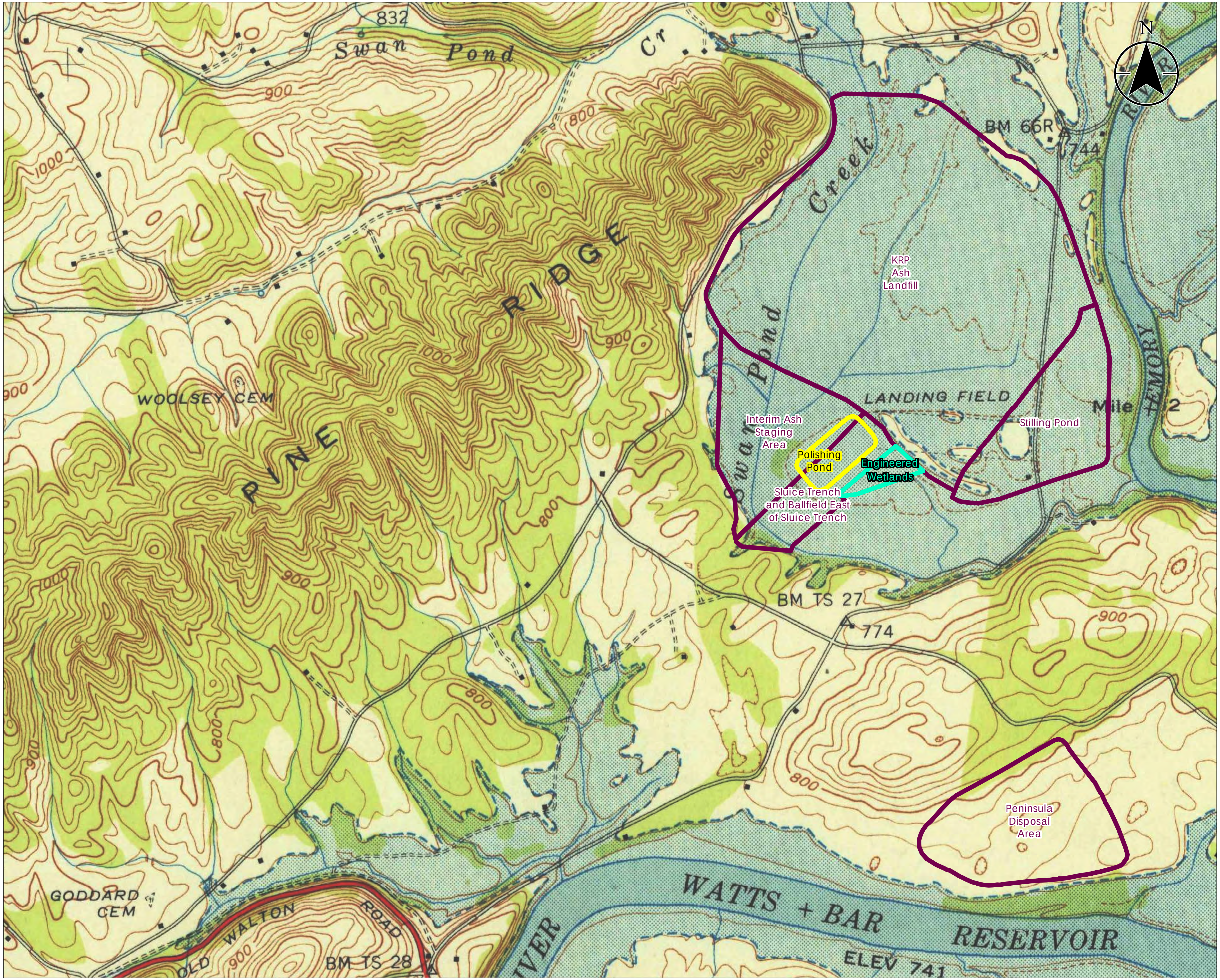
Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LT on 2018-06-11
Technical Review by LP on 2018-06-11

0 500 1,000 1,500 Feet
1:6,000 (At original document size of 22x34)



Legend

CCR Unit Area (Approximate)

Engineered Wetlands (Approximate)

Polishing Pond (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Topographic mapping corresponds to the Harriman Quadrangle (Edition of 1941, Scale 1:24,000)

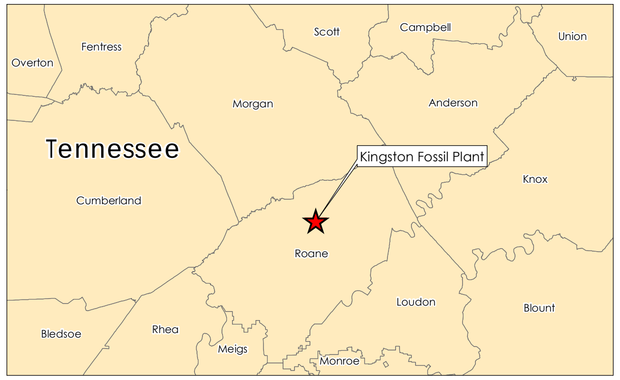


Exhibit No.
16

Title
Existing and Closed Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-06-11
Technical Review by LP on 2018-06-11

0 300 600 900 1,200
Feet
1:3,600 (At original document size of 22x34)

Legend

- Potential Replacement Well for Well 22
- Existing Well for Other Programs
- Closed Wells
- Existing Wells For Study Area
- Existing Wells Proposed As Observation Wells For Study Area
- Surface Water Gauging Station For Study Area
- KIF Study Area Boundary
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- TVA Property Boundary (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

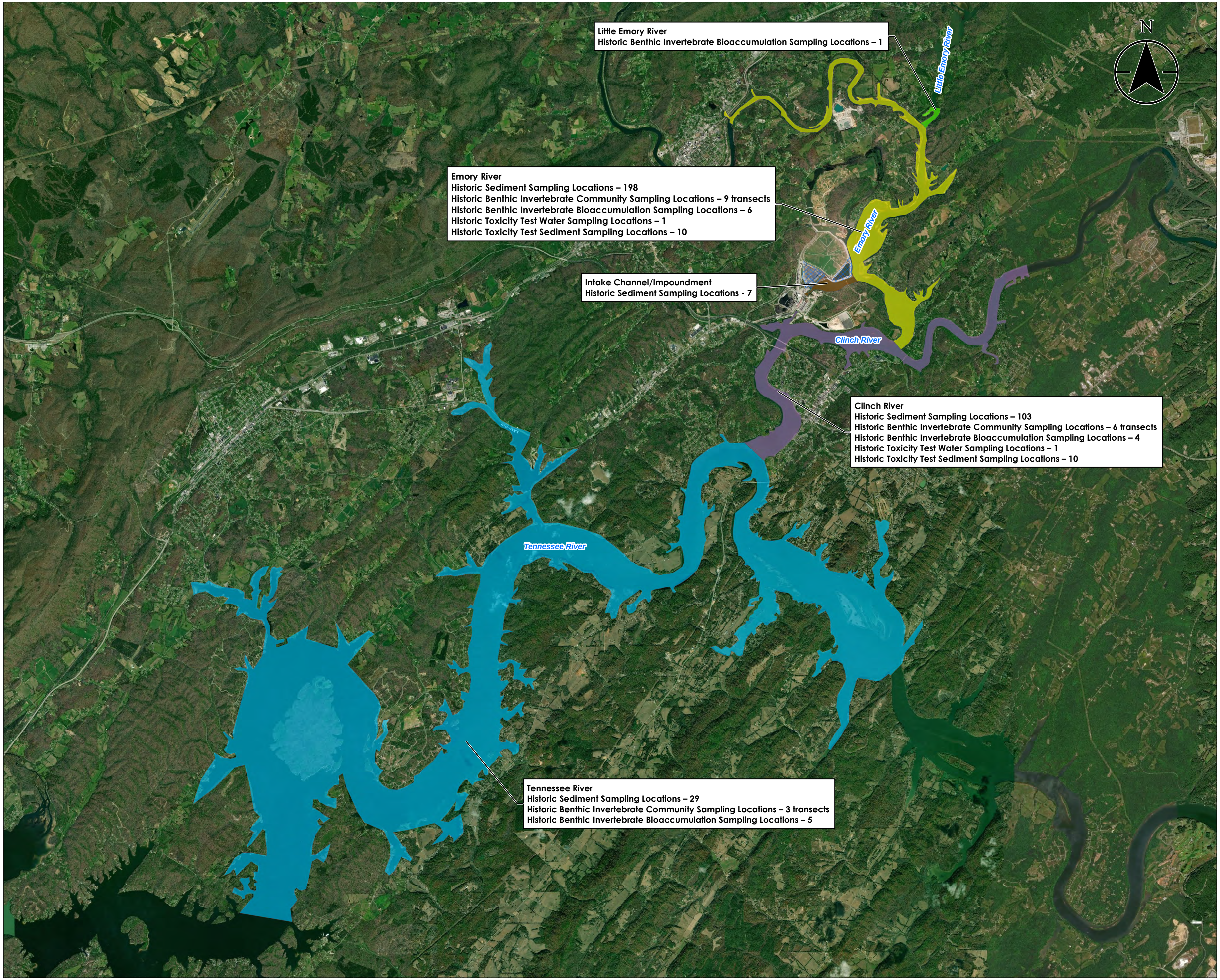


Exhibit No.
17

Title

Historic Sediment and Benthic Invertebrate Sample Locations Kingston Fossil Plant

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location 175618610
Roane County, Tennessee
Prepared by LMB on 2018-06-11
Technical Review by JC on 2018-06-11

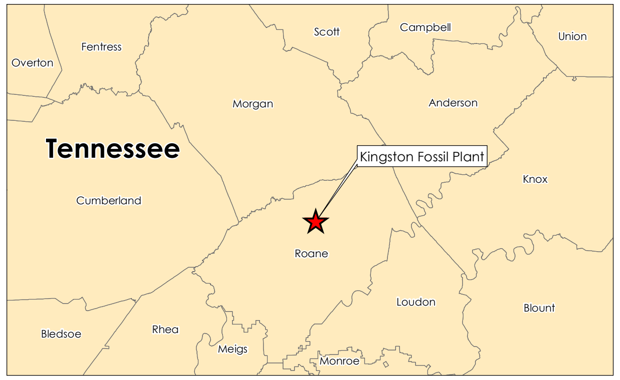
0 4,000 8,000 12,000 16,000 Feet
1:48,000 (At original document size of 22x34)

Legend

KIF Study Area Boundary
- KIF Study Area Boundary

Sampling Reach Location
- Clinch River
- Emory River
- Intake Channel/Impoundment
- Tennessee River
- Little Emory River

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by AND ESRI
3. Reports used for Sample Identification include: 2012 Task Completion Memorandum – Ash Deposits, Submerged Sediment, and Seasonally-Exposed Sediment; 2012 Baseline Environmental Risk Assessment (BERA); 2016 Updated Data Analysis and Temporal Trend Evaluations in Biota: 2009-2015
4. A total of 81 submerged sediment sample locations were assigned and co-located with ash deposit sample locations.



Stantec

TVA

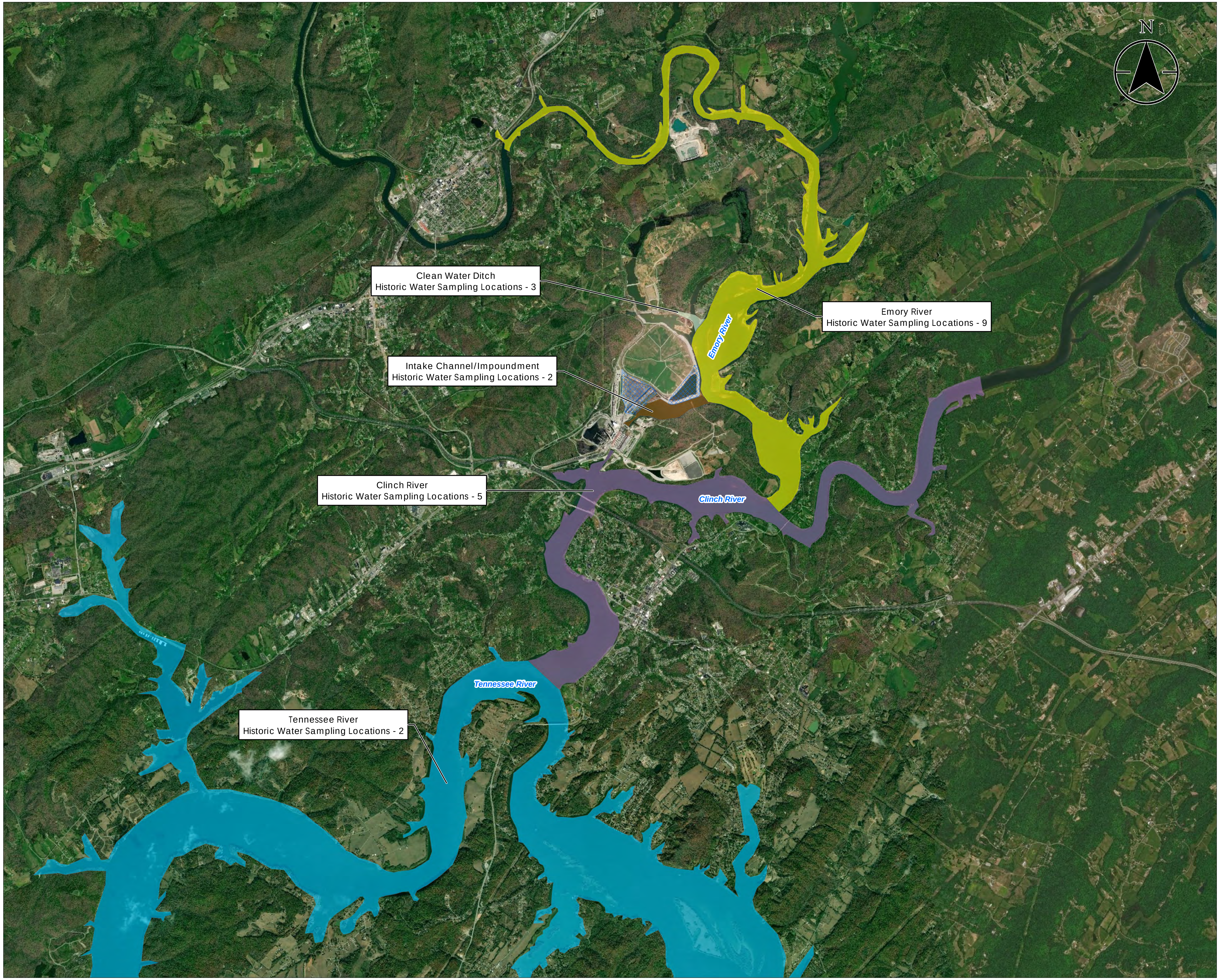


Exhibit No.
18

Title

Historic Surface Water Sample Locations Kingston Fossil Plant

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-06-11
Technical Review by LP on 2018-06-11

0 2,500 5,000 7,500 10,000 Feet

1:30,000 (At original document size of 22x34)

Legend

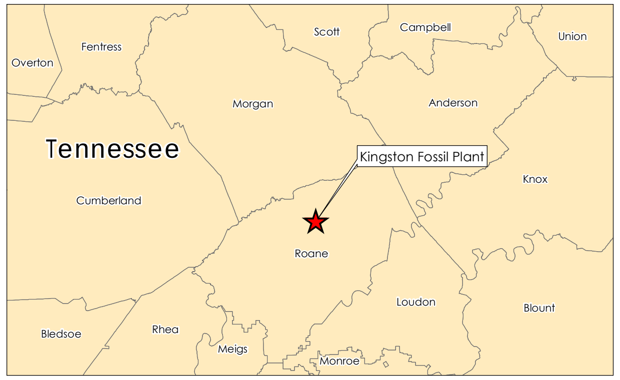
KIF Study Area Boundary

Sampling Reach Location

- Clean Water Ditch
- Clinch River
- Emory River
- Intake Channel/Impoundment
- Tennessee River

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI
3. Reports used for Sample Identification include:
   May 4, 2012 - EPA-AO-035 SAP Surface Water TM 2012-05-04 Final;
   July 11, 2012 - EPA-AO-052 River System BHHRA;
   September 5, 2012 - EPA-AO-055 Data Summary Report 2011;
   August 7, 2014 - EPA-AO-055C Groundwater and Surface Water Data Report 2014_r1



Stantec

TVA

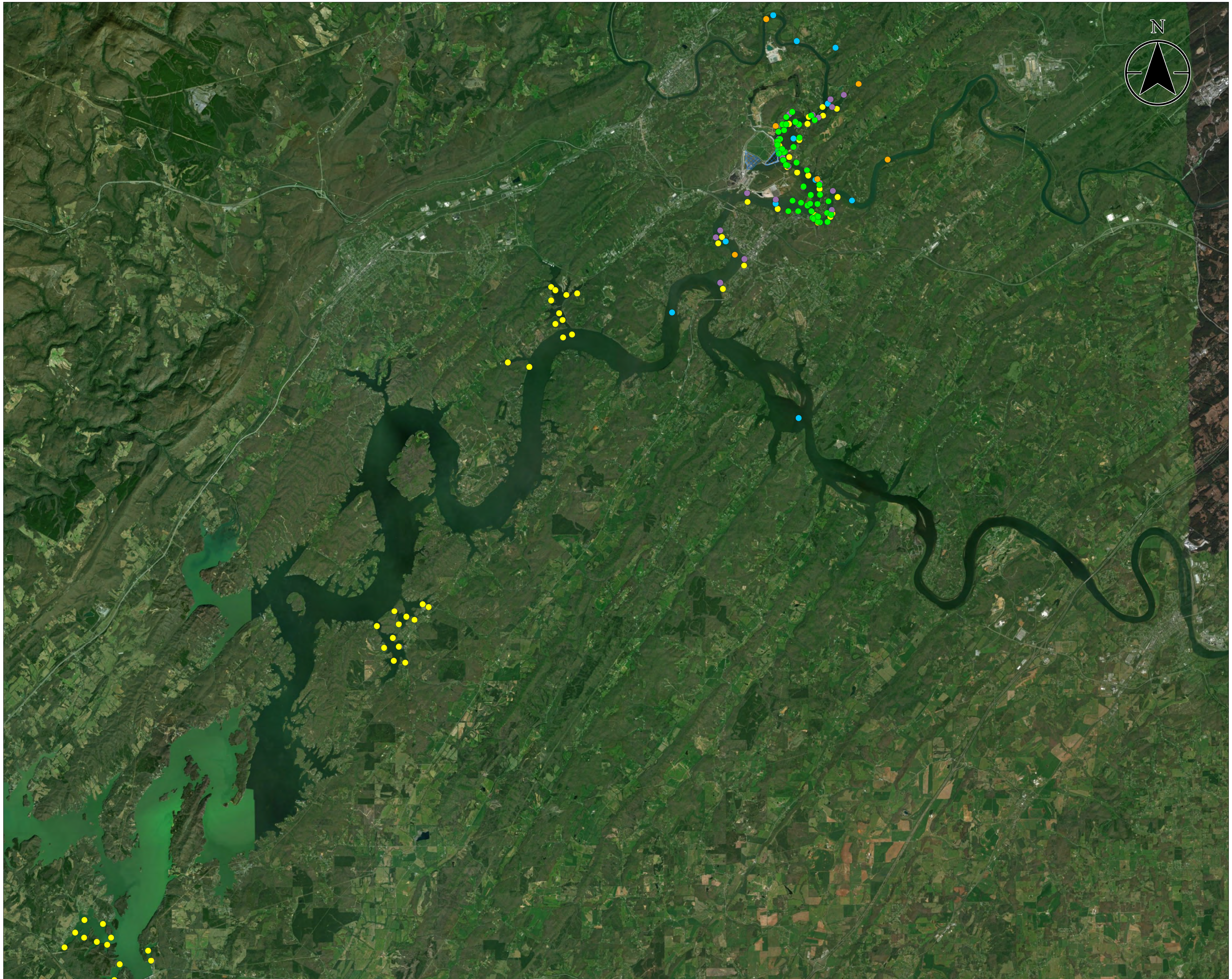


Exhibit No.
19

Title
Historic Fish Sampling Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-06-11
Technical Review by JK on 2018-06-11

0 6,000 12,000 18,000 24,000 Feet
1:72,000 (At original document size of 22x34)

Legend

- Fish Reproduction Study
  Oak Ridge National Labortory. 2009-2010
- Evaluation of Fish Community
  TVA 2001-2010
- Spring Sport Fish Survey
  TVA 2002-2011
- Data Analysis and Temporal Trend Evaluations in Biota
  ARCADIS 2009-2015
- Data Analysis and Temporal Trend Evaluations in Biota
  ARCADIS 2009-2014
- KIF Study Area Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.

Stantec

TVA

U:\TVA-EIP\175618610\gis\mxds\19_KIF_Historic_Fish_Sampling.mxd Revised: 2018-06-11 By: trink

APPENDIX F
GROUNDWATER INVESTIGATION SAP

Groundwater Investigation Sampling and Analysis Plan Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	September 8, 2017
2	Addresses December 8, 2017 TDEC Review Comments and Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Addresses Applicable Programmatic Revisions and Issued for TDEC Approval	November 9, 2018

GROUNDWATER INVESTIGATION
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Groundwater Investigation
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018

Revision 4

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 — Date: 11/6/18

McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.11.05 10:08:54 -05'00'
TVA Investigation Field Lead — Date

Health, Safety, and Environmental (HSE) Manager — Date: 11-7-18

Investigation Project Manager — Date: 10/24/2018

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.11.05 20:30:54 -05'00'
QA Oversight Manager — Date

Laboratory Project Manager — Date: 11/2/18

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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF 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 KIF 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 TVA 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 Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and 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 measuring groundwater levels and sampling groundwater at the Plant for CCR Rule, TDEC permitting requirements, Federal permitting and program commitments, and to develop a baseline of existing groundwater quality. Groundwater samples 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 environmental investigation sampling schedule. The data collected for other programs will be utilized in the Environmental Assessment Report (EAR). In addition, synchronous groundwater levels will be measured in certain monitoring wells that are part of other programs to augment the groundwater elevation data set and provide additional data to support preparation of groundwater contour maps for the Study Area. If a well used to collect groundwater level measurements for this investigation is replaced and installed in the same saturated unit as the previous well as part of other ongoing programs, this replacement well will be used to collect these measurements.

For the purposes of the SAP, observation wells are defined as wells that will be used to observe changes in groundwater levels over time, and monitoring wells are defined as wells that will be used to monitor groundwater quality and measure groundwater levels. Existing wells that are outside of the Study Area were designated as observation wells because groundwater quality results from these wells may not be representative of groundwater conditions in the Study Area. However, groundwater level measurements from these wells provide useful information related to groundwater flow conditions. The existing wells designated as monitoring wells are screened in the overburden and provide useful information related to groundwater quality and groundwater flow conditions.

Sampling Scope

TVA will measure groundwater level elevations at the following monitoring well locations:

- Existing locations AD-1, AD-2, AD-3, 6AR, 22, 22B, 27A, 27B and GW-2;
- Proposed monitoring well locations KIF-102, KIF-103, KIF-104, KIF-105 and KIF-106; and
- Piezometers installed in the CCR units as part of other activities.

Groundwater water quality samples will be collected from proposed wells KIF-102, KIF-103, KIF-104, KIF-105, KIF-106 and existing well GW-2 and submitted for laboratory analysis of parameters listed in Section 5.2.7.

The Hydrogeological Investigation SAP provides the rationale, locations, and installation methods for the proposed monitoring wells.

Surface water elevations will be measured at the gauging station in the Emory River located near the southeast corner of the Study Area. This station is currently automated with instrumentation to record the elevation of the Emory River in 5-minute intervals and is stored in TVA's instrumentation database.

Figure 1 shows the surface water gauging station and 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. If additional monitoring wells are needed to fully characterize groundwater at the Plant, then those additional wells will be monitored according to the Groundwater 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 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 (U.S. EPA 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.

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% microsiemens per centimeter (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 Field Team Leader 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 or 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 Project Manager 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-TI-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 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
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 Dissolved Solids	SM2540C	Cool to <6°C	250-mL HDPE	7 days
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 disposed 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's site-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 Project Manager 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. Duplicate 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 groundwater 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 bimonthly 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 EI. The first bimonthly sampling event will occur 10 days after completion of development of the proposed monitoring wells. The next five sampling events will occur on a bimonthly basis.

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 (U.S. EPA). 1989. "Sampling Frequency for Ground-Water Quality Monitoring Project Summary Document." September.

ATTACHMENT A
FIGURE

Figure No.
1

Title
Proposed Groundwater Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-31
Technical Review by LP on 2018-10-31

0 200 400 600 800
Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Groundwater Monitoring Well for Study Area
- Existing Wells Proposed As Observation Wells For Study Area
- Existing Wells for Study Area
- Surface Water Gauging Station For Study Area
- TVA Property Boundary (Approximate)
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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 G
HYDROGEOLOGICAL INVESTIGATION
SAP

Hydrogeological Investigation
Sampling and Analysis Plan
Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	September 8, 2017
2	Addresses December 8, 2017 TDEC Review Comments and Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions and Issued for TDEC Approval	November 9, 2018

HYDROGEOLOGICAL INVESTIGATION
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Hydrogeological Investigation
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018

Revision 4

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	11/6/18 Date
McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.11.05 10:10:00 -05'00' TVA Investigation Field Lead	Date
Stanley Nixon Health, Safety, and Environmental (HSE) Manager	11-9-18 Date
Erin Mattmiller Investigation Project Manager	10/24/2018 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.11.05 20:31:21 -05'00' QA Oversight Manager	Date
Ryan Jones Laboratory Project Manager	10/24/2018 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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF 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 KIF Plant (Plant).

2.0 OBJECTIVES

The objectives of this Hydrogeological Investigation SAP are to further characterize groundwater flow direction at the Plant and install monitoring wells to provide locations to collect groundwater samples for analysis of CCR constituents. A 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, 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 Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and 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 completed many studies at KIF and has programs underway for CCR Rule, TDEC permitting requirements, Federal permitting and program commitments that can be used to characterize the hydrogeology of the KIF Study Area. TVA will incorporate pertinent data from those investigations that meet the Quality Assurance (QA)/Quality Control (QC) requirements of the QAPP with the results of this SAP to meet the objectives listed in Section 2.0.

As part of the above activities, TVA installed four groundwater monitoring wells (AD-1, AD-2, AD-3 and 6AR) in the overburden around the Study Area. Monitoring well AD-1 currently serves as an existing upgradient background well location. Monitoring wells AD-2, AD-3 and 6AR currently serve as downgradient well locations. To supplement the existing network to investigate groundwater quality, groundwater flow conditions and aquifer properties (e.g. hydraulic conductivity, transmissivity, storage), TVA proposes to install one additional background monitoring well (KIF-102) west of the Study Area and four wells (KIF-103, KIF-104, KIF-105 and KIF-106) downgradient of the Study Area near the Stilling Pond and Sluice Trench. The well drilling will be overseen by a Tennessee licensed Professional Geologist. The locations of the proposed wells were selected to evaluate groundwater conditions in additional upgradient background and downgradient locations within the unconsolidated materials above bedrock. The existing and proposed monitoring well locations are shown on Figure 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
AD-1*	35.7	25.5 – 35.4	Residuum
AD-2*	28.6	18.5 – 28.4	Residuum
AD-3*	18.9	13.9-18.8	Residuum
6AR*	44.7	34.5 – 44.2	Residuum
GW-2*	22.8	13.5 - 22.8	Residuum
22*	50.5	20.2 – 50.2	Residuum
22B*	82.2	59.9 – 81.4	Bedrock
27A*	47.8	31.4 – 47.5	Weathered Shale
27B*	72.5	50.4 – 71.9	Bedrock
KIF-102	35	25 - 35	Residuum
KIF-103	35	25 - 35	Residuum
KIF-104	35	25 - 35	Residuum
KIF-105	35	25 - 35	Residuum
KIF-106	35	25 - 35	Residuum

* Existing well

The proposed background monitoring well to be installed in this investigation will serve three purposes: 1) it will provide a second potential background monitoring location to measure groundwater levels to evaluate groundwater flow direction; 2) it will provide an additional sampling location to assess background water quality; and 3) it will provide an additional location to measure aquifer properties. The screened interval for the proposed well is proposed to be placed in the unconsolidated materials above bedrock.

Four additional wells (KIF-103, KIF-104, KIF-105 and KIF-106) are also proposed to evaluate groundwater quality and groundwater flow conditions downgradient of the Study Area. The screened intervals for the proposed wells are proposed to be placed in the unconsolidated materials above bedrock at approximately 25 to 35 feet below ground surface.

TVA plans to complete the initial phase of the investigation and jointly review the results with TDEC to identify data gaps. If data gaps exist, then TVA will fill those gaps with additional investigation in collaboration with TDEC. This may include installing additional groundwater monitoring wells or piezometers to further characterize the hydrogeology. Results of the hydrogeological investigations will be included and described in the Environmental Assessment Report (EAR).

Groundwater sampling frequency and procedures are provided in the Groundwater Investigation SAP.

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 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.).

In addition to the soil log, the field geologist will collect soil samples through the well screen intervals of background monitoring wells as described in Section 5.2.1.2 of the Background Soil SAP.

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 and a crosswalk will be provided to indicate what the Plant datum's equivalency is to mean sea level (MSL).

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 Field Team Leader, 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 systems (GIS or global positioning systems (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 grout will be placed by tremie method through one-inch (minimum) diameter PVC pipe. The grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process. In open (uncased) boreholes, the sand filter zones and bentonite pellets will be placed by tremie method through one-inch (minimum) diameter PVC. In cased boreholes (i.e., through hollow-stem augers or temporary casing), the sand filter zones and bentonite pellets may be placed by tremie method or may be poured slowly into the annular space of the drill tooling to prevent bridging.

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. A crosswalk will be provided that indicates what the Plant datum's equivalency is to MSL.

An example installation log is shown on Figure 2. A drawing of the wellhead construction is shown on Figure 3.

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 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, 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 evaluated 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 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 Project Manager 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, site 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	30 Days	Following EIP Approval
Conduct Field Activities	30 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
- Saturated alluvial materials exist at each proposed location.

9.0 REFERENCES

Tennessee Valley Authority (2017a). "Field Record Keeping." Technical Instruction ENV-TI-05.80.03. March.

Tennessee Valley Authority (2017b). "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05. March.

Tennessee Valley Authority (2017c). "Monitoring Well and Piezometer Installation and Development." Technical Instruction ENV-TI-05.80.25. April.

ATTACHMENT A
FIGURE

Figure No.
1

Title
Proposed Groundwater Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-31
Technical Review by LP on 2018-10-31

0 200 400 600 800 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Groundwater Monitoring Well for Study Area
- Existing Wells Proposed As Observation Wells For Study Area
- Existing Wells for Study Area
- Surface Water Gauging Station For Study Area
- TVA Property Boundary (Approximate)
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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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 H
MATERIAL QUANTITY SAP

Material Quantity
Sampling and Analysis Plan
Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	September 8, 2017
2	Addresses December 8, 2017 TDEC Review Comments and Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Issued for TDEC Approval	November 9, 2018

MATERIAL QUANTITY
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Material Quantity
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018 Revision 4

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 — Date: 11/6/18

McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.11.05 10:10:48 -05'00'
TVA Investigation Field Lead — Date: ~~11-7-18~~

Health, Safety, and Environmental (HSE) Manager — Date: 11-7-18

Investigation Project Manager — Date: 10/24/2018

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.11.05 20:31:47 -05'00'
QA Oversight Manager — Date

Laboratory Project Manager — Date: 10/24/2018

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

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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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF 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 Interim Ash Staging (Ballfield) Area, Sluice Trench and Ballfield East of Sluice Trench, and Stilling Pond (Study Area Units) at the KIF 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 Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and 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 EXPLORATION PLAN

4.1.1 Proposed TDEC Order Temporary Well Borings

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 borings with temporary well installations at locations shown on Figure 1 in Attachment A. These additional borings will provide supplemental data relative to CCR thickness, water levels, and foundation soil type for the interior of the CCR units. A total of 5 borings with temporary well installations are proposed. Table 1 provides the number of borings with temporary well installations proposed in each CCR unit.

Table 1. Exploratory Drilling Proposed in each CCR Unit

CCR Unit	No. of Borings with Temporary Wells
Interim Ash Staging Area	3
Sluice Trench and Ballfield East of Sluice Trench	2
Total	**5**

Additional information about the temporary well installations is described in the Exploratory Drilling SAP. TVA also plans to install groundwater monitoring wells at the locations shown in Figure 2 as described in the Hydrogeological Investigation SAP.

4.1.2 Data Analysis

Data from the proposed borings will be compared to the existing boring data and pre-construction topographic information available for each 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.

4.1.3 Water Level Monitoring

Monthly water level monitoring will be conducted for a minimum of six months to estimate and monitor levels in each CCR unit. TVA proposes using temporary wells, manual readings from existing piezometers, and automated readings from existing automated vibrating wire transducer piezometers shown on Figure 1 to estimate saturation levels in CCR. Details regarding water level monitoring field activities are provided in the CCR Material Characteristics SAP. Monitoring and/or sampling of temporary wells is not addressed in this SAP.

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. The models will be developed using the data summarized below which includes data from the proposed exploratory borings as well as other relevant data collected during the Investigation.

1. The most recent aerial and topographic survey data and record drawings for the Polishing Pond and Interim Ash Staging Area closure projects will be used to model the soil cap constructed at the Interim Ash Staging Area and Sluice Trench and the upper CCR surface.

2. Aerial and topographic survey data, record drawings, and the proposed temporary well borings shown on Figure 1 will be used to model the upper CCR surface of the Sluice Trench which was capped in 2017 and the Ballfield East of Sluice Trench. The upper CCR surface will correspond to the lowest contour of the Sluice Trench.

3. The most recent aerial and topographic survey data and record drawings for the Stilling Pond closure project will be used to model the engineered cap constructed at the Stilling Pond and the upper CCR surface.

4. Pre-construction topographic information from drawings including TVA Drawings 10N200 R10 and 10N400 R6 (Attachment B), the 1941 USGS Topographic Map of the Harriman Quadrangle, and data from borings that penetrated the lower boundary of the CCR surface shown on Figure 3 will be used to model the lower CCR surfaces of the Study Area Units.

5. Data from existing borings that encountered foundation soils shown on Figure 4 will be used to model the foundation soils underlying each site.

6. Top of bedrock elevations were recorded along the Kingston Recovery Project Ash Landfill perimeter wall as it was constructed. This data along with data from existing borings that encountered top of bedrock shown on Figure 5 and geologic lithology information discussed in Section 3.7.1 of the Kingston EIP will be used to model the top of bedrock underlying the Study Area Units.

7. Observed piezometric levels of saturation discussed in Section 4.1.3 will be incorporated into the models.

8. Groundwater levels estimated as part of the Investigation will be incorporated into the models.

9. 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.

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.

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:

- Subsurface material types, properties, elevations, and thickness from the ground surface to top of bedrock
- Final elevations of units
- Upper and lower CCR surfaces and CCR thickness for each facility
- 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
- Estimated extent of foundation soils 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
- 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
- Volume of CCR below the highest recorded groundwater surface

The combined total volume of CCR for all Study Area Units at KIF 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 Plant-specific Quality Assurance Project Plan (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 Project Manager 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 CPTs and borings	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

Tennessee Valley Authority (TVA). 1981. "General Plan, Kingston Steam Plant." TVA Record Drawing No. 10N200, Rev. 10.

Tennessee Valley Authority (TVA). 1967. "Ash Disposal Area, Kingston Steam Plant." TVA Record Drawing No. 10N400, Rev. 6

United States Geological Survey (USGS).1941. "USGS Topographic Map of the Harriman Quadrangle".

ATTACHMENT A
FIGURES

Figure No.
1

Title
Proposed Temporary Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-31
Technical Review by EM on 2018-10-31

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe (Screened Interval)
- Existing Piezometer Vibrating Wire (Tip Interval)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- TVA Property Boundary (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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Figure No.
2

Title
Proposed Groundwater Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-31
Technical Review by LP on 2018-10-31

0 200 400 600 800 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Groundwater Monitoring Well for Study Area
- Existing Wells Proposed As Observation Wells For Study Area
- Existing Wells for Study Area
- Surface Water Gauging Station For Study Area
- TVA Property Boundary (Approximate)
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec TVA

Figure No.
3

Title
Existing CCR Thickness Boring Data

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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Figure No.
4

Title
Uppermost Foundation Soil Data

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Clay
- Sand
- Silt
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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TVA

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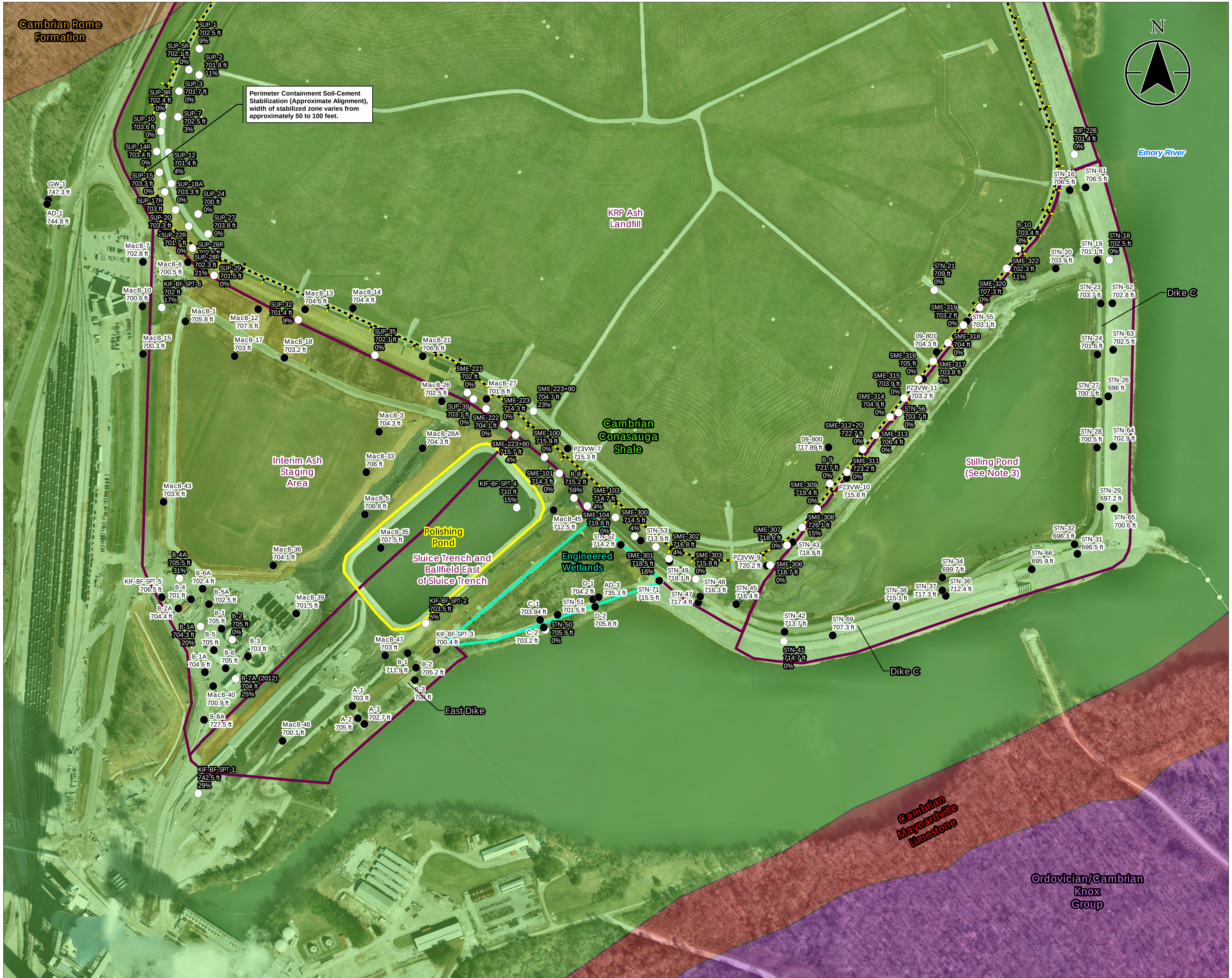

Figure No.

5

Title

Existing Top of Rock Elevation Boring Data

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location

Roane County, Tennessee

175618610

Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet

1:2,400 (At original document size of 22x34)

Legend

- Borings without Rock Core Data [ID & TOR Elevation]
- Borings with Rock Core Data [ID, TOR Elevation, RQD]
- Perimeter Containment Alignment (Approximate)
- Ordovician/Cambrian Knox Group
- Cambrian Maynardville Limestone
- Cambrian Conasauga Shale
- Cambrian Rome Formation
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.
4. During the construction of the Perimeter Containment Soil-Cement Stabilization, top of rock elevations were determined by a combination of predrilling (S&ME 2011) and trench excavations. This top of rock information is available for the entirety of the Stabilization alignment and the spacing between top of rock observations range from approximately 15 feet to 20 feet.
5. RQD value corresponds to upper 20 feet of rock core.
6. Geologic map corresponds to Moore, James L. et al (1993). "Geologic Map of The Harriman Quadrangle, Tennessee"

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TVA

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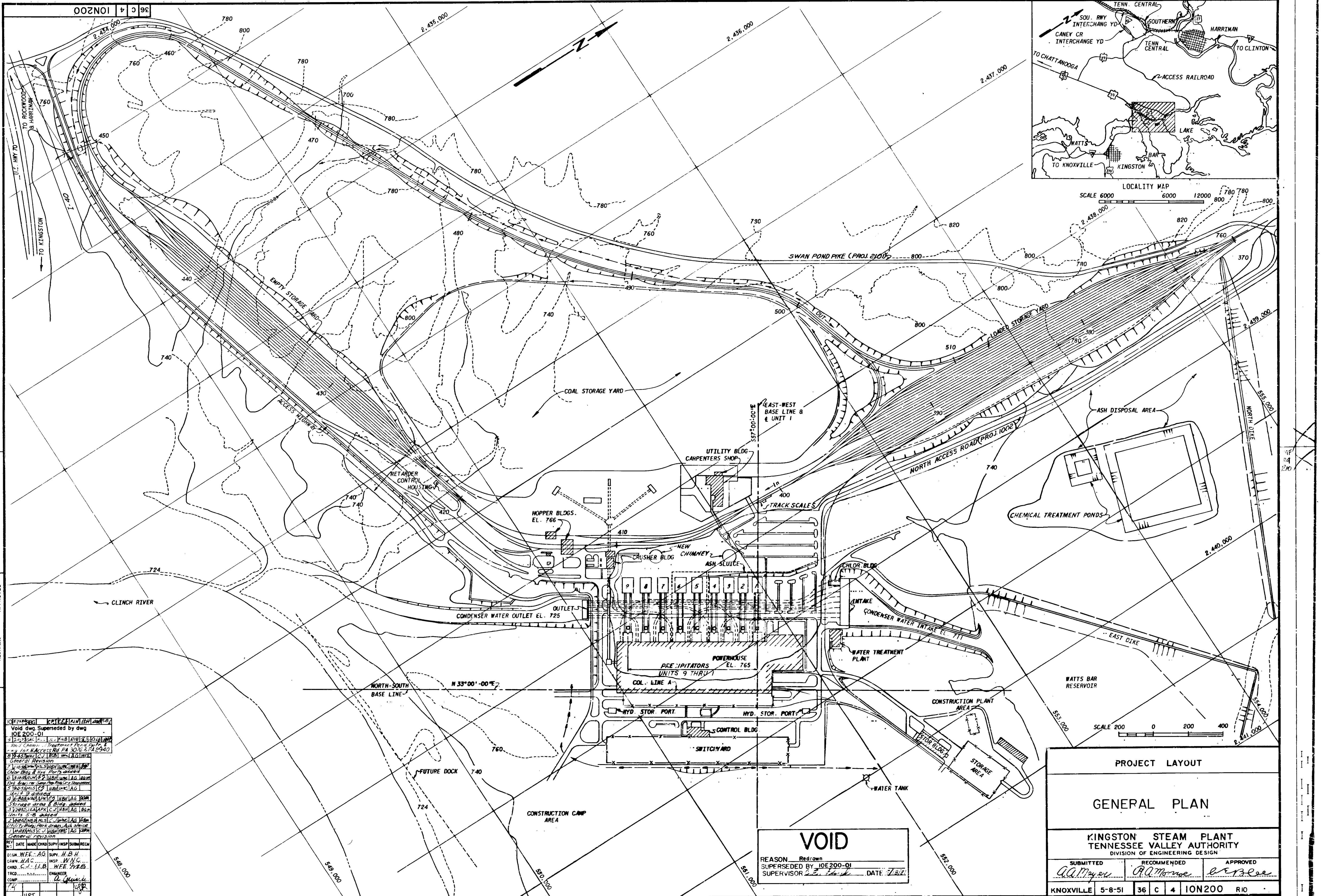
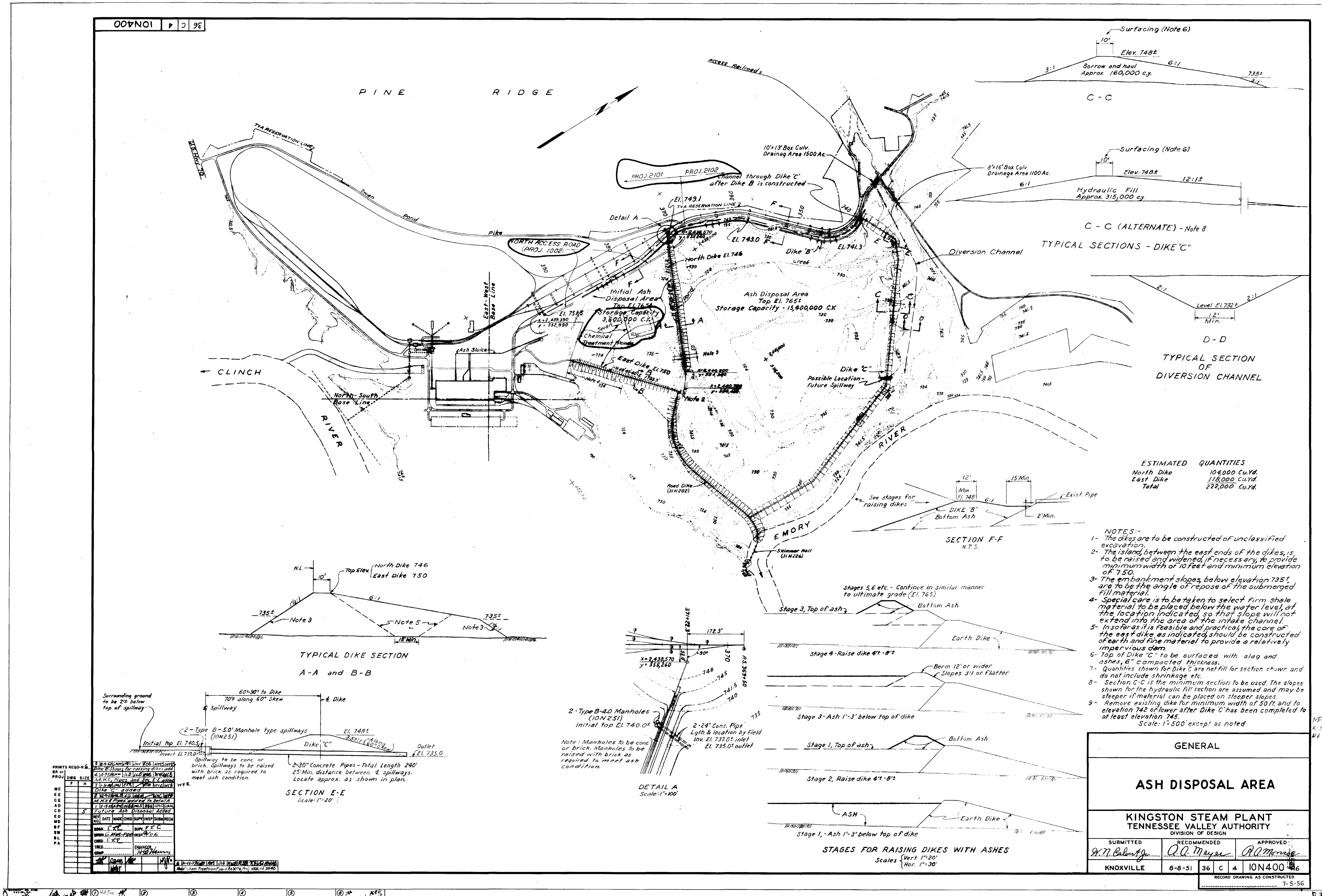
ATTACHMENT B
HISTORIC DRAWINGS



PROJECT LAYOUT
GENERAL PLAN
KINGSTON STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
SUBMITTED
RECOMMENDED
APPROVED
KNOXVILLE 5-8-51 36 C 4 10N200 R10
RECORD DRAWING AS CONSTRUCTED
VOID
REASON Redrawn
SUPERSEDED BY 10E200-01
SUPERVISOR
DATE
Void dwg. Superseded by dwg 10E200-01
General Revision
Chlor Bldg & Hyd Ports added
Storage area & Bldg added
Units 5-8 added
General revision
THIS DRAWING HAS BEEN REDRAWN
ORIGINAL DESTROYED
DATE / INITIAL
REDRAWN
APPROVED
LOCALITY MAP
SCALE 6000 0 6000 12000
TENN. CENTRAL
SOU. RWY INTERCHANG YD
SOUTHERN
HARRIMAN
CANEY CR INTERCHANGE YD
TENN CENTRAL
TO CLINTON
TO CHATTANOOGA
ACCESS RAILROAD
LAKE
WATTS
BAR
TO KNOXVILLE
KINGSTON
SWAN POND PIKE (PROJ 2100)
LOADED STORAGE YARD
EMPTY STORAGE YARD
COAL STORAGE YARD
ACCESS HIGHWAY
TO ROCKWOOD & HARRIMAN
U.S. HWY 70
TO KINGSTON
EAST-WEST BASE LINE 8 ℄ UNIT 1
N 57°00'-00"E
UTILITY BLDG
CARPENTERS SHOP
TRACK SCALES
NORTH ACCESS ROAD (PROJ 1002)
ASH DISPOSAL AREA
CHEMICAL TREATMENT PONDS
NORTH DIKE
EAST DIKE
RETARDER CONTROL HOUSING
HOPPER BLDGS. EL. 766
CRUSHER BLDG
NEW CHIMNEY
ASH SLUICE
CHLOR. BLDG
INTAKE
CONDENSER WATER INTAKE EL. 711
OUTLET
CONDENSER WATER OUTLET EL. 725
CLINCH RIVER
WATER TREATMENT PLANT
POWERHOUSE EL. 765
PRECIPITATORS UNITS 9 THRU 1
COL. LINE A
NORTH-SOUTH BASE LINE
N 33°00'-00"E
HYD. STOR. PORT
CONTROL BLDG
SWITCHYARD
WATTS BAR RESERVOIR
CONSTRUCTION PLANT AREA
STOR. BLDG
STORAGE AREA
WATER TANK
FUTURE DOCK
CONSTRUCTION CAMP AREA
SCALE 200 0 200 400



10N400 36 C 4
PINE RIDGE
TVA RESERVATION LINE
Swan Pond Pike
NORTH ACCESS ROAD (PROJ. 1002)
PROJ. 2101
PROJ. 2102
Channel through Dike 'C' after Dike B is constructed
Access Railroad
10'x13' Box Culv. Drainag Area 1500 Ac.
8'x16' Box Culv. Drainage Area 1100 Ac.
Detail A
El. 749.1
El. 743.0
El. 741.3
Dike "B"
North Dike El. 746
Diversion Channel
Initial Ash Disposal Area Top El. 765± Storage Capacity 3,500,000 C.Y.
Chemical Treatment Ponds
Ash Disposal Area Top El. 765± Storage Capacity - 15,400,000 C.Y.
East Dike El. 750
East-West Base Line
North-South Base Line
Ash Sluice
Note 1
Note 2
Note 3
Dike "C"
Possible Location Future Spillway
CLINCH RIVER
EMORY RIVER
Road Dike (31N202)
Skimmer Wall (31N226)
Surfacing (Note 6)
Elev. 748±
Borrow and haul Approx. 160,000 c.y.
C - C
Hydraulic Fill Approx. 315,000 c.y.
C - C (ALTERNATE) - Note 8
TYPICAL SECTIONS - DIKE "C"
Level El. 732±
12' Min.
D - D
TYPICAL SECTION OF DIVERSION CHANNEL
ESTIMATED QUANTITIES
North Dike 104,000 Cu.Yd.
East Dike 118,000 Cu.Yd.
Total 222,000 Cu.Yd.
See stages for raising dikes
DIKE "B" Bottom Ash
Exist. Pipe
SECTION F-F N.T.S.
NOTES:-
1- The dikes are to be constructed of unclassified excavation.
2- The island, between the east ends of the dikes, is to be raised and widened, if necessary, to provide minimum width of 10 feet and minimum elevation of 750.
3- The embankment slopes, below elevation 735±, are to be the angle of repose of the submerged fill material.
4- Special care is to be taken to select firm shale material to be placed below the water level, at the location indicated, so that slope will not extend into the area of the intake channel.
5- Insofar as it is feasible and practical, the core of the east dike, as indicated, should be constructed of earth and fine material to provide a relatively impervious dam.
6- Top of Dike "C" to be surfaced with slag and ashes, 6" compacted thickness.
7- Quantities shown for Dike C are net fill for section shown and do not include shrinkage etc.
8- Section C-C is the minimum section to be used. The slopes shown for the hydraulic fill section are assumed and may be steeper if material can be placed on steeper slopes.
9- Remove existing dike for minimum width of 50 ft. and to elevation 742 or lower after Dike C has been completed to at least elevation 745.
Scale: 1"=500' except as noted
Top Elev. North Dike 746 East Dike 750
TYPICAL DIKE SECTION A-A and B-B
Surrounding ground to be 2± below top of spillway
60°-90° to Dike
70± along 60° Skew
2 - Type B-5.0' Manhole type spillways (10N251)
Initial top El. 740.5±
Invert El. 737.0±
Spillway to be conc. or brick. Spillways to be raised with brick as required to meet ash condition.
2-30" Concrete Pipes - Total Length 240' 25' Min. distance between ℄ spillways. Locate approx. as shown in plan.
Outlet El. 735.0
SECTION E-E Scale: 1"=20'
2 - Type B-4.0 Manholes (10N251) Initial top El. 740.0±
Note: Manholes to be conc. or brick. Manholes to be raised with brick as required to meet ash condition.
2-24" Conc. Pipe Lgth. & location by Field Inv. El. 737.0± inlet El. 735.0± outlet
DETAIL A Scale: 1"=100'
Stages 5, 6 etc. - Continue in similar manner to ultimate grade (El. 765)
Stage 3, Top of ash
Bottom Ash
Earth Dike
Stage 4 - Raise dike 4'± - 8'±
Berm 12' or wider Slopes 3:1 or flatter
Stage 3 - Ash 1'-3' below top of dike
Stage 1, Top of ash
Stage 2, Raise dike 4'± - 8'±
ASH
Stage 1 - Ash 1'-3' below top of dike
STAGES FOR RAISING DIKES WITH ASHES
Scales Vert. 1"=20' Hor. 1"=30'
Dike "C" added
Future Ash Disposal Added
GENERAL
ASH DISPOSAL AREA
KINGSTON STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN
SUBMITTED RECOMMENDED APPROVED
KNOXVILLE 8-8-51 36 C 4 10N400
RECORD DRAWING AS CONSTRUCTED 7-5-56

APPENDIX I
EXPLORATORY DRILLING SAP

Exploratory Drilling
Sampling and Analysis Plan
Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	June 15, 2018
1	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	November 9, 2018

EXPLORATORY DRILLING
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Exploratory Drilling
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018 Revision 1

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 — Date 11/6/18

McClung, Nicholas Anthony — Digitally signed by McClung, Nicholas Anthony Date: 2018.11.05 10:14:03 -05'00'
TVA Investigation Field Lead — Date

Health, Safety, and Environmental (HSE) Manager — Date 11-7-18

Investigation Project Manager — Date 10/24/2018

Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.11.05 20:33:55 -05'00'
QA Oversight Manager — Date

Laboratory Project Manager — Date 10/24/2018

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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 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 September 16, 2016, TVA submitted KIF EIP Revision 0 to TDEC.

On June 22, 2017, TDEC issued a letter to TVA regarding the TDEC Order and attached to the letter were environmental investigation comments for the TVA KIF site. According to this letter and subsequent discussions between TVA and TDEC, the specific questions and tasks found in the June 22, 2017 TDEC letter were to supersede the original specific questions and tasks found in TDEC's June 14, 2016 letter. On September 8, 2017, TVA submitted the KIF EIP Rev. 1 to TDEC.

On December 8, 2017, TDEC issued a letter to TVA regarding their review of the KIF Rev. 1 EIP and attached to the letter were environmental investigation comments. On March 2, 2018, TVA submitted the KIF EIP Rev. 2 to TDEC.

On May 2, 2018, TDEC issued a letter to TVA regarding their review of the KIF Rev. 2 EIP and attached to the letter were environmental investigation comments. This KIF Rev. 3 EIP has been prepared to address those comments.

Through the various information requests, as well as TDEC comments, a need for several exploratory borings at KIF (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 Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and 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 boring locations were selected to aid in addressing data gaps and supplementing existing data, as necessary to address information requests of the TDEC Multi-site Order for KIF. Rationale for individual borings with temporary well locations are discussed below. Refer to Figure 1 in Attachment A for a layout of proposed locations.

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 borings with temporary well installations at locations shown on Figure 1 in Attachment A. These additional borings will provide supplemental data relative to CCR thickness, water levels, and foundation soil type for the interior of the CCR units. A total of 5 borings with temporary well installations are proposed. Table 1 provides the number of borings with temporary well installations proposed in each CCR unit. Table 2 lists the borings and more detail about the purpose of each.

Table 1. Exploratory Drilling Proposed in each CCR Unit

CCR Unit	No. of Borings with Temporary Wells
Interim Ash Staging Area	3
Sluice Trench and Ballfield East of Sluice Trench	2
Total	**5**

Table 2. Detailed Boring Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	Boring Purpose[1]
TW01	Interim Ash Staging Area	Foundation Soils	Sluiced Ash	PZ, PW, Geo
TW02	Interim Ash Staging Area	Foundation Soils	Sluiced Ash	PZ, PW, Geo
TW03	Interim Ash Staging Area	Foundation Soils	Sluiced Ash	PZ, PW, Geo
TW04	Sluice Trench and Ballfield East of Sluice Trench	Foundation Soils	Sluiced Ash	PZ, PW, Geo
TW05	Sluice Trench and Ballfield East of Sluice Trench	Foundation Soils	Sluiced Ash	PZ, PW, Geo

[1] PZ = Piezometric (Water) Levels in CCR; PW = Pore Water Sampling; Geo = Geotechnical Data

As shown in Figure 1, a total of five (5) borings with temporary wells (labeled TW01 through TW05) are proposed within the footprints of the Interim Ash Staging Area (3 temporary wells) and Sluice Trench and Ballfield East of Sluice Trench (2 temporary wells). The temporary wells are located in accessible areas of the unit interiors to improve spatial coverage for CCR thickness and water levels, and to facilitate CCR material characterization and pore water sampling. The temporary wells will be screened near the bottom of the CCR in the units, after the portion of the borehole is sealed that penetrated the foundation soils.

Borings will be advanced using a conventional rotary drill rig with standard penetration test (SPT) and undisturbed (Shelby) tube sampling. SPT samples will be collected for general soil and CCR characterization. Undisturbed tube samples will be collected for laboratory testing. No rock coring or downhole testing in rock is proposed for the units at KIF.

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.
- If a boring will penetrate an engineered final cap component (e.g., low hydraulic conductivity soil layer, geosynthetic cap system, or vegetative soil layer), a temporary penetration will be prepared to allow drilling access. When applicable, field work plans will include detailed procedures for creating this temporary penetration.

- 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 (only where specified) 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 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 casing will be installed and seated into competent rock. The purpose of the 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 Field Team Leader, 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 (only where specified) 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

The decontamination procedures below apply to drilling and sampling in borings for temporary wells. For drilling and sampling in all other borings, as well as for all cone penetration testing, decontamination (per procedures listed in TVA TI ENV-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*) will only occur before the first boring/CPT and after the last boring/CPT.

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 (only 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, geosynthetic cap system, or vegetative soil layer), these interval(s) will be backfilled such that equivalent or better performance is maintained. When applicable, field work plans will include procedures for repair of geosynthetics, protection around well riser pipes, and quality control monitoring and testing of such repairs.

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 grout will be placed by tremie method through one-inch (minimum) diameter PVC. The grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process. In open (uncased) boreholes, the sand filter zones and bentonite pellets will be placed by tremie method through one-inch (minimum) diameter PVC. In cased boreholes (i.e., through hollow-stem augers or temporary casing), the sand filter zones and bentonite pellets may be placed by tremie method or may be poured slowly into the annular space of the drill tooling to prevent bridging.

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-inch (minimum) 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 2. A drawing of the wellhead construction is shown in Figure 3.

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 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 Project Manager 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	60 Days	Following Field Preparation
Laboratory Analysis (if any)	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.

9.0 REFERENCES

Tennessee Valley Authority (2017a). "Field Record Keeping." Technical Instruction ENV-TI-05.80.03. March.

Tennessee Valley Authority (2017b). "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05. March.

Tennessee Valley Authority (2017c). "Monitoring Well and Piezometer Installation and Development." Technical Instruction ENV-TI-05.80.25. May.

United States Army Corps of Engineers (2001). "Geotechnical Investigations." EM 1110-1-1804. January.

ATTACHMENT A
FIGURES

Figure No.
1

Title
Proposed Temporary Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-31
Technical Review by EM on 2018-10-31

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe (Screened Interval)
- Existing Piezometer Vibrating Wire (Tip Interval)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- TVA Property Boundary (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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TVA

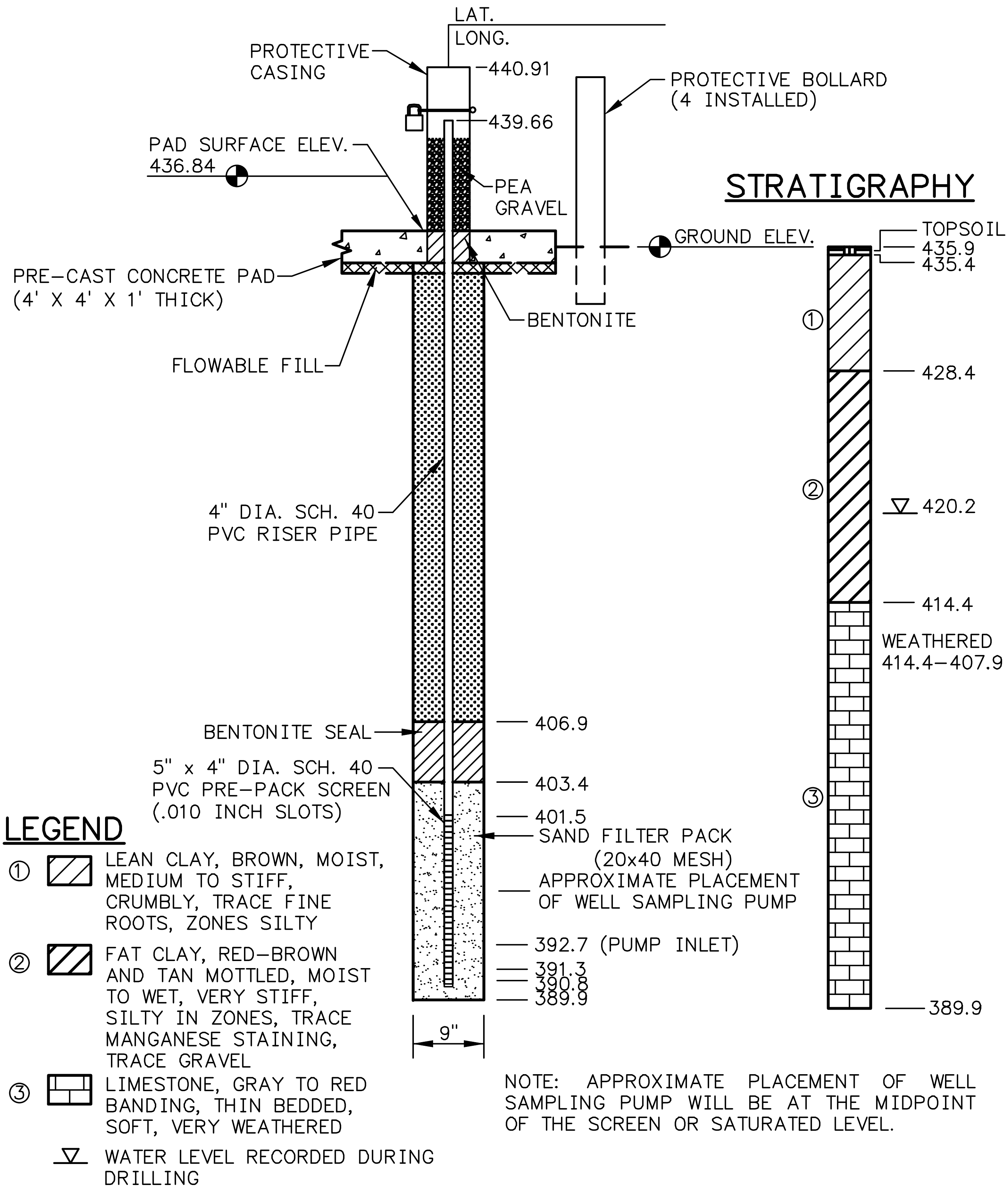
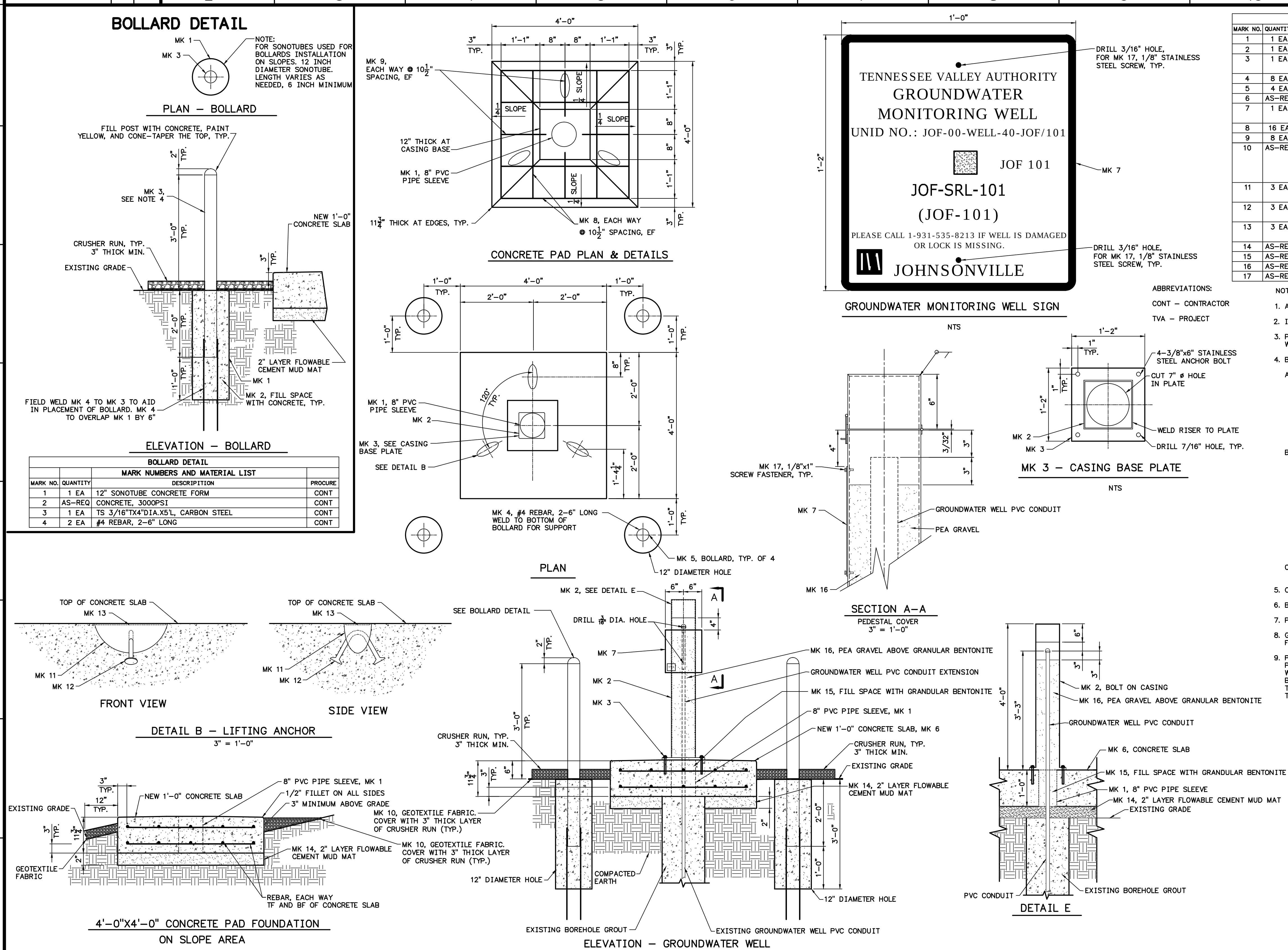


Figure 2. Temporary Well Installation Schematic



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

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.

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											

DISCIPLINE INTERFACE

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

TASK COMPLETED BY: | REV NO.

PLOT FACTOR: W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

Figure 3. 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
Acoustic Televiewer
Rubber packers
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 J
BACKGROUND SOIL SAP

Background Soil
Sampling and Analysis Plan
Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	September 8, 2017
2	Addresses December 8, 2017 TDEC Review Comments and Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	November 9, 2018

BACKGROUND SOIL
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Background Soil
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018

Revision 4

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 — Date 11/6/18

McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.11.05 10:11:40 -05'00'
TVA Investigation Field Lead — Date

Health, Safety, and Environmental (HSE) Manager — Date 11-7-18

Investigation Project Manager — Date 10/24/2018

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.11.05 20:32:16 -05'00'
QA Oversight Manager — Date

Laboratory Project Manager — Date 11/2/18

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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of 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 provide procedures and methods necessary to characterize background soils in the vicinity of the KIF 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 Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and 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 twelve-proposed background soil sampling locations is provided as Figure 1 (Attachment A). Figure 1 additionally depicts the locations of proposed background groundwater monitoring well KIF-102 as well as existing background monitoring wells AD-1 and GW-1. Background soil boring KIF-BG-04 is collocated with the location of KIF-102. In the event that additional background groundwater monitoring wells are proposed, soil samples will be collected through the well screen intervals. The locations were selected based on access, current hydrogeologic knowledge, and the sample location criteria set forth by TDEC. In addition, areas where known or suspected beneficial reuse of CCR has occurred were excluded from consideration as sampling locations. Additional considerations in selection of background soil boring locations included: 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 will be conducted at locations shown on Figure 1, all of which are within a one-mile radius of the Plant. Soil borings will be advanced using a direct-push technology (DPT) drill rig (typically equipped with five-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 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). Each boring will be logged by a Tennessee-licensed professional geologist.

In addition to collection of soil samples from the twelve-background soil boring locations, accessible rock and residuum outcrops in the vicinity of the Plant will be visually inspected in an attempt to determine if naturally occurring sources of metallic ore minerals are present in the area. This visual inspection is needed due to the presence of 23 mineral deposits listed by the United States Geological Service in Roane County, Tennessee. The presence of metallic ore deposits in the area, which include both barium and lead deposits, could naturally increase the concentrations of these elements in the background soils. If the visual inspections identify potential naturally occurring sources of metallic ore minerals, rock samples will be collected for further assessment.

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 planned in accordance with TVA TI ENV-TI-05.80.01 *Planning Sampling* Events, conducted according to TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling*, and 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. If a proposed boring location is discovered to have accessibility restrictions related to agricultural, cultural, biological, or other such limiting factors, then a replacement boring will be proposed at a location that will meet the study's goals with approval from TDEC.

- 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. Sampling activities will be conducted according to TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling*.

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 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) for 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 Field Team Leader, 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 Project Manager 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 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 <6º C	4 oz. glass	180 days
Mercury	SW-846 7471B	Cool to <6º C	4 oz. glass	28 days
Radium 226	SW-846 901.1	Cool to <6º C	8 oz. glass	180 days
Radium 228	SW-846 901.1	Cool to <6º C	8 oz. glass	180 days
Chloride	SW-846 9056A Modified	Cool to <6º C	4 oz. glass	28 days
Fluoride	SW-846 9056A Modified	Cool to <6º C	4 oz. glass	28 days
Sulfate	SW-846 9056A Modified	Cool to <6º C	4 oz. glass	28 days
pH	SW-846 9045D Modified	Cool to <6º 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 Project Manager 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 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 1995.

Environmental Protection Agency (EPA). 2004. "National Functional Guidelines for Inorganic Data Review." October.

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Tennessee Valley Authority (TVA). 2017a. "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0000 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. "Soil and Sediment Sampling." Technical Instruction ENV-TI-05.80.50, Revision 0000 September 29.

ATTACHMENT A
FIGURE

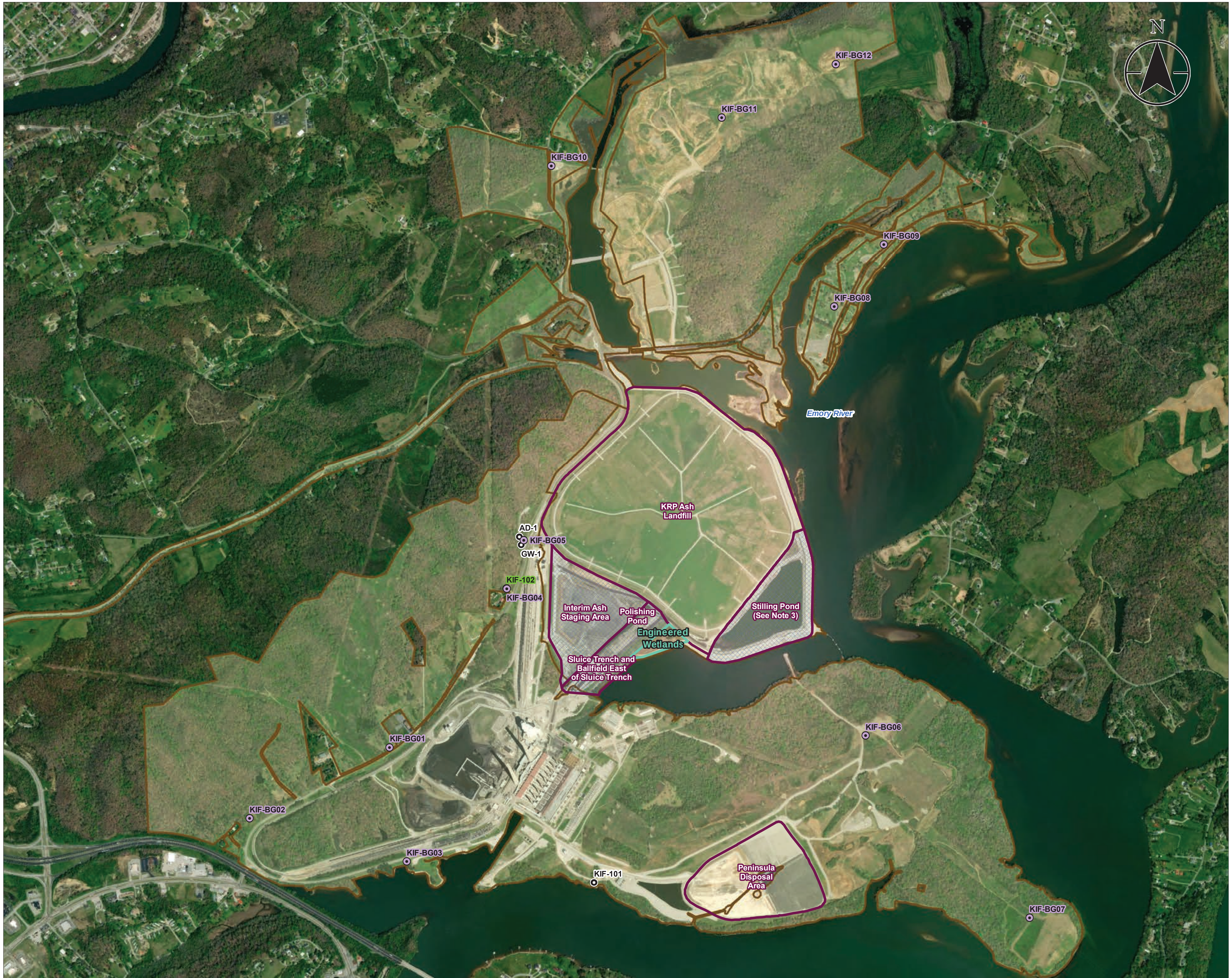


Figure No.
1

Title
Proposed Background Soil Sampling Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-11-06
Technical Review by EM on 2018-11-06

0 750 1,500 2,250 3,000 Feet
1:9,000 (At original document size of 22x34)

Legend

- Existing Background Monitoring Well Location
- Proposed Groundwater Well Location
- Proposed Background Soil Sample Location
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- KIF Study Area Boundary
- TVA Property Boundary (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by ESRI
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec

TVA

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 K
NPDES OUTFALL DATA

Summary of NPDES Outfall Analytical Results
Kingston Fossil Plant - 001
Kingston, Tennessee

TSS (mg/l)

DATCOL	VALUE	DATCOL	VALUE	DATCOL	VALUE
01/06/2015	18.9	12/06/2016	14.8	07/25/2017	5.4
02/03/2015	9.47	01/05/2017	7.4	08/03/2017	3.8
03/02/2015	11.5	02/01/2017	3.7	08/08/2017	6.6
04/02/2015	5.79	03/09/2017	4.6	08/14/2017	4.7
05/12/2015	5.6	03/14/2017	14.1	08/23/2017	4.1
06/02/2015	6.7	03/21/2017	7.2	08/29/2017	3.3
07/07/2015	29.4	03/28/2017	7	09/06/2017	4.7
08/04/2015	11.2	04/04/2017	6.8	09/11/2017	2.3
09/01/2015	7.08	04/11/2017	6.4	09/11/2017	2.8
09/01/2015	7.33	04/19/2017	4.8	09/18/2017	4.5
10/07/2015	5.6	04/25/2017	21.8	09/26/2017	4.9
11/03/2015	7	04/25/2017	22.2	10/03/2017	4.7
12/01/2015	8.8	05/02/2017	5.4	10/12/2017	5.2
01/05/2016	9.23	05/08/2017	9.9	10/18/2017	4.3
02/02/2016	8.5	05/16/2017	3.8	10/25/2017	8
03/01/2016	5.1	05/22/2017	4.4	11/01/2017	7.2
04/05/2016	15.6	05/30/2017	5.3	11/08/2017	21.1
05/03/2016	6.6	06/06/2017	11.5	11/15/2017	6.5
06/01/2016	6	06/13/2017	7	11/20/2017	3.2
07/05/2016	21.3	06/20/2017	6.6	11/20/2017	3.23
08/02/2016	10.1	06/26/2017	7	11/30/2017	6.8
09/06/2016	16.8	07/05/2017	5.9	12/06/2017	4.1
10/05/2016	7.9	07/05/2017	6.2	12/13/2017	3.4
10/05/2016	6.2	07/11/2017	6.7	12/19/2017	3
11/01/2016	13.4	07/19/2017	6.9	12/27/2017	8.1
12/06/2016	15.7				

Summary of NPDES Outfall Analytical Results
Kingston Fossil Plant - 001
Kingston, Tennessee

Oil and Grease (mg/l)

DATCOL	SYM	VALUE	DATCOL	SYM	VALUE
01/06/2015	<	4.57	04/25/2017	<	4.5
02/03/2015	<	4.17	05/02/2017	<	4.4
03/02/2015	<	4.27	05/08/2017	<	4.4
04/02/2015	<	5.26	05/16/2017	<	4.5
05/12/2015	<	4.36	05/22/2017	<	4.7
06/02/2015	<	4.57	05/30/2017	<	4.6
07/07/2015	<	4.41	06/06/2017	<	4.7
08/04/2015	<	4.47	06/13/2017	<	4.4
09/01/2015	<	4.13	06/20/2017	<	5.3
10/07/2015	<	4.36	06/26/2017	<	4.6
11/03/2015	<	4.27	07/05/2017	<	4.4
12/01/2015	<	4.31	07/11/2017	<	4.8
01/05/2016	<	4.47	07/19/2017	<	4.4
02/02/2016	<	4.27	07/25/2017	<	4.7
03/01/2016	<	4.52	08/03/2017	<	4.4
04/05/2016	<	4.52	08/08/2017	<	4.6
05/03/2016	<	4.57	08/14/2017	<	5.1
06/01/2016	<	4.09	08/23/2017	<	4.7
06/28/2016	<	4.63	08/29/2017	<	4.4
06/28/2016	<	4.36	09/06/2017	<	4.7
06/29/2016	<	4.36	09/11/2017	<	4.5
06/29/2016	<	4.17	09/18/2017	<	4.5
07/05/2016	<	4.13	09/26/2017	<	4.7
08/02/2016	<	4.1	10/03/2017	<	4.8
09/06/2016	<	4	10/12/2017	<	4.4
10/05/2016	<	4.3	10/18/2017	<	4.2
11/01/2016	<	4.3	10/25/2017	<	4.2
12/06/2016	<	4.4	11/01/2017	<	4.4
01/05/2017	<	4.2	11/08/2017	<	4.3
02/01/2017	<	4.7	11/15/2017	<	4.3
03/09/2017	<	4.2	11/20/2017	<	4.3
03/14/2017	<	4.4	11/30/2017	<	4
03/21/2017	<	4.4	12/06/2017	<	4.5
03/28/2017	<	4.5	12/13/2017	<	4.2
04/04/2017	<	4.3	12/19/2017	<	4
04/11/2017	<	4.4	12/27/2017	<	4
04/19/2017	<	4.4			

Summary of NPDES Outfall Analytical Results

Kingston Fossil Plant - 001

Kingston, Tennessee

pH

DATCOL	VALUE	DATCOL	VALUE	DATCOL	VALUE
01/06/2015	6.71	01/05/2016	6.55	01/05/2017	6.6
01/13/2015	6.57	01/12/2016	7.02	01/10/2017	6.65
01/20/2015	6.89	01/19/2016	7.51	01/17/2017	7.95
01/27/2015	6.93	01/26/2016	7.47	01/25/2017	6.61
02/03/2015	7	02/02/2016	7.01	02/01/2017	6.73
02/10/2015	6.67	02/09/2016	7.33	02/07/2017	7.54
02/20/2015	8.13	02/16/2016	6.93	02/14/2017	7.7
02/23/2015	6.62	02/24/2016	6.38	02/23/2017	7.27
03/02/2015	7.2	03/01/2016	6.3	02/28/2017	7.4
03/11/2015	6.99	03/08/2016	7.7	03/09/2017	7.12
03/11/2015	6.91	03/08/2016	7.65	03/09/2017	7.11
03/17/2015	7.3	03/15/2016	7.55	03/14/2017	7.27
03/24/2015	7.63	03/22/2016	7.88	03/21/2017	7.71
04/02/2015	7.52	03/29/2016	7.92	03/28/2017	7.71
04/07/2015	7.67	04/05/2016	6.84	04/04/2017	7.92
04/14/2015	7.17	04/12/2016	6.98	04/11/2017	7.37
04/21/2015	6.8	04/19/2016	6.75	04/19/2017	7.59
04/28/2015	7.37	04/26/2016	7.17	04/25/2017	7.26
05/05/2015	8.09	05/03/2016	7.33	05/02/2017	7.83
05/12/2015	8.29	05/10/2016	7.74	05/08/2017	7.54
05/19/2015	8.1	05/18/2016	7.27	05/08/2017	7.57
05/27/2015	8.01	05/18/2016	7.26	05/16/2017	7.5
05/27/2015	8.02	05/24/2016	8.19	05/22/2017	7.55
06/02/2015	8.25	06/01/2016	8.09	05/30/2017	7.66
06/09/2015	8.38	06/07/2016	7.88	06/06/2017	7.59
06/16/2015	8.63	06/14/2016	8.01	06/13/2017	7.73
06/24/2015	8.27	06/22/2016	7.9	06/20/2017	7.58
06/29/2015	8.13	06/30/2016	8.54	06/26/2017	7.73
07/07/2015	8.71	07/05/2016	7.72	07/05/2017	7.37
07/15/2015	7.78	07/12/2016	8.15	07/11/2017	8.06
07/21/2015	7.94	07/19/2016	8.49	07/19/2017	7.3
07/21/2015	7.95	07/26/2016	7.95	07/19/2017	7.35
07/28/2015	8.53	07/26/2016	8	07/25/2017	7.73
08/04/2015	8.44	08/02/2016	8.14	08/03/2017	7.96
08/11/2015	8.22	08/10/2016	8.07	08/08/2017	7.77
08/19/2015	7.81	08/16/2016	8.17	08/14/2017	7.7
08/26/2015	8.66	08/23/2016	8.03	08/23/2017	7.7
09/01/2015	8.45	08/30/2016	8.14	08/29/2017	7.66
09/08/2015	8.36	09/06/2016	7.84	09/06/2017	7.45
09/14/2015	8.54	09/14/2016	7.35	09/11/2017	7.22
09/23/2015	7.35	09/20/2016	7.27	09/20/2017	7.65

Summary of NPDES Outfall Analytical Results

Kingston Fossil Plant - 001

Kingston, Tennessee

pH

DATCOL	VALUE	DATCOL	VALUE	DATCOL	VALUE
09/30/2015	7.71	09/27/2016	7.78	09/20/2017	7.67
09/30/2015	7.68	10/05/2016	7.58	09/26/2017	7.75
10/07/2015	8.06	10/05/2016	7.61	10/03/2017	7.64
10/14/2015	7.74	10/13/2016	7.73	10/12/2017	7.57
10/20/2015	7.51	10/19/2016	7.58	10/18/2017	7.63
10/26/2015	7.55	10/25/2016	7.64	10/19/2017	7.16
11/03/2015	7.54	11/01/2016	7.85	11/01/2017	7.1
11/10/2015	7.41	11/08/2016	7.44	11/08/2017	7.4
11/18/2015	7.61	11/15/2016	7.06	11/15/2017	7.2
11/24/2015	7.17	11/22/2016	7.15	11/20/2017	7.21
12/01/2015	7.02	11/29/2016	7.1	11/30/2017	7.25
12/09/2015	6.64	12/06/2016	7.28	11/30/2017	7.27
12/09/2015	6.65	12/13/2016	8.51	12/06/2017	7.37
12/15/2015	6.64	12/13/2016	8.57	12/13/2017	7.79
12/22/2015	6.67	12/19/2016	7.21	12/19/2017	7.74
12/28/2015	7.03	12/28/2016	7.58	12/27/2017	7.12

Summary of NPDES Outfall Analytical Results

Kingston Fossil Plant - 001

Kingston, Tennessee

Ammonia Nitrogen (mg/l)

DATCOL	SYM	VALUE	DATCOL	SYM	VALUE
01/06/2015	<	0.1	01/05/2017		0.103
01/20/2015		0.15	01/17/2017	<	0.1
02/03/2015	<	0.1	02/01/2017	<	0.1
02/20/2015		0.133	02/14/2017	<	0.1
03/02/2015		0.145	03/09/2017	<	0.1
03/17/2015	<	0.1	03/14/2017		0.371
04/02/2015		1.44	03/21/2017	<	0.1
04/14/2015		0.149	03/28/2017	<	0.1
05/12/2015		0.112	04/04/2017	<	0.1
05/19/2015		0.189	04/11/2017	<	0.1
06/02/2015	<	0.1	04/11/2017	<	0.1
06/09/2015	<	0.1	04/19/2017	<	0.1
06/09/2015	<	0.1	04/25/2017	<	0.1
07/07/2015	<	0.1	05/02/2017	<	0.1
07/15/2015		0.169	05/08/2017	<	0.1
08/04/2015	<	0.1	05/16/2017	<	0.1
08/19/2015	<	0.1	05/22/2017	<	0.1
09/01/2015		0.232	05/30/2017	<	0.1
09/14/2015	<	0.1	06/06/2017	<	0.1
10/07/2015	<	0.1	06/13/2017		0.128
10/07/2015	<	0.1	06/20/2017	<	0.1
10/20/2015	<	0.1	06/20/2017	<	0.1
11/03/2015	<	0.1	06/26/2017	<	0.1
11/18/2015	<	0.1	07/05/2017	<	0.1
12/01/2015		0.101	07/11/2017	<	0.1
12/15/2015		0.165	07/19/2017	<	0.1
01/05/2016	<	0.1	07/25/2017	<	0.1
01/19/2016	<	0.1	08/03/2017	<	0.1
02/02/2016		0.14	08/08/2017	<	0.1
02/16/2016		0.145	08/14/2017	<	0.1
03/01/2016		0.515	08/23/2017	<	0.1
03/08/2016		0.158	08/29/2017	<	0.1
04/05/2016	<	0.1	08/29/2017	<	0.1
04/19/2016	<	0.1	09/06/2017	<	0.1
05/03/2016		0.115	09/11/2017	<	0.1
05/10/2016		0.102	09/18/2017	<	0.1
05/10/2016	<	0.1	09/26/2017	<	0.1
06/01/2016	<	0.1	10/03/2017	<	0.1
06/07/2016		0.246	10/12/2017	<	0.1
07/05/2016	<	0.1	10/18/2017	<	0.1
07/19/2016	<	0.1	10/25/2017	<	0.1

Summary of NPDES Outfall Analytical Results

Kingston Fossil Plant - 001

Kingston, Tennessee

Ammonia Nitrogen (mg/l)

DATCOL	SYM	VALUE	DATCOL	SYM	VALUE
08/02/2016	<	0.1	11/01/2017		0.177
08/16/2016		0.231	11/08/2017	<	0.1
09/06/2016		0.157	11/08/2017	<	0.1
09/20/2016	<	0.1	11/15/2017	<	0.1
10/05/2016	<	0.1	11/20/2017	<	0.1
10/13/2016	<	0.1	11/30/2017	<	0.1
10/13/2016	<	0.1	12/06/2017		0.109
11/01/2016	<	0.1	12/13/2017		0.105
11/08/2016	<	0.1	12/19/2017	<	0.1
12/06/2016		0.321	12/27/2017	<	0.1
12/13/2016		0.256			

APPENDIX L
EVALUATION OF EXISTING GEOTECHNICAL DATA

Evaluation of Existing Geotechnical Data Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	September 8, 2017
2	Addresses December 8, 2017 TDEC Review Comments and Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Issued for TDEC Approval	November 9, 2018

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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF 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, 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 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 the waste fill and side-slope berms,
3. CCR and soil material parameters.

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 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 and extents (horizontal and vertical) of various foundation soils beneath the CCR and perimeter dikes.

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

1. Suitability of methods used to perform topographic surveys and geotechnical borings, 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.

2. Spatial coverage of borings.

3. Potential for relevant changes in subsurface conditions since borings were performed.

2.2 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.

2.3 CCR AND SOIL MATERIAL PARAMETERS

For evaluating CCR and soil material parameters (e.g., shear strengths, hydraulic conductivity), existing data to be considered includes:

1. Parameters based on in-situ testing,

2. Parameters based on laboratory testing,

3. Parameters 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 judged 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.

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. Unless otherwise noted, boring locations from each of the summarized reports are shown on Figure 1 in Attachment A.

Existing geotechnical data collected in materials impacted by the 2008 KIF Dredge Cell failure, which are not representative of materials within the Study Area, will not be used to evaluate the CCR units in the Study Area.

3.1 TVA (1951)

Table 1. Summary of Evaluation for TVA (1951)

Reference:	Tennessee Valley Authority (1951). "Preliminary Geological Investigations for Eastern Area Steam Plant." Report by Charles P. Bensiger and John M. Kellberg for TVA Division of Water Control Planning, Geologic Branch. February.	
Purpose:	Preliminary site explorations for proposed Kingston Plant	
CCR Unit(s):	None	
Spatial coverage:	Steam Plant	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	41 Borings
Rock coring:	Yes	41 Borings
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:	No	
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:	No	

3.1.1 Field Activities

In 1951, 41 soil and rock core borings were advanced on a grid pattern (predominantly spaced on 200-feet centers) within the vicinity of the proposed Kingston Steam Plant site. A total of 1,775 feet of rock core was advanced using “fishtail” drilling methods and diamond bit coring techniques.

Additionally, a test pit and a 250-foot long test trench were excavated to sound bedrock to examine the rock surface. The preliminary investigation was to ascertain a generalized profile of the bedrock conditions for the proposed steam plant and was not an investigation of the subsurface conditions beneath the future CCR disposal units. Thus, the boring locations are not included in figure 1.

3.1.2 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. General bedrock formation descriptions in the vicinity of the CCR disposal units.

3.2 TVA (1964)

Table 2. Summary of Evaluation for TVA (1964)

Reference:	TVA. (1964). "The Kingston Steam Plant, A Report on the Planning, Design, Construction, Costs, and First Power Operations, Technical Report No. 34." July 2.	
Purpose:	Preliminary site explorations for proposed Kingston Plant	
CCR Unit(s):	None	
Spatial coverage:	Steam Plant	
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:	No	
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:	No	

3.2.1 Field Activities

This report summarizes the preliminary foundation exploration (TVA 1951) that was conducted to determine the approximate surface of bedrock and to characterize the geologic formations at the proposed Kingston Steam Plant site. A total of 41 rock core borings were drilled. A test pit and a 250-foot long test trench were excavated to sound bedrock to examine the top of rock and determine the permeability of the overburden soils.

3.2.2 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. General bedrock formation descriptions in the vicinity of the CCR disposal units.

3.3 TVA (1975)

Table 3. Summary of Evaluation for TVA (1975)

Reference:	TVA. (1975). "Kingston Steam Plant, Ash Disposal Area Dike Raising, Soil Investigation." November 3.	
Purpose:	Exploration of existing perimeter dike, foundation soils, and on-site borrow sources in anticipation of future raised dike construction.	
CCR Unit(s):	Stilling Pond	
Spatial coverage:	Inside and outside edges of the starter dike crest (Dike C and Road Dike), 3 borrow areas (A, B, and C) on Peninsula	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	24 borings (existing perimeter dike), 31 borings (borrow areas)
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Elevations provided by TVA
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	No	
Piezometer installation:	No	
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing follows ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strength of existing CCR and foundation soils
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.3.1 Field Activities

A total of 24 soil borings were drilled in 1975 along the inside and outside edges of the perimeter dike crest (Dike C and Road Dike) of the Ash Disposal Area. The approximate locations are shown on the boring layout in Figure 1.

The borings were drilled using truck-mounted drill rigs with hollow stem augers. Borings extended up to 43 feet in depth into ash, embankment dike materials, and foundation soils. SPTs were performed in all the borings at selected intervals and Shelby tube samples were obtained at selected locations. No boring backfill methods were documented.

In addition to the dike exploration, three separate potential areas were explored in the Peninsula Area for borrow material to raise the existing dikes. The three borrow areas (labeled A, B, and C) had 15, 10, and 6 borings drilled, respectively, for a total of 31 borings overall. These borings are outside the area of the CCR impoundments and were not included in Figure 1.

The borings were drilled using truck-mounted drill rigs with hollow stem augers. Borings extended up to 32 feet in depth into clay foundation soils. SPTs were not performed. Boring backfill methods and soil sampling methods were not documented. Based upon the encountered subsurface conditions, approximately 2,000,000 cubic yards of clay material is available from these borrow source areas.

3.3.2 Laboratory Testing

Laboratory tests were performed in accordance with ASTM standard testing procedures. The disturbed (SPT) and undisturbed (Shelby tube) soil samples obtained from the dike exploration during conventional drilling were subjected to the following laboratory tests:

- 21 natural moisture content
- 4 Atterberg limits
- 21 gradations
- 19 unit weight tests
- 8 UU triaxial tests
- 12 CU triaxial tests
- 1 vane shear test

The soil samples obtained from the borrow source exploration during conventional drilling were subjected to the following laboratory tests:

- 4 natural moisture contents
- 4 Atterberg limits
- 4 gradations
- 4 specific gravity tests
- 4 standard Proctor tests
- 8 UU triaxial tests
- 8 CU triaxial tests

3.3.3 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 different, but the foundation geometry is substantially the same as current.
2. Soil properties (including shear strengths)
    a. Sampling and testing standards are unknown, but results can be used qualitatively to compare against other data.
    b. Foundation soil conditions should be substantially the same as current except in the area of 2008 dredge cell failure.

3.4 TVA (1982)

Table 4. Summary of Evaluation for TVA (1982)

Reference:	TVA. (1982). "Potential Ground-Water Quality Impacts at TVA Steam Plants, Report No. WR28-2-520-119." September.	
Purpose:	To assess, through a reconnaissance level survey, the potential for impacts on groundwater resources from existing waste disposal facilities at the 12 TVA fossil fuel steam plants.	
CCR Unit(s):	Interim Ash Staging Area, Sluice Channel, Stilling Pond	
Spatial coverage:	Entire Kingston Site	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	Yes	Geologic lithology and mapping references for Kingston site.
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	No	
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:	No	

3.4.1 Field Activities

A reconnaissance trip was performed in 1981 to evaluate the potential of leachate from the waste disposal facilities to migrate offsite and to impact groundwater aquifers (i.e., an aquifer which yields substantial supply to municipal, industrial, agricultural, or multiple domestic needs or has the potential for future development of a water supply).

3.4.2 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. General bedrock formation descriptions at the Kingston site.

3.5 MACTEC (2004)

Table 5. Summary of Evaluation for MACTEC (2004)

Reference:	MACTEC. 2004. "Report of Geotechnical Exploration, Ash Disposal Area, Kingston Fossil Plant, Kingston, Tennessee." Prepared for Tennessee Valley Authority. May 4.	
Purpose:	To determine subsurface conditions and obtain data to evaluate strength and hydraulic conductivity of the ash materials and consolidation characteristics of the alluvial soils.	
CCR Unit(s):	Stilling Pond	
Spatial coverage:	Perimeter of Stilling Pond adjacent to former Dredge Cell and along Dike C. Several borings associated with the former Dredge Cell.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	21 Borings (18 former Dredge Cell, 3 Stilling Pond)
Rock coring:	No	
Other subsurface data:	Yes	11 CPT borings (8 former Dredge Cell, 3 Stilling Pond)
Boring locations surveyed:	Yes	Borings surveyed by TVA after drilling, but coordinates not documented in report. Boring layout drawing is provided.
Data adequate to support three-dimensional model:	No	No boring logs were found.
Geometry at time of document representative of 2017 conditions:	No	
Piezometer installation:	Yes	3 Piezometers (former Dredge Cell)
In-situ testing:	Yes	SPT, CPT (with pore pressure dissipation), Hydraulic Conductivity
Laboratory testing:	Yes	Testing standards are not documented, but likely followed ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strength of existing CCR.
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Laboratory testing is representative of existing CCR and foundation soils.
Other relevant analyses:	No	

3.5.1 Field Activities

A subsurface exploration program was developed that consisted of a total of 21 soil borings, 18 within the former Dredge Cell and three (3) around the Stilling Pond. Eleven CPT borings were performed, eight (8) within the Ash Disposal Area and three (3) around the Stilling Pond.

The borings were drilled using truck-mounted and all-terrain vehicle mounted drill rigs and hollow stem augers. Boring depths ranged from 5 to 101.5 feet. SPTs were performed in accordance with ASTM D1586, at five-foot intervals. Shelby tube samples were obtained in accordance with ASTM D1587 at depths determined by MACTEC within five borings. Water levels within the borings were observed during drilling. Along the northwest perimeter of the former Dredge Cell, three auger borings were drilled to allow in-situ hydraulic conductivity testing and three borings were drilled to install piezometers.

Eleven CPT soundings were performed in accordance with ASTM D5778. Pore pressure dissipation tests were performed in the CPT soundings to evaluate the rate of pore pressure dissipation within the CCR materials and the foundation soils.

Upon completion of drilling, the borings were backfilled with a Type 1 Portland cement-bentonite grout mixture using a tremie method. All borings and CPT sounding locations were surveyed by TVA and the location and top of hole elevations for each boring were provided to MACTEC.

3.5.2 Laboratory Testing

The disturbed (SPT) and undisturbed (Shelby tube) soil samples obtained during conventional drilling were subjected to the following laboratory tests:

- 59 natural moisture contents
- 6 Atterberg limits
- 27 gradation
- 18 specific gravity
- 13 unit weight tests
- 3 CU triaxial with pore pressure measurements
- 2 falling head permeability tests
- 1 consolidation test

3.5.3 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; however, documentation of the boring locations was not recovered,
    b. Perimeter dike geometry is substantially different in some areas after the 2008 Dredge Cell failure, but the foundation geometry is substantially the same as current.
2. Soil properties (including shear strengths)
    a. Sampling and testing standards are unknown, but results can be used qualitatively to compare against other data.
    b. Subsurface conditions are substantially the same as current except in area of 2008 Dredge Cell failure.

3.6 AECOM (2009)

Table 6. Summary of Evaluation for AECOM (2009)

Reference:	AECOM. (2009). "Root Cause Analysis Report, TVA Kingston Dredge Pond Failure". Prepared for Tennessee Valley Authority. June 25.	
Purpose:	Evaluation of the most probable cause(s) and location of the dredge cell failure.	
CCR Unit(s):	Stilling Pond	
Spatial coverage:	Divider Dike between Stilling Pond and former Ash Pond (now part of the Recovery Project Landfill footprint)	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 borings (800-series)
Rock coring:	No	
Other subsurface data:	Yes	2 CPTs (800-series)
Boring locations surveyed:	Yes	Surveyed by TVA
Data adequate to support three-dimensional model:	Yes	Data support foundation soil stratigraphy
Geometry at time of document representative of 2017 conditions:	No	
Piezometer installation:	No	
In-situ testing:	Yes	SPT, Vane Shear, CPT
Laboratory testing:	Yes	Testing followed ASTM standards
Shear strength parameters:	Yes	Drained and undrained shear strengths of CCR and foundation soils
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.6.1 Field Activities

The field exploration program included 87 cone penetrometer (CPT) soundings, 59 SPT borings, 48 vane shear test (VST) borings, and 40 borings to collect undisturbed samples using an Osterberg piston sampler (OST). This exploration was focused on the failed Dredge Cell, but for this evaluation of existing geotechnical data, only borings associated with the Stilling Pond will be considered. Thus, six borings and two CPTs were performed at 2 locations within the 800-series borings. Each location had a SPT, VST, OST, and CPT boring performed. Upon completion of the borings and CPTs, the locations were surveyed into Tennessee state plane coordinates. The approximate locations of the 800-series borings are shown on Figure 1.

3.6.2 Laboratory Testing

Laboratory tests were performed in accordance with relevant ASTM standards. Natural moisture content (D2216) tests were performed on all SPT and Osterberg samples. Soil index classification testing (D2487) was performed on selected soil samples. These tests included particle size analyses (D421 and D422), Atterberg limits (D4318), and specific gravity (D854).

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. Material descriptions, thicknesses, and elevations from boring logs.
    a. Boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
2. Soil and CCR properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.

3.7 MACTEC (2009)

Table 7. Summary of Evaluation for MACTEC (2009)

Reference:	MACTEC. 2009. "Geotechnical Exploration – TVA Kingston Phase I Geotube Disposal Area." Prepared for Tennessee Valley Authority. March 9.	
Purpose:	Evaluation of the Interim Ash Staging and Sluice Trench areas for a proposed Geotube disposal area	
CCR Unit(s):	Interim Ash Storage Area, Sluice Trench	
Spatial coverage:	Footprint of above mentioned units.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	26 borings + 6 offset borings
Rock coring:	No	
Other subsurface data:	Yes	11 CPT soundings + 1 offset sounding
Boring locations surveyed:	Yes	Locations surveyed by TVA after drilling
Data adequate to support three-dimensional model:	Yes	Data to support CCR, dike fill, foundation soil, and top of rock geometry
Geometry at time of document representative of 2017 conditions:	No	CCR and some foundation soils have since been regraded.
Piezometer installation:	No	
In-situ testing:	Yes	SPT, CPT with pore pressure dissipation testing
Laboratory testing:	Yes	Testing followed ASTM standards
Shear strength parameters:	Yes	Drained and undrained static strengths of CCR and native foundation soils.
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.7.1 Field Activities

A geotechnical drilling program was developed that consisted of 26 SPT borings, with six locations also including an offset boring to obtain undisturbed (Shelby tube) samples. Typically, continuous SPT sampling was performed in the first 10 feet of each boring and then at 5-foot intervals thereafter. Disturbed samples were visually classified in the field. Shelby tube samples were obtained at select intervals within the offset borings and some of the SPT borings. Additionally, 11 CPT soundings with one offset sounding were performed. Pore pressures were recorded with cone advancement and dissipation tests were performed at selected depths.

Upon completion of the field work, TVA surveyed boring locations. Several locations were unable to be found by the surveyors due to grading work performed after drilling. In those cases, the elevations and locations were estimated based upon the pre-drilling staked locations. The approximate locations are shown on the boring layout in Figure 1.

3.7.2 Laboratory Testing

The Laboratory tests were performed in accordance with ASTM standard testing procedures. The disturbed (SPT) and undisturbed (Shelby tube) soil samples obtained during conventional drilling were subjected to the following laboratory tests:

- 82 natural moisture content (D2216)
- 23 Atterberg limits (D4318)
- 23 particle size analysis (D422)
- 23 specific gravity (D854)
- 26 unit weight (D2937)
- 1 percent organic matter(D2974-87)
- 9 UU triaxial compression with pore pressure measurements (D2850)
- 13 CU triaxial compression with pore pressure measurements (D4767)
- 12 one-dimensional consolidation (D2435)

3.7.3 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. Foundation geometry is substantially the same as current.
2. Soil and CCR properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.

3.8 STANTEC (2009)

Table 8. Summary of Evaluation for Stantec (2009)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2009. "Report of Geotechnical Exploration and Slope Stability for Dike C, Kingston Fossil Plant, Harriman, Tennessee." Prepared for Tennessee Valley Authority. August 3.	
Purpose:	Evaluate the current stability of Dike C, the perimeter containment dike around the ash pond and stilling pond.	
CCR Unit(s):	Stilling Pond	
Spatial coverage:	Along centerline of Dike C starter dike, raised dike, and other selected locations.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	54 borings + 21 offset borings
Rock coring:	Yes	9 NQ-sized rock core borings
Other subsurface data:	Yes	21 CPT soundings
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Stilling pond dike geometry similar to current, with exception of outboard rock buttress added later.
Piezometer installation:	Yes	15 locations with 20 piezometers, screened in CCR, clay, and sand
In-situ testing:	Yes	SPT, CPT, Slope Inclinometers
Laboratory testing:	Yes	All testing follows ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strengths for dike and foundation soils.
Static slope stability:	Yes	Five cross-sections along Dike C.
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Static strengths can be used. Dike geometry does not reflect current conditions with the added rock buttress.
Other relevant analyses:	Yes	Seepage analyses performed for five cross-sections along Dike C.

3.8.1 Field Activities

A subsurface exploration program consisted of 54 boring locations with a total of 75 borings and offset borings and 21 CPT soundings along the starter dike crest and raised dike crest of Dike C and other select locations. The approximate locations are shown on the boring layout in Figure 1.

Note that the boring log for STN-50 (along the exterior dike of the Engineered Wetlands) indicates the presence of CCR (fly ash); however, after reviewing construction drawings, historical aerial images, Engineered Wetlands design documents, and adjacent boring logs, it is apparent that this material was misclassified in boring STN-50. TVA design drawing 10W440 (1987) and the written proposal to treat red water discharge (TVA 1986) indicate that earthfill was to be used to build the Engineered Wetlands dikes. Further, the written proposal specifically prohibited the use of ash as a borrow material to construct the interior and exterior dikes. The drawing and proposal, as well as historical aerial photos, also confirm that the Engineered Wetlands were constructed on the outboard side of the pre-existing East Dike. The East Dike contains the CCR in the Sluice Trench and Ballfield East of Sluice Trench area. Finally, several nearby 2009-2010 borings (AD-3, C-1, C-2, STN-51) on the same exterior dike did not encounter CCR. It is likely that the boring log for STN-50 misclassified fly ash that is actually a soft clay (as noted on boring logs for C-1 and C-2 nearby). Given the above information, no CCR is believed to be present at STN-50.

The borings were drilled using either a truck-mounted or ATV-mounted drill rig. Continuous SPTs were performed in the soil borings in accordance with ASTM D1586. Shelby tube samples were obtained in accordance with ASTM D1587 within dike and foundation materials at depths determined by Stantec.

Upon completion of drilling, slotted screen piezometers were installed at 15 selected boreholes, with five boreholes receiving both an upper and a lower piezometer. The piezometers were constructed from 1-inch diameter Schedule 40 PVC riser pipe and 5-foot long No. 10 slot well screens. The annular backfill consisted of a sand filter pack to some distance above the screen followed by a minimum two-foot bentonite seal. After allowing the bentonite to hydrate, the remaining annulus was backfilled with cement bentonite grout.

Stantec installed six slope inclinometers as part of the overall stability evaluation. The slope inclinometers were constructed by advancing the boring into bedrock, installing 2.75-inch slope inclinometer casing, and backfilling the annulus with a bentonite-cement grout.

3.8.2 Laboratory Testing

The Laboratory tests were performed in accordance with ASTM standard testing procedures. The disturbed (SPT) and undisturbed (Shelby tube) soil samples obtained during conventional drilling were subjected to the following laboratory tests:

- natural moisture content (D2216)
- 115 Atterberg limits (D4318)
- 115 gradation (D422)
- 115 USCS classification (D2487)
- 115 specific gravity (D854)
- 50 unit weight tests (D2937)

- 2 unconfined compressive strength (D2166)
- 5 consolidated undrained direct simple shear tests (D6528)
- 23 UU triaxial tests with pore pressure measurements (D2850)
- 10 CU triaxial tests with pore pressure measurements (D4767)
- 15 falling head permeability tests (D5084)
- 9 consolidation tests (D2435)

3.8.3 Analysis

Seepage and static slope stability analyses were performed for five cross sections along Dike C at Stations 108+93, 119+69, 132+37, 138+27, and 149+14 using SEEP/W and SLOPE/W software. Factors of safety against piping were determined based on seepage modeling. Phreatic surfaces generated from the seepage analyses were incorporated into the stability analyses. Material shear strength parameters were estimated based on site-specific geotechnical data, published data/information and experience with similar materials in similar applications.

3.8.4 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 (except for rock buttress) 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. 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 (except for rock buttress) is substantially the same as present.
    c. Pool elevations and phreatic conditions are similar or more conservative than current.
    d. Analysis methods meet current standard of practice.

3.9 GEOSYNTEC (2010A)

Table 9. Summary of Evaluation for Geosyntec (2010A)

Reference:	Geosyntec Consultants. (Geosyntec). 2010a. "Seepage and Stability Study for East Dike and Raised Dike". Prepared for Tennessee Valley Authority. June 30.	
Purpose:	Evaluation of seepage regime and slope stability of East Dike and Raised Dike haul road adjacent to Intake Channel.	
CCR Unit(s):	Interim Ash Staging Area and Sluice Trench	
Spatial coverage:	2 cross-sections along outboard slope of East Dike	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 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 to support dike fill and foundation soil geometry
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. Phreatic conditions were similar to or more conservative than current.
Piezometer installation:	Yes	6 piezometers, screened in dike fill
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing followed relevant ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strengths for CCR, dike fill, and foundation soils
Static slope stability:	Yes	1 cross-section (A-A')
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long-term, static slope stability of the east dike and short-term dynamic (i.e., construction traffic) slope stability of the raised dike.
Other relevant analyses:	Yes	Seepage modeling

3.9.1 Field Activities

The subsurface exploration program consisted of six borings along two cross-sections (A-A' and B-B'). The borings were advanced to auger refusal and included continuous split-spoon (SPT) sampling. Undisturbed (Shelby tube) samples were obtained in targeted soil layers. Upon completion of drilling, TVA personnel surveyed the boring locations and the local ground surface elevations adjacent to the borings. The approximate locations are shown on the boring layout in Figure 1.

Additionally, standpipe piezometers were installed at each boring location to monitor water levels within the dike fill. The annular backfill for the piezometer consisted of a sand filter pack to some distance above the screened zone followed by a minimum two-foot bentonite seal.

3.9.2 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), one-dimensional consolidation testing (D2435), and hydraulic conductivity (D5084).

3.9.3 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. Based on Geosyntec's review of the exploration program, cross-section A-A' was selected as the critical cross-section due to slightly lower blow counts in the encountered subsurface materials.

The static slope stability analyses were completed for dynamic loading (i.e., construction traffic along the raised dike) and long-term, steady-state seepage conditions. The seepage analysis was performed assuming steady-state conditions with static water levels in the adjacent rim ditch, sluice channel, and intake channel as boundary conditions. The vertical hydraulic conductivity was estimated using available laboratory data and the anisotropy ratio to horizontal conductivity was estimated based on placement conditions of the materials. The analyses indicated that the existing conditions had factors of safety that met or exceeded the acceptance criteria.

3.9.4 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,
3. 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.

3.10 GEOSYNTEC (2010B)

Table 10. Summary of Evaluation for Geosyntec (2010B)

Reference:	Geosyntec Consultants. (Geosyntec). 2010b. "Seepage and Stability Study for North End of East Dike". Prepared for Tennessee Valley Authority. October 29.	
Purpose:	Evaluation of seepage regime and slope stability of North end of the East Dike, adjacent to Intake Channel.	
CCR Unit(s):	Interim Ash Staging Area and Sluice Trench	
Spatial coverage:	2 cross-sections along outboard slope of East Dike	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	4 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 to support dike fill and foundation soil geometry
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. Phreatic conditions were similar to or more conservative than current.
Piezometer installation:	Yes	6 piezometers, screened in dike fill
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing followed relevant ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strengths for CCR, dike fill, and foundation soil
Static slope stability:	Yes	1 cross-section (A-A')
Seismic slope stability:	Yes	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long-term, static and short-term, seismic slope stability of the north end of the east dike.
Other relevant analyses:	Yes	Seepage modeling

3.10.1 Field Activities

The subsurface exploration program consisted of four borings along two cross-sections (C-C' and D-D'). The borings were advanced to auger refusal and included continuous split-spoon (SPT) sampling. Undisturbed (Shelby tube) samples were obtained in targeted soil layers. Upon completion of drilling, TVA personnel surveyed the boring locations and the local ground surface elevations adjacent to the borings. The approximate locations are shown on the boring layout in Figure 1.

Additionally, standpipe piezometers were installed at each boring location to monitor water levels within the dike fill. The annular backfill for the piezometer consisted of a sand filter pack to some distance above the screened zone followed by a minimum two-foot bentonite seal. Daily monitoring of the piezometers for water levels was performed through October 13, 2010.

3.10.2 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), one-dimensional consolidation testing (D2435), and hydraulic conductivity (D5084).

3.10.3 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. Based on Geosyntec's review of the exploration program, cross-section D-D' was selected as the critical cross-section due to slightly lower blow counts in the encountered subsurface materials.

The static slope stability analyses were completed using long-term, steady-state seepage conditions. The seepage analysis was performed assuming steady-state conditions with static water levels in the adjacent rim ditch, sluice channel, and intake channel as boundary conditions. The vertical hydraulic conductivity was estimated using available laboratory data and the anisotropy ratio to horizontal conductivity was estimated based on placement conditions of the materials. The analyses indicated that the existing conditions had factors of safety that met or exceeded the acceptance criteria for slope stability, but less than recommended for factor of safety against piping.

Pseudostatic slope stability analysis was performed in order to estimate the yield acceleration, the horizontal acceleration that produces a factor of safety of 1.0. To estimate deformations, this yield acceleration is compared to anticipated peak horizontal accelerations using a simplified, sliding block analysis method. The calculated deformation was considered acceptable.

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,
3. 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 seismic 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 (2010)

Table 11. Summary of Evaluation for Stantec (2010)

Reference:	Stantec Consulting Ltd. (Stantec). 2010. "Dike C of Kingston Fossil Plant". Prepared for Jacobs Engineering Group, Inc. August 20.	
Purpose:	Installation of piezometers to support seepage and slope stability evaluation of Dike C at Sta. 122+00, 138+27, and 149+14.	
CCR Unit(s):	Stilling Pond	
Spatial coverage:	3 cross-sections (2 at Stilling Pond, 1 at former Ash Pond)	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	8 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 to support CCR, dike fill and foundation soil geometry
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current, with exception of added rock buttress. Phreatic conditions were similar to or more conservative than current.
Piezometer installation:	Yes	14 piezometers, screened in CCR, dike fill, and 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:	No	

3.11.1 Field Activities

A subsurface exploration program was designed that consisted of 8 borings. The cross-sections and boring locations were selected and staked by Stantec in response to recommendations made by Marshall Miller. Upon completion of drilling, TVA surveyed the boring locations. The approximate locations are shown in Figure 1.

The borings were drilled using a track-mounted drilling rig with hollow stem augers. In the soil borings, continuous SPTs were performed in accordance with ASTM D1586. Upon completion of drilling, a piezometer was installed at each boring location with select locations receiving an additional piezometer screened at a higher interval.

The annular backfill for the piezometer consisted of a sand filter pack approximately one foot above the screened zone followed by at least a two-foot bentonite seal. In borings with two screened intervals, a bentonite seal was installed between the sand filter packs to isolate each screened interval. The remaining backfill was bentonite to the surface.

3.11.2 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 (with exception of added rock buttress) 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.

3.12 S&ME (2010)

Table 12. Summary of Evaluation for S&ME (2010)

Reference:	S&ME. (2010). Initial Perimeter Exploration Borings (boring logs only). October.	
Purpose:	Unknown (boring logs only)	
CCR Unit(s):	Interim Ash Staging Area and Stilling Pond	
Spatial coverage:	Divider Dike between former Ash Pond and the adjacent Interim Ash Staging Area and Stilling Pond	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	3 borings
Rock coring:	Yes	3 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Locations surveyed by TVA after drilling
Data adequate to support three-dimensional model:	Yes	Data to support CCR, dike fill, and foundation soil geometry
Geometry at time of document representative of 2017 conditions:	Yes	
Piezometer installation:	No	
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:	No	

3.12.1 Field Activities

A geotechnical drilling program was developed that consisted of 3 SPT borings with a minimum of 10 foot of rock core obtained using PQ coring equipment after encountering auger refusal. The water level in the borehole was recorded during drilling. The borings were drilled using an ATV-mounted drilling rig with hollow stem augers. In the soil borings, SPTs were performed in accordance with ASTM D1586 with sampling on 2.5-foot intervals. Disturbed samples were visually classified in the field. Upon completion of the field work, TVA surveyed boring locations. The approximate locations are shown in Figure 1.

3.12.2 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 (with exception of added rock buttress) and foundation geometry is substantially the same as current.

3.13 MACTEC (2010)

Table 13. Summary of Evaluation for MACTEC (2010)

Reference:	MACTEC. 2010. "Report of Piezometer Installation" Prepared for Tennessee Valley Authority. December 2.	
Purpose:	To install two new vibrating wire piezometers, to replace two damaged vibrating wire piezometers in the Interim Ash Staging Area.	
CCR Unit(s):	Sluice Trench and Ballfield East of the Sluice Trench	
Spatial coverage:	Footprint of above mentioned units.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	2 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Horizontal coordinates are based on proposed locations. Elevations are as-installed, although it is unclear how these were determined.
Data adequate to support three-dimensional model:	Yes	Data to support CCR, dike fill, and foundation soil geometry
Geometry at time of document representative of 2017 conditions:	No	Final closure of the Interim Ash Staging Area and construction of the Polishing Pond have been completed since this exploration and instrument installation.
Piezometer installation:	Yes	Two vibrating wire piezometers
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:	No	

3.13.1 Field Activities

A geotechnical drilling program was developed that consisted of 2 SPT borings, PC-3A and PA-3A. Continuous SPT sampling was performed in the first 10 feet of each boring and then at 5-foot intervals thereafter. Disturbed samples were visually classified in the field. Upon completion of drilling, a vibrating wire (VW) piezometer was installed at each boring location. Each boring was backfilled with sand in the interval around the piezometer, then a bentonite seal, then CCR to the ground surface. The VW piezometer PA-3A was installed in the encountered CCR material and the VW piezometer in PC-3A was installed in the encountered foundation soil, just below the CCR. The approximate locations are shown in Figure 1.

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. Material descriptions, thicknesses, and elevations from boring logs
   a. Boring locations and elevations may not have been surveyed, but are known with reasonable certainty.
   b. Boring logs document material descriptions and thicknesses,
   c. Foundation geometry is substantially the same as current.
2. Soil and CCR properties (including shear strengths)
   a. Sampling followed relevant ASTM standards.

3.14 S&ME (2011)

Table 14. Summary of Evaluation for S&ME (2011)

Reference:	S&ME. (2011). Full Perimeter Exploration Borings (boring logs only). April.	
Purpose:	Unknown (boring logs only)	
CCR Unit(s):	Interim Ash Staging Area and Stilling Pond	
Spatial coverage:	Divider Dike between former Ash Pond and the adjacent Interim Ash Staging Area and Stilling Pond	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	28 borings
Rock coring:	Yes	28 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Locations surveyed by TVA after drilling
Data adequate to support three-dimensional model:	Yes	Data to support CCR, dike fill, and foundation soil geometry
Geometry at time of document representative of 2017 conditions:	Yes	
Piezometer installation:	No	
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:	No	

3.14.1 Field Activities

A geotechnical drilling program was developed that consisted of 28 SPT borings with rock coring. The borings were drilled using a ATV-mounted drilling rig with hollow stem augers. In the soil borings, SPT sampling was performed on 5-foot intervals in accordance with ASTM D1586. Disturbed samples were visually classified in the field. The water level was recorded in each boring during drilling prior to rock coring operations. Upon encountering auger refusal, a minimum of 10 feet of rock core was obtained. Upon completion of the field work, TVA surveyed boring locations. The approximate locations are shown in Figure 1.

3.14.2 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 (with exception of added rock buttress) and foundation geometry is substantially the same as current.

3.15 STANTEC (2011)

Table 15. Summary of Evaluation for Stantec (2011)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2011. "Design Report for Segment B of the Dike C Buttress Project, Kingston Fossil Plant, Harriman, Tennessee." Prepared for Tennessee Valley Authority. September 1.	
Purpose:	To outline the buttress design along Segment B of Dike C between Station 120+00 and Station 128+00.	
CCR Unit(s):	Stilling Pond	
Spatial coverage:	Stilling Pond, Dike C, Segment B	
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 to support dike fill and foundation soil geometry
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. Phreatic conditions were similar to or more conservative than current.
Piezometer installation:	Yes	4 Piezometers
In-situ testing:	Yes	SPTs
Laboratory testing:	Yes	Testing followed relevant ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strengths for CCR (soft pond ash and bottom ash), dike fill (upper and lower), and alluvium foundation
Static slope stability:	Yes	5 cross-sections
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long-term and short-term (construction), static slope stability of Segment B of Dike C.
Other relevant analyses:	Yes	Seepage modeling

3.15.1 Field Activities

Three supplemental borings (STN-76, STN-77A, & STN-77B) were drilled to provide additional geotechnical data for the Dike C, Segment B Buttress design as shown in Figure 1. Continuous SPT samples were collected during drilling. Four standpipe piezometers were installed within boreholes STN-76 and STN-77A.

3.15.2 Laboratory Testing

Laboratory tests were performed in accordance with ASTM standard testing procedures. The disturbed (SPT) soil samples obtained during conventional drilling were subjected to the following laboratory tests:

- 14 natural moisture content (D2216)
- 9 Atterberg limits (D4318)
- 13 gradation (D422)

3.15.3 Analyses

Five cross sections within Segment B of Dike C were evaluated for seepage and slope stability. The analyses were performed for both the existing condition and for a proposed rock fill buttress design. The stability of the Segment B section of Dike C was evaluated using limit equilibrium methods as implemented in the SLOPE/W software. Analyses were completed for static, long-term and static, short-term conditions with steady-state seepage. Using effective strength parameters, in conjunction with results of the seepage analyses, the existing dike configuration was analyzed at each of the five cross sections.

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. 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.

3.16 AMEC (2012)

Table 16. Summary of Evaluation for AMEC (2012)

Reference:	AMEC Environment and Infrastructure, Inc. (AMEC). 2012. "Report of Geotechnical Exploration, Bottom Ash Dewatering Facility, TVA Kingston Fossil Plant, Harriman, Tennessee." Prepared for Tennessee Valley Authority. April 2.	
Purpose:	Characterize subsurface conditions, develop recommendations for foundation support and site preparation for the proposed facility.	
CCR Unit(s):	Interim Ash Staging Area and Sluice Trench	
Spatial coverage:	Southern portion of Interim Ash Staging Area, adjacent to the Sluice Trench	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	7 borings + 4 offset borings
Rock coring:	Yes	2 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	TVA surveyed the boring locations prior to drilling. However, ground surface elevations were approximated based on plotting the locations on topographic mapping.
Data adequate to support three-dimensional model:	Yes	Data support CCR thickness, foundation soils, top of rock, and bedrock stratigraphy.
Geometry at time of document representative of 2017 conditions:	No	Dewatering facility has now been constructed within this area.
Piezometer installation:	No	
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing followed relevant ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strengths for CCR and alluvial clay
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Shear strength testing data.
Other relevant analyses:	No	

3.16.1 Field Activities

The geotechnical exploration program included 7 borings and 4 offset borings. One offset boring was completed due to shallow refusal depth, while the other three offset borings were performed to collect undisturbed samples. All offset borings were performed within approximately five feet of the original boring.

Undisturbed samples were obtained in accordance with ASTM D1587. The borings were drilled using a CME Model 55 truck-mounted drill rig with hollow stem augers in accordance with ASTM D1452. Standard penetration tests (SPT) were performed starting at the surface and on approximately 5 feet intervals thereafter in accordance with ASTM D1586 until auger refusal was encountered. Upon encountering auger refusal, two borings were extended an additional 5 feet into bedrock by rock coring per ASTM D2113.

The boring and sounding locations were horizontally located in the field by TVA and provided to AMEC. However, it was stated that the "ground surface elevations at the boring locations were obtained by plotting the borings on the provided topographic site plan and should be considered approximate." The approximate locations are shown on the boring layout in Figure 1.

3.16.2 Laboratory Testing

Laboratory tests were performed in accordance with ASTM standard testing procedures. The disturbed (SPT) and undisturbed (Shelby tube) soil samples obtained during conventional drilling were subjected to the following laboratory tests:

- 35 natural moisture content tests (D2216)
- 14 Atterberg limits tests (D4318)
- 14 grain size distribution with hydrometer tests (D422)
- 3 specific gravity tests (D854)
- 6 UU triaxial compression tests (D2850)
- 6 CU triaxial compression tests with pore pressure measurements (D4767)
- 3 one-dimensional consolidation tests (D2435)

3.16.3 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 were surveyed, and approximate elevations were obtained from a topographic map of the project site,
    b. Boring logs document material descriptions and thicknesses,

2. Soil properties (including shear strengths)

    a. Sampling and testing followed relevant ASTM standards.

3.17 GEOSYNTEC (2012)

Table 17. Summary of Evaluation for Geosyntec (2012)

Reference:	Geosyntec. (2012). "Supplemental Assessment of Seepage and Slope Stability, Kingston Fossil Plant, East Dike." Prepared for Tennessee Valley Authority. May.	
Purpose:	Assess seepage and slope stability along the East Dike based on newly acquired subsurface data.	
CCR Unit(s):	Interim Ash Storage Area, Sluice Trench	
Spatial coverage:	East Dike	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	Yes	25 total - CPTu borings and offsets
Boring locations surveyed:	Yes	
Data adequate to support three-dimensional model:	Yes	Data support dike geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar to current.
Piezometer installation:	No	
In-situ testing:	Yes	CPT with pore pressure dissipation
Laboratory testing:	No	
Shear strength parameters:	Yes	Undrained strengths for CCR, lower dike fill, and cohesive alluvium, drained strengths for rock embankment, non-cohesive alluvium, and upper dike fill
Static slope stability:	Yes	2 cross-sections
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of static stability of the East Dike.
Other relevant analyses:	Yes	Updated seepage modeling

3.17.1 Field Activities

A supplemental geotechnical investigation program was performed. This program consisted of a total of 25 CPTu soundings and offset soundings at 12 locations that were performed by the subcontracted drilling company, ConeTec, along the length of the East Dike as shown in Figure 1. CPTu soundings were performed at the location of the four previously identified cross-sections A through D, as well as at intermediate locations between these cross-section locations. Cone tip resistance, sleeve friction and pore pressures were recorded at approximately 2-inch vertical intervals throughout the depth of advancement. At each approximate 1-meter vertical interval, the rate of pore water pressure dissipation was measured for up to 5 minutes to aid in the assessment of in-situ hydraulic conductivity.

3.17.2 Analysis

Using information captured as the cone was advanced through the material of the East Dike, the soils were classified using the normalized behavior type classification chart. This information was combined with data collected during the previous SPT field investigations performed at the site (Geosyntec 2010a, 2010b) to develop an updated interpretation of the subsurface stratigraphy.

Seepage and static slope stability analyses were performed using the computer program SLIDE. A seepage model for cross sections A, B, C, and D was developed using SLIDE to perform steady-state saturated and unsaturated groundwater seepage analysis. The slope stability analyses were performed through the East Dike at cross sections A and D.

3.17.3 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 and sounding 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.

3. 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.

3.18 STANTEC (2012A)

Table 18. Summary of Evaluation for Stantec (2012A)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2012a. "Summary of Results for Engineering Evaluation, Segments 5 and 6 Perimeter Containment Alternative Alignments, Kingston Fossil Plant, Harriman, Roane County, Tennessee." Prepared for Tennessee Valley Authority. October 1.	
Purpose:	Supplemental borings to further define bedrock conditions to support design of perimeter containment	
CCR Unit(s):	Interim Ash Staging Area and Stilling Pond	
Spatial coverage:	Portions of proposed Section 6 alignment	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	19 borings
Rock coring:	Yes	18 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed into TN state plane coordinates
Data adequate to support three-dimensional model:	Yes	Data support foundation soil stratigraphy, top of rock elevation, and bedrock conditions.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions like current. Document precedes the as-built perimeter containment segments.
Piezometer installation:	No	
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:	No	

3.18.1 Field Activities

The geotechnical exploration program included 19 borings along selected portions of the Segment 6 alignment. The borings were drilled using a ATV-mounted drilling rig with hollow stem augers. The soil borings were drilled without sampling to a depth of approximately 50 feet. Then continuous SPTs were performed in accordance with ASTM D1586 until auger refusal was encountered. Disturbed samples were visually classified in the field. Upon encountering auger refusal, a minimum of 5 feet of rock core was obtained from each boring location, except for boring SUP-18. Upon completion of the field work, the boring locations were surveyed. The approximate locations are shown in Figure 1.

3.18.2 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 and sounding 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.

3.19 STANTEC (2012B)

Table 19. Summary of Evaluation for Stantec (2012B)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2012b. PWS Segments 3 and 4 Instrumentation (boring logs only). October.	
Purpose:	Supplemental borings to further define bedrock conditions to support design of perimeter containment	
CCR Unit(s):	Stilling Pond	
Spatial coverage:	Portions of proposed Segment 3 and 4 alignment	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	12 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed into TN state plane coordinates
Data adequate to support three-dimensional model:	Yes	Data support foundation soil stratigraphy, top of rock elevation, and bedrock conditions.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar to current. Document precedes the as-built perimeter containment segments.
Piezometer installation:	Yes	12 piezometers, screened in CCR and 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:	No	

3.19.1 Field Activities

The geotechnical exploration program included 12 borings to install vibrating wire piezometers (VWPZ) along the divider dike (Segments 3 and 4) between the Stilling Pond and the Ash Pond. The soil borings were drilled without sampling to a targeted depth that varied for each boring. Then SPT sampling was performed in accordance with ASTM D1586 either on 2.5- or 5-feet centers in the CCR and continuously within the alluvium. Disturbed samples were visually classified in the field.

Upon completion of the boring, multiple VWPZs were installed in each boring location to measure pore water pressures in the CCR, alluvial clays, and alluvial sands. No details were provided in the boring logs for VWPZ construction. The boring locations were surveyed. The approximate locations are shown in Figure 1.

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. 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. Vibrating Wire Piezometers
    a. Locations and elevations were surveyed,

3.20 STANTEC (2013)

Table 20. Summary of Evaluation for Stantec (2013)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2013. "KIF - Perimeter Containment, Segments 5 and 6 (Sta A197+60 to Sta A225+18.27)." Calculation No. FPGKIFDEGCDX0003002012001136, Revision 0. Prepared for Tennessee Valley Authority. March 29.	
Purpose:	Documents engineering analyses and other technical details in support of the design for two segments of a new, stabilized perimeter containment around the site of the former Dredge Cell and Ash Pond at Kingston Fossil Plant.	
CCR Unit(s):	Former Dredge Cell and Ash Pond, Interim Ash Storage Area	
Spatial coverage:	Perimeter Segments 5 and 6 (adjacent to Interim Ash 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	
Geometry at time of document representative of 2017 conditions:	Yes	
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static drained and undrained, and liquefied residual post-earthquake strengths of CCR, fill, and foundation soils (Exhibit 13 - Soil strength properties)
Static slope stability:	Yes	Exhibit 15 A & B – Limit Equilibrium Stability Analysis
Seismic slope stability:	Yes	Exhibit 11 – Liquefaction Analysis, Exhibit 23A/23B – Dynamic Analysis for Earthquake Loading, Exhibit 26 – Ground Deformation Outside the Perimeter Containment
Information adequate to support stability evaluation:	Yes	
Other relevant analyses:	Yes	Exhibit 5 – Long-Term Groundwater Levels, Exhibit 8 - geophysical test results

3.20.1 Field Activities

No new field results are presented. A summary of prior field testing is included in the Exhibits.

3.20.2 Laboratory Testing

No new laboratory testing results are presented. A summary of prior laboratory testing is included in the Exhibits.

3.20.3 Analyses

Summaries of limit equilibrium stability analyses, liquefaction analysis, and dynamic stability/ deformation analysis are included in the Exhibits.

3.20.4 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. Static and seismic 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.

3.21 TVA (2014)

Table 21. Summary of Evaluation for TVA (2014)

Reference:	TVA. (2014). "Groundwater Monitoring Plan, Tennessee Valley Authority, Kingston Fossil Plant, Ash Landfill #IDL 73-0094." February 26.	
Purpose:	Develop a Groundwater Monitoring Plan for the former Dredge Cell and Ash Pond areas at Kingston Fossil Plant. Update the existing monitoring plan contained in the Dredge Cell Lateral Expansion Operations Manual.	
CCR Unit(s):	former Dredge Cell, former Ash Pond, Stilling Pond and Interim Ash Staging Area	
Spatial coverage:	Perimeter monitoring well network	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 borings
Rock coring:	Yes	1 boring
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 and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar to current.
Piezometer installation:	Yes	5 monitoring wells, screened in alluvium, residuum, or bedrock
In-situ testing:	Yes	SPT noted in existing monitoring well installation logs.
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:	No	

3.21.1 Field Activities

The groundwater monitoring system associated with the Ash Landfill facility consists of three downgradient wells (KIF-22, KIF-6AR, and KIF-AD-3) and one background monitoring well (KIF-AD-1). Please note that one additional existing background monitoring well (GW-1) is proposed to be added to the groundwater monitoring system. Boring logs of these monitoring well installations are included in the proposed monitoring well plan. A new landfill monitoring well network was proposed in 2014. The approximate locations are shown on the boring layout in Figure 1.

3.21.2 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. Monitoring wells
    a. Installation methods meet current standard of practice,
    b. Locations and elevations were surveyed,
    c. Instruments are adequate to provide current water level readings and water samples.

3.22 STANTEC (2014)

Table 22. Summary of Evaluation for Stantec (2014)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2014. "Construction Certification Report, Ash Landfill Perimeter Containment, Kingston Fossil Plant, Harriman, Roane County, Tennessee." Prepared for Tennessee Valley Authority. October 31.	
Purpose:	Document the as-built record conditions for the completed Ash Landfill Perimeter Containment. Selected elements from the construction period (including field observations and measurements, sampling, and testing) serve to establish the as-built record conditions.	
CCR Unit(s):	Kingston Recovery Project (KRP) Ash Landfill	
Spatial coverage:	Perimeter wall around the KRP Ash Landfill, adjacent to the northwest side of the Stilling Pond and the north side of the Interim Ash Staging Area.	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	Yes	Rock coring was completed along the Perimeter Containment Soil-Cement Wall and the spacing between rock core locations range from approximately 20 feet to 40 feet.
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA after drilling/excavations
Data adequate to support three-dimensional model:	Yes	Data supports top of rock information around the perimeter of the Ash Landfill
Geometry at time of document representative of 2017 conditions:	Yes	Reflects current conditions.
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:	No	

3.22.1 Field Activities

Field activities documented in the construction certification report include a combination of pre-drilling, trench excavations, and post-drilling. Pre-drilling was completed by S&ME between January and April 2011 and consisted of SPT borings with rock core data spaced approximately every 100 feet around the perimeter of the proposed walls. (see Section 3.14). Trench excavations were completed during the construction of the perimeter containment walls and top of rock elevations were estimated based on measurements from the excavation equipment. Post-drilling was completed after the cement-bentonite perimeter walls had cured and top of rock information was observed by coring back through the walls and into the bedrock. From the combination of these three data sets, top of rock elevations were recorded approximately every 15 to 20 feet.

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. Material descriptions, thicknesses, and elevations from a combination of excavation depth measurements and boring logs
    a. Excavation trench/pre-drilling/post-drilling locations and elevations were surveyed,
    b. Pre-drilling logs document material descriptions, thicknesses and top of rock elevations,
    c. Excavation trench and post drilling logs document top of rock elevations,
    d. Perimeter dike and foundation geometry is substantially the same as current.

3.23 AMEC FOSTER WHEELER (2015)

Table 23. Summary of Evaluation for Amec Foster Wheeler (2015)

Reference:	Amec Foster Wheeler Environment and Infrastructure, Inc. (Amec Foster Wheeler). 2015. "Report of Geotechnical Exploration and Liquefaction Analysis, Bottom Ash Dewatering Facility, TVA Kingston Fossil Plant, Harriman, Tennessee." Prepared for Tennessee Valley Authority. March 6.	
Purpose:	Subsurface characterization, evaluate liquefaction potential, develop recommendations for foundation support of the proposed facility.	
CCR Unit(s):	Interim Ash Staging Area and Sluice Trench	
Spatial coverage:	Southern portion of Interim Ash Staging Area, adjacent to the Sluice Trench	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	7 borings + 2 offset borings
Rock coring:	Yes	2 borings
Other subsurface data:	Yes	4 CPTu soundings
Boring locations surveyed:	Yes	Surveyed after drilling
Data adequate to support three-dimensional model:	Yes	Data support CCR thickness, foundation soil, top of rock, and bedrock stratigraphy.
Geometry at time of document representative of 2017 conditions:	No	Dewatering facility has now been constructed within this area.
Piezometer installation:	No	
In-situ testing:	Yes	SPT, CPTu with pore pressure dissipation and shear wave velocity testing
Laboratory testing:	Yes	Testing followed relevant ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strengths of CCR and alluvium
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Shear strength testing data.
Other relevant analyses:	Yes	Liquefaction triggering analyses

3.23.1 Field Activities

The geotechnical exploration program included 7 borings and 2 offset borings. The offset borings were drilled within approximately five feet of the companion boring, to collect undisturbed samples. Undisturbed samples were obtained in accordance with ASTM D1587. The borings were drilled using a CME Model 55 rubber-track drilling rig with hollow stem augers and casing advancer in accordance with ASTM D1452. Standard penetration tests (SPT) were performed starting at the surface and on approximately 5 feet intervals thereafter in accordance with ASTM D1586 until auger refusal was encountered. Upon encountering auger refusal, two borings were extended an additional 10 feet into bedrock by rock coring.

Additionally, CPTu soundings were performed using a 20 ton CPT track rig. A total of four CPTu soundings were performed in accordance with ASTM D5778. Seismic cone penetration testing was performed in one of the soundings to obtain shear wave velocities at approximately 3-foot intervals. Pore pressure dissipation tests were performed in each sounding at a selected depth.

The boring locations were surveyed by others and TVA provided Amec with horizontal and vertical location of each boring and sounding. The approximate locations are shown on the boring layout in Figure 1.

3.23.2 Laboratory Testing

Laboratory tests were performed in accordance with ASTM standard testing procedures. The disturbed (SPT) and undisturbed (Shelby tube) soil samples obtained during conventional drilling were subjected to the following laboratory tests:

- 50 natural moisture content tests (D2216)
- 16 Atterberg limits tests (D4318)
- 16 grain size distribution with hydrometer tests (D422)
- 6 specific gravity tests (D854)
- 8 UU triaxial compression tests (D2850)
- 8 CU triaxial compression tests with pore pressure measurements (D4767)
- 3 one-dimensional consolidation tests (D2435)

3.23.3 Analyses

A site-specific seismic liquefaction analysis was performed for the proposed dewatering facility. Response spectra parameters were established using the 2008 USGS National Seismic Hazard Mapping Project for 2% probability of exceedance in 50-year hazard level for a Site Class B condition. A dynamic site response analysis was performed to account for site-specific soil and rock conditions when estimating peak ground accelerations. Laboratory index testing in conjunction with CPT field data was used to categorize soils as sand-like or clay-like. The liquefaction triggering potential of the susceptible soil layers was evaluated for both the design earthquake and maximum considered earthquake (MCE) using both SPT- and CPT-based empirical analysis methods.

The results of the analysis were used to determine the potential liquefaction-induced settlement under the design earthquake and MCE loading conditions. Based on these results, recommendations for foundation design and site development were provided to TVA for the bottom ash dewatering facility.

3.23.4 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,
2. Soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.

3.24 STANTEC (2015)

Table 24. Summary of Evaluation for Stantec (2015)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2015. "Ballfield Piezometer Installation - Kingston Fossil Plant." Prepared for Tennessee Valley Authority. May 27.	
Purpose:	Installation of new piezometers to support the Drainage and Flow Management aspect of the Stilling Pond closure design	
CCR Unit(s):	Interim Ash Staging Area and Sluice Trench	
Spatial coverage:	Northern and eastern perimeter of Interim Ash Staging Area	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 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 to support top of CCR elevations
Geometry at time of document representative of 2017 conditions:	No	Polishing Pond construction and unit closures completed after drilling
Piezometer installation:	Yes	6 vibrating wire piezometers, screened in CCR
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:	No	

3.24.1 Field Activities

The geotechnical exploration program included 6 borings to install vibrating wire piezometers (VWPZ) in the interior of the Interim Ash Staging Area, generally along the northern and eastern perimeter of the unit. The soil borings were drilled without sampling to a depth of 5 feet. Then SPT sampling was performed on five-foot intervals through the CCR in accordance with ASTM D1586. Disturbed samples were visually classified in the field.

One VWPZ was installed at approximately elevation 750 feet within each boring to measure pore water pressures in the CCR. The remaining annular space was then grouted to the surface. Boring locations were surveyed by TVA personnel upon completion. The approximate locations are shown in Figure 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. Borings did not locate the bottom of CCR, and surface elevations may not represent capped and closed conditions.
2. Vibrating Wire 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 and water samples.

3.25 TVA (2015)

Table 25. Summary of Evaluation for TVA (2015)

Reference:	TVA. (2015). "Groundwater Monitoring Wells, Site Inspection Summary Reports, Kingston Fossil Plant, Kingston, Tennessee." Revision 2. May 5.	
Purpose:	Site walk down inspection to locate and document the condition of groundwater monitoring wells at Kingston.	
CCR Unit(s):	Stilling Pond, Sluice Trench, and Interim Ash Staging Area	
Spatial coverage:	Perimeter monitoring well network	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	Logs of 3 existing monitoring wells included
Rock coring:	Yes	Logs of 2 existing monitoring wells screened in bedrock
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 and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar to current.
Piezometer installation:	Yes	3 Monitoring wells, screened in alluvial sand or bedrock
In-situ testing:	Yes	SPT noted in existing monitoring well installation logs.
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:	No	

3.25.1 Field Activities

The field activities consisted of site walkdowns to locate and document the condition of groundwater monitoring wells at Kingston. Logs of the current monitoring well installations are included in inspection report. Boring logs of three monitoring wells installed in 2014 by S&ME are included in the inspection report.

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. Monitoring wells
   a. Installation methods meet current standard of practice,
   b. Locations and elevations were surveyed,
   c. Instruments are adequate to provide current water level readings and water samples.

3.26 AECOM (2016A)

Table 26. Summary of Evaluation for AECOM (2016A)

Reference:	AECOM. 2016a. "KIF Geotechnical Exploration and Analysis Report (Rev. A) Interim Ash Staging Area Closure & Drainage Flow Management Project." Prepared for Tennessee Valley Authority. April 4.	
Purpose:	Evaluate slope stability of Raised and East Dike system and Dike C, with proposed final closure of the Interim Ash Staging Interim Ash Storage Area, proposed Polishing Pond, and proposed Conveyance Pipe Bench. Consider how site geology may affect foundations of proposed outflow structures.	
CCR Unit(s):	Interim Ash Staging Area and Stilling Pond	
Spatial coverage:	1 cross section through Polishing Pond and East Dike, 1 cross section through Dike C	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 SPT borings
Rock coring:	No	6 borings
Other subsurface data:	Yes	Seismic CPT
Boring locations surveyed:	Yes	Surveyed by TVA after drilling
Data adequate to support three-dimensional model:	Yes	Data support dike geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Reflects current conditions.
Piezometer installation:	No	
In-situ testing:	Yes	SPT, Seismic CPT with pore pressure dissipation
Laboratory testing:	Yes	Testing followed relevant ASTM standards
Shear strength parameters:	Yes	Static drained and undrained and seismic (pseudostatic and post-earthquake) strengths for CCR and foundation soil
Static slope stability:	Yes	2 cross sections, normal pool and flood pool
Seismic slope stability:	Yes	2 cross sections, pseudostatic and post-earthquake
Information adequate to support stability evaluation:	Yes	Analyses are representative of static and seismic stability of Polishing Pond, East Dike, and portion of Dike C for current conditions
Other relevant analyses:	Yes	Liquefaction triggering, seepage modeling, foundation recommendations for structures, settlement, seismic displacement

3.26.1 Field Activities

The exploration included six hollow stem auger (HSA) borings (KIF BF SPT-1 through KIP BF SPT-6) and six cone penetration test (CPT) soundings (KIF BF CPT-1 through KIP BF CPT-6) as shown in Figure 1. The borings were located directly adjacent to the corresponding CPT soundings and were advanced to refusal. Four of the six HSA borings were extended an average of six feet each into the underlying bedrock by means of coring. The purpose for the rock coring was to confirm published geologic mapping and make a further assessment about the potential for karst development.

Upon completion, the borings were backfilled with bentonite cement grout via the tremie method. Upon CPT refusal, the cone and rods were removed from the sounding and a PVC tremie pipe was inserted to the refusal depth. The soundings were then backfilled with bentonite cement grout and the tremie pipe was removed.

3.26.2 Laboratory Testing

Soil tests were performed on Shelby Tube soil samples obtained while advancing hollow stem auger borings during the subsurface investigation. Laboratory tests were performed to determine sample moisture content (ASTM D2216), particle size (ASTM D422 and ASTM D1140), Atterberg limits (ASTM D4318), CU (ASTM D4767) and UU (ASTM D2850) triaxial shear tests, one-dimensional consolidation (ASTM D2435), and hydraulic conductivity (ASTM D5084).

3.26.3 Analysis

Slope stability analyses were performed using limit equilibrium methods through the computer software SLOPE/W. The stability analyses were performed using two-dimensional limit equilibrium analysis based on the method of slices according to Spencer's Method. Pore water pressures and exit gradients were estimated based on seepage modeling performed using SEEP/W. Static slope stability analyses were performed for normal pool and flood pool cases. Seismic slope stability analyses were performed for pseudostatic and post-earthquake (with liquefaction) cases.

Simplified liquefaction triggering analyses were performed based on SPT and CPT data. Residual strengths were estimated for materials judged to liquefy in the design earthquake, for use in post-earthquake slope stability analyses. Simplified seismic displacement analyses were performed for the East Dike and Dike C.

Settlements due to static loads and/or liquefaction were estimated for proposed outlet structures and proposed earth structures (dikes, etc.).

3.26.4 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 (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.
3. Static and seismic 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.

3.27 AECOM (2016B)

Table 27. Summary of Evaluation for AECOM (2016B)

Reference:	AECOM. (2016b). "Polishing Pond Engineering Report, Drainage and Flow Measurement Project (Downstream), Revision 0." Prepared for Tennessee Valley Authority. April.	
Purpose:	The report documents the design of the Polishing Pond and associated Drainage and Flow Management components. A brief summary of the geotechnical report from AECOM (2016a) is included herein, along with select attachments such as boring layouts and logs, CPT report, laboratory data, and slope stability analyses.	
CCR Unit(s):	Interim Ash Staging Area and Sluice Trench	
Spatial coverage:	Polishing Pond	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	Information presented is identical to AECOM (2016a)
Rock coring:	Yes	Information presented is identical to AECOM (2016a)
Other subsurface data:	No	No
Boring locations surveyed:	Yes	Information presented is identical to AECOM (2016a)
Data adequate to support three-dimensional model:	Yes	Information presented is identical to AECOM (2016a)
Geometry at time of document representative of 2017 conditions:	Yes	Information presented is identical to AECOM (2016a)
Piezometer installation:	No	
In-situ testing:	Yes	Information presented is identical to AECOM (2016a)
Laboratory testing:	Yes	Information presented is identical to AECOM (2016a)
Shear strength parameters:	Yes	Information presented is identical to AECOM (2016a)
Static slope stability:	Yes	Information presented is identical to AECOM (2016a)
Seismic slope stability:	Yes	Information presented is identical to AECOM (2016a)
Information adequate to support stability evaluation:	Yes	Information presented is identical to AECOM (2016a)
Other relevant analyses:	No	

3.27.1 Field Activities

No new field work was performed. The boring layouts, boring logs, and CPT report from AECOM (2016a) are provided again as an attachment.

3.27.2 Laboratory Testing

No new laboratory testing was performed. The laboratory testing results from AECOM (2016a) are provided again as an attachment.

3.27.3 Analysis

No new analyses were performed. The slope stability results from AECOM (2016a) are provided again as an attachment.

3.27.4 Evaluation of Existing Data

No new geotechnical data is presented. Refer to summary of AECOM (2016a) for the evaluation of existing data.

3.28 STANTEC (2017A)

Table 28. Summary of Evaluation for Stantec (2017A)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2017a. "Summary of Seismic Performance, Closed Stilling Pond, Kingston Fossil Plant, Harriman, Roane County, Tennessee." Prepared for Tennessee Valley Authority. May 16.	
Purpose:	To perform engineering analyses for the Stilling Pond closure design, including calculations to predict how the closed facility will perform in a large earthquake. Both static and seismic stability analyses were performed.	
CCR Unit(s):	Stilling Pond	
Spatial coverage:	2 cross sections	
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	Proposed closed Stilling Pond and Dike C geometry, CCR thickness, foundation stratigraphy
Geometry at time of document representative of 2017 conditions:	Yes	Data support dike geometry and phreatic conditions for closure design,
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static drained, static undrained, seismic, and post-earthquake strengths (CCR and soils)
Static slope stability:	Yes	2 cross sections through Dike C
Seismic slope stability:	Yes	2 cross sections through Dike C
Information adequate to support stability evaluation:	Yes	Analyses are representative of static and seismic stability and post-earthquake deformation.
Other relevant analyses:	Yes	Settlement analysis, liquefaction triggering analysis, post-earthquake deformation analyses.

3.28.1 Analysis

Data from soil borings show that Dike C is underlain by a substantial thickness of loose, alluvial silts and sands (up to about 25 feet thick in some places). Engineering analyses show that these soil deposits will liquefy during the design earthquake. In addition, liquefaction is expected within the CCR deposits that will remain in the bottom of the backfilled Stilling Pond.

As part of closure design, the backfilled Stilling Pond closure design was evaluated for stability during an earthquake. Seismic hazards associated with both local seismic source zones and larger magnitude events in western Tennessee were considered. Consistent with regulatory guidelines, the design seismic motions represent earthquakes having a return period of about 2,500 years (the peak accelerations have a 2% probability of exceedance in 50 years).

Engineering calculations using multiple, simplified methods predict lateral movements in the range of 0.2 to 35 feet. A more robust computer simulation in *FLAC* indicated movements of 7 feet. This is much less than the minimum 120 feet distance between the retained CCRs and the Emory River water line. Lateral spreading may cause cracks in the perimeter dike, but the retained ash is unlikely to escape through these fissures. The sand and rock filter buttress on the outside of the dike provides an additional defense to prevent the discharge of CCRs to the river.

The analyses show that the CCR material in the bottom of the closed Stilling Pond will remain within the current facility footprint during and after a large earthquake. Based on these results, combined with the relatively low seismicity of the region, there is little risk for an uncontrolled release of CCRs from the closed Kingston Stilling Pond.

3.28.2 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 slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same as present.
    c. Pool elevations and phreatic conditions are similar or more conservative than current.
    d. Analysis methods meet current standard of practice.

3.29 STANTEC (2017B)

Table 29. Summary of Evaluation for Stantec (2017B)

Reference:	Stantec. (2017b). "Geotechnical Field Services for Well Installations and Closures, Groundwater Monitoring Optimization – Phase 3, Kingston Fossil Plant, Kingston, Roane County, Tennessee." Prepared for Tennessee Valley Authority. February 27.	
Purpose:	The installation of a new groundwater monitoring well and redeveloping existing wells to establish the groundwater monitoring networks for the CCR units	
CCR Unit(s):	Recovery Project Landfill, Interim Ash Staging Area, Sluice Channel, Stilling Pond, and Peninsula Disposal Area	
Spatial coverage:		
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	4 borings
Rock coring:	No	
Other subsurface data:	Yes	Well development records, downhole well video logs, updated well construction details, pump installation records
Boring locations surveyed:	Yes	Surveyed by Stantec after drilling
Data adequate to support three-dimensional model:	Yes	Data support foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Phreatic conditions similar to current.
Piezometer installation:	Yes	One monitoring well installed.
In-situ testing:	Yes	SPTs performed in monitoring well borings.
Laboratory testing:	Yes	Analytical testing of soil samples.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.29.1 Field Activities

The work included installation of one new monitoring well, the redevelopment of 28 existing wells and assistance to TVA with the replacement of existing well surface protection (concrete pad, bollards, and protective cover).

Stantec drilled two soil borings, designated as KIF-101A and KIF-101B, prior to successfully installing a new well at KIF-101. Groundwater was not observed in either KIF-101A or KIF-101B and the boreholes were subsequently tremie-backfilled with high solids (30%) bentonite grout. A third boring (KIF-101) was drilled southwest of the gypsum loading yard, about eight feet north of a location chosen by AECOM. Groundwater was observed in this boring and new well KIF-101 was established at this location. The boring locations are shown in Figure 1.

Boring G-2AR was drilled to install a replacement well for Well G-2A. Soil samples for boring G2AR were obtained via SPTs. A saturated zone of clay was observed at a depth of 43.0 feet bgs but no measurable water level was found during drilling or 24 hours after its completion. Auger refusal was observed at a depth of 58.4 feet bgs (elevation 795.8 feet). Well materials were temporarily installed but removed and the borehole tremie-backfilled with high solids (30%) bentonite grout after no measurable groundwater was observed.

One new well, KIF-101, was installed using current industry and regulatory protocols to prevent introducing contaminants during the drilling and installation process. Standard Penetration Tests (SPTs) were performed at 2½-foot depth intervals through the soil overburden for borings KIF-101 and G-2AR to assist in characterizing the subsurface soils. The new well was constructed of four-inch diameter by ten-foot long Schedule 40 PVC pre-packed well screen (0.010-inch slots) and riser. 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 was allowed to sufficiently hydrate, the remaining annular space was backfilled with a bentonite grout (containing 30% bentonite solids).

Each new and existing well remaining in-service was developed by a combination of bailing, surging, and pumping. If the well contained heavy sediment, further bailing was performed before continuation of development with surge blocks and submersible pumps. A target turbidity value of ten (10) Nephelometric turbidity units (NTUs) was utilized for the wells at KIF. The turbidity level of all 29 wells, except for Well AD-1, was measured below 10 NTUs at completion. The turbidity of the groundwater in well AD-1 was measured no lower than 65.3 NTUs. It was pumped dry multiple times during development activities.

Each new and existing well remaining in-service were completed with wellheads in accordance with TVA standard design drawings. Stantec completed a field survey of all wells to remain in-service. Stantec was tasked with videoing the inside of the wells to remain in service. Based on the field surveys and video logging, Stantec has updated the construction diagrams for existing wells to remain in service.

New dedicated sampling pumps supplied by QED Environmental Systems, Inc. were installed in existing and new compliance monitoring wells except those to be used for groundwater level purposes (GW-2 and GW-3) and G-2A that exhibited a minimal water column.

3.29.2 Laboratory Testing

During the drilling process for new background well KIF-101, select soil samples collected from the screened interval were analyzed for the presence of existing and/or naturally occurring metal sources within the in-situ subsurface materials. Select soil samples collected during the drilling process were also analyzed for general chemistry parameters and radiochemical analysis. The two composite soil samples from well KIF-101 were tested for the presence of 27 different metals, seven general chemistry parameters and three radiochemical analyses.

3.29.3 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. Foundation geometry is substantially the same as current.
2. Monitoring Wells
   a. Installation methods meet current standard of practice,
   b. Locations and elevations were surveyed,
   c. Instruments are adequate to provide current water level readings and water samples.

4.0 ASSUMPTIONS AND LIMITATIONS

In preparing this document, TVA has made the following assumptions:

- The summaries presented herein cannot fully communicate the information contained in each document. Refer to the individual reference documents for additional context and detail.

5.0 REFERENCES

References are provided in the summary table for each document discussed herein.

Additional references are as follows:

Tennessee Valley Authority (1986). "Kingston Steam Plant - NPDES Permit No. TN 0005452, Red Water Treatment Using Engineered Wetlands, Design Description." February.

Tennessee Valley Authority (1987). "10W440-1 R0, Kingston Steam Plant. Redwater Treatment Using Engineered Wetlands (Manmade). Sheet 1." July 28.

ATTACHMENT A
FIGURE

Figure No.

1

Title

Existing Borings

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location

Roane County, Tennessee

175618610

Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet

1:2,400 (At original document size of 22x34)

Legend

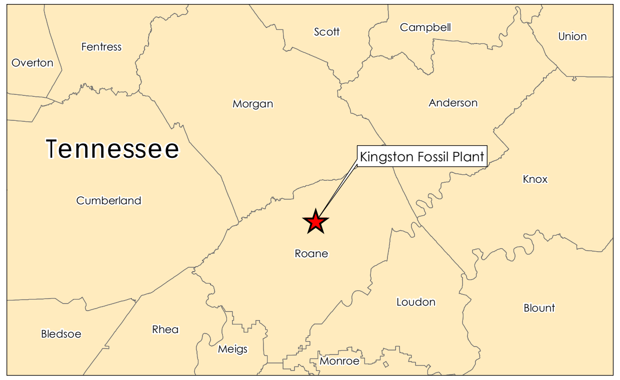
- Existing Boring
- Existing CPT

Boring Locations for Other Ongoing TVA Projects

- Closure Design Boring
- Perimeter Containment Alignment (Approximate)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.
4. During the construction of the Perimeter Containment Soil-Cement Stabilization, top of rock elevations were determined by a combination of predrilling (S&ME 2011) and trench excavations. This top of rock information is available for the entirety of the Stabilization alignment and the spacing between top of rock observations range from approximately 15 feet to 20 feet.



Stantec

TVA

APPENDIX M
WATER USE SURVEY SAP

Water Use Survey
Sampling and Analysis Plan
Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	September 8, 2017
2	Addresses December 8, 2017 TDEC Review Comments and Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Addresses Applicable Programmatic Revisions and Issued for TDEC Approval	November 9, 2018

WATER USE SURVEY
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Water Use Survey
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018 Revision 4

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 — Date: 11/6/18

McClung, Nicholas Anthony — Digitally signed by McClung, Nicholas Anthony Date: 2018.11.05 10:12:16 -05'00'
TVA Investigation Field Lead — Date:

Health, Safety, and Environmental (HSE) Manager — Date: 11-7-18

Investigation Project Manager — Date: 10/24/2018

Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.11.05 20:32:40 -05'00'
QA Oversight Manager — Date:

Laboratory Project Manager — Date: 11/2/18

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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF 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 KIF Study Area, which includes the Stilling Pond, Sluice Trench and Ballfield Area East of Sluice Trench, and the Interim Ash Staging Area. 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 existing 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 Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and 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

TVA will conduct a survey of water supplies within a ½ mile radius of the boundary of the KIF Study Area. TVA owned property will be included in the survey. The water supplies will be sampled if access is granted. A map showing properties within ½ mile of the KIF Study Area is provided in Attachment A. A final map displaying surveyed and sampled water supplies will be provided in the EAR.

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:

- Existing information related to the water survey area provided by TVA;
- Public and private utilities water service maps on file;
- County water well inventory records on file with TDEC; and
- 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 supplies used for domestic or business purposes, 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 (e.g., 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 Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by the 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 Project Manager 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 (measured and recorded in microsiemens per centimeter [µS/cm] in accordance with ENV-TI-05.80.42)
- 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 flushed 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 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
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	EPA 200.8	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	EPA 200.8	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Mercury, dissolved	EPA 245.1	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	EPA 245.1	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Radium 226	EPA 903.0	HNO3 to pH < 2 Cool to <6°C	1 L glass or Plastic	180 days
Radium 228	EPA 904.0	HNO3 to pH < 2 Cool to <6°C	2 L glass or plastic	180 days
Chloride	EPA 300.0	Cool to <6°C	250-mL HDPE	28 days
Fluoride	EPA 300.0	Cool to <6°C	250-mL HDPE	28 days
Sulfate	EPA 300.0	Cool to <6°C	250-mL HDPE	28 days
pH	SW-846 9040C (field measurement)	NA	NA	15 minutes
Total Dissolved Solids	SM2540C	Cool to <6°C	250-mL HDPE	7 days
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 disposed in accordance with Section 5.4.7

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 Project Manager 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 the water use survey and sampling are summarized in Table 6 below. This schedule is preliminary and subject to change based on approval of this SAP, site conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the KIF EIP.

Table 6. Preliminary Schedule for Water Use Survey Activities

Project Schedule		
Task	**Duration**	**Notes**
Water Use Survey SAP Submittal		Completed
Field Activities Preparation	90 Days	Following EIP Approval
Field Activities Implementation	65 Days	Following Field Preparation
Lab 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:

- Private water sources will only be sampled and measured when access is granted. The Investigation Project Manager 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). 2001. "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual." November.

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

KIF 1/2 Mile Radius Map

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location

Roane County, Tennessee

175618610
Prepared by LMB on 2018-06-11
Technical Review by JK on 2018-06-11

0 500 1,000 1,500 2,000 Feet

1:6,000 (At original document size of 22x34)

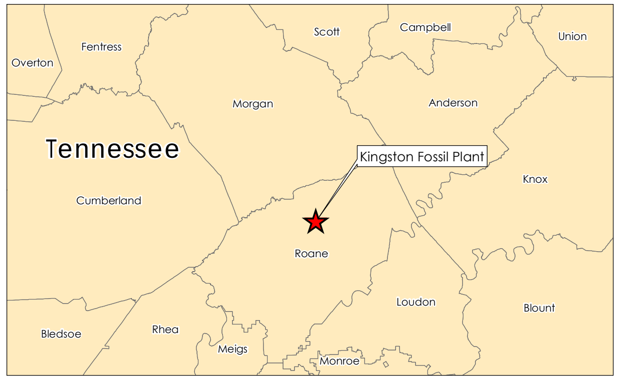
Legend

TVA Property 1/2 Mile Buffer

Approximate CCR Unit Area

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.



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 N
GROUNDWATER MONITORING DATA

Figure No.
1

Title

Existing and Closed Well Locations

Client/Project

Tennessee Valley Authority
Kingston Fossil Plant

Project Location 175618610

Roane County, Tennessee

Prepared by LMB on 2018-06-07
Technical Review by LP on 2018-06-07

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Potential Replacement Well for Well 22
- Existing Well for Other Programs
- Closed Wells
- Existing Compliance Wells For Study Area
- Existing Wells Proposed As Observation Wells For Study Area
- Surface Water Gauging Station For Study Area
- KIF Study Area Boundary
- Approximate CCR Unit Area
- Approximate Engineered Wetlands Area

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec

TVA

U:\TVA-EIP\175618610\gis\mxds\KIF_Existing_and_Closed_Well_locations.mxd Revised: 2018-06-07 By: trink

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.

TVA Kingston Fossil Plant
Existing Monitoring Well Construction Details

Well ID	Program	Function	Well Installation Date	Facility / Location	Screened Formation	Current Status	Screened Interval (ft btoc)	Latitude NAD27 (D M S)	Longitude NAD27 (D M S)	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 (in)	Well Depth (ft btoc)	Existing Stickup Height (ft ags)
22A	State Compliance Well	WQS	7/10/2002	KRP Ash Landfill	Residuum	Active Existing Compliance Well	20.2 - 50.2	N35°54'33.23"	W84°30'17.68"	N35°54'33.50"	W84°30'17.44"	759.12	755.6	2.0	50.5	3.5
22B	State Compliance Well	WQS	8/1/2014	KRP Ash Landfill	Lower Conasauga Group	Active Existing Compliance Well	59.9 - 81.4	N35°54'33.12"	W84°30'17.65"	N35°54'33.39"	W84°30'17.41"	759.18	755.0	2.0	82.2	4.2
27A	State Compliance Well	WQS	7/22/2014	KRP Ash Landfill	Weathered Shale	Active Existing Compliance Well	31.4 - 47.5	N35°54'46.54"	W84°30'24.87"	N35°54'46.81"	W84°30'24.63"	757.97	753.7	2.0	47.8	4.3
27B	State Compliance Well	WQS	8/1/2014	KRP Ash Landfill	Lower Conasauga Group	Active Existing Compliance Well	50.4 - 71.9	N35°54'46.47"	W84°30'24.76"	N35°54'46.74"	W84°30'24.52"	758.15	754.1	2.0	72.5	4.1
6AR	State Compliance Well	WQS	9/3/2009	KRP Ash Landfill	Residuum	Active Existing Compliance Well	34.5 - 44.2	N35°54'16.27"	W84°30'17.77"	N35°54'16.55"	W84°30'17.53"	758.01	754.0	2.0	44.7	4.0
AD-1	State Compliance Well	WQS	5/5/2009	KRP Ash Landfill and the Interim Ash Staging Area	Residuum	Active Background Compliance Well	25.5 - 35.4	N35°54'31.69"	W84°31'10.77"	N35°54'31.96"	W84°31'10.53"	781.13	777.4	2.0	35.7	3.7
AD-2	State Compliance Well	WQS	3/18/2009	Interim Ash Staging Area	Residuum	Active Monitoring Well	18.5 - 28.4	N35°54'10.25"	W84°30'54.10"	N35°54'10.52"	W84°30'53.86"	757.10	753.0	2.0	28.6	4.1
AD-3	State Compliance Well	WQS	4/3/2009	Interim Ash Staging Area	Residuum	Active Monitoring Well	13.9 - 18.8	N35°54'14.80"	W84°30'42.57"	N35°54'15.07"	W84°30'42.34"	752.30	748.4	2.0	18.9	3.9
GW-2	State Compliance Well	WLS	8/3/2010	KRP Ash Landfill	Residuum	Existing Observation Well	13.5 - 22.8	N35°54'50.22"	W84°30'54.09"	N35°54'50.50"	W84°30'53.85"	769.98	766.7	2.0	22.8	3.3

Well construction depths based on video logging performed by Stantec.
Ground surface elevations are based on survey datum and/or well completion data.

Abbreviations:

in	inches
ft	feet
ft btoc	feet below top of casing
ft ags	feet above ground surface
D M S	Degrees Minutes Seconds
ft NGVD 29	Feet North American Vertical Datum 1929
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
WQS	water quality sample
WLS	water level measurement

Well ID	Historical Well ID Ref.	Date	Inorganics																															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	-
	MCLs	EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-2	2	07/02/76	0.8	--	--	--	<10	--	<1	92	<5	--	40	10000	<10	--	--	--	<0.2	--	<50	--	--	<1	--	--	--	--	--	--	--	--	40	--	--	--
		03/09/77	<0.2	--	**26**	<100	<10	5600	<1	110	<5	--	<10	16000	<10	--	42	4600	<2	--	<50	--	--	<1	--	--	--	--	--	--	--	--	<10	--	--	65
		01/11/89	4.2	--	**270**	710	--	5300	<0.1	110	3	--	10	49000	3	--	51	5300	--	--	--	0.65	4.1	<1	21000	--	2400	6.5	--	--	--	30	40	3	0.2	6
		03/30/89	0.63	--	**160**	470	--	3300	<0.1	96	3	--	<10	47000	3	--	42	5200	--	--	--	<0.01	2.9	<1	20000	--	1500	5.9	--	--	--	<10	20	3	0.2	8
		06/29/89	1.5	--	**180**	510	--	2900	<0.1	95	2	--	<10	47000	1	--	38	4600	--	--	--	<0.01	2.2	<1	13000	--	1500	6.7	--	--	--	20	<10	2	<0.1	3
		09/14/89	3.4	--	**150**	500	--	25000	0.1	88	4	--	<10	42000	3	--	43	4800	--	--	--	0.29	2.4	<1	11000	--	1400	7.9	--	--	--	<10	60	4	0.3	2
		11/29/89	5.7	--	**320**	--	--	2400	0.3	96	--	--	20	63000	--	--	42	4900	--	--	--	0.05	2.8	1	8700	--	--	6.3	--	--	--	--	330	4	0.5	18
		03/07/90	6.6	--	**73**	--	--	2900	0.9	100	--	--	70	48000	--	--	40	4900	--	--	--	0.13	3	<1	24000	--	--	5.8	--	--	--	--	90	4	0.1	36
		06/05/90	5.4	--	**180**	510	--	2800	<0.1	93	6	--	<10	43000	11	20	39	4800	--	--	--	<0.01	2.7	<1	21000	--	1500	6.5	--	--	--	10	60	2	<0.1	18
		09/05/90	6.8	--	**430**	560	--	2800	0.8	110	12	--	<10	51000	**22**	50	52	6100	--	--	--	0.5	4	<1	20000	--	1800	6.8	--	--	--	<10	120	3	<0.1	10
		12/04/90	16	--	**310**	670	--	2800	0.3	100	6	--	20	54000	**18**	40	42	5300	--	--	--	<0.01	2.7	3	34000	--	1600	6.4	--	--	--	30	180	4	0.1	27
		03/20/91	19	--	**270**	710	--	2400	0.6	95	11	--	30	73000	**22**	30	42	5500	--	--	--	0.05	6.4	1	24000	--	1400	6.1	--	--	--	<10	200	4	<0.1	23
		06/04/91	13	--	**220**	670	--	2800	0.6	92	2	--	20	52000	**21**	30	42	5700	<0.2	--	--	<0.01	2.5	<1	31000	--	1600	6.1	--	--	--	30	130	4	0.16	21
		09/10/91	12	--	**200**	590	--	2400	1	99	9	--	30	55000	15	30	43	5600	--	--	--	<0.01	2.6	<1	30000	--	1500	6	--	--	--	30	110	3	0.2	20
		12/17/91	17	--	**230**	520	--	1700	0.6	90	10	--	20	53000	**19**	20	37	5200	--	<20	--	--	2.8	--	17000	--	1200	5.9	--	--	--	20	110	6	--	16
		06/02/92	4.8	--	**170**	460	--	2300	0.3	87	5	--	20	46000	5	<10	39	4900	--	30	--	--	2.8	--	20000	--	1200	6.3	--	--	--	<10	140	4	--	120
		12/07/92	11	<1	**440**	770	**6**	3900	0.9	110	17	--	<10	65000	**25**	40	46	6500	--	40	18	--	4.1	--	--	--	1900	5.4	--	--	--	20	170	4	--	35
		12/09/93	3.9	<1	**170**	540	<1	3600	<0.1	100	4	--	<10	40000	5	10	43	5200	--	80	8	--	3.1	--	--	--	1800	4.8	--	--	--	<10	20	4	--	16
		12/06/94	4.7	2	**230**	420	<1	4000	0.2	95	6	--	<10	33000	8	--	40	4400	--	--	7	--	4.6	--	--	--	1800	4	--	--	--	<10	20	1	--	41
		12/11/95	4.9	1	**130**	440	<1	4200	--	110	--	--	<10	18000	7	--	39	2900	--	--	5	--	12	--	--	--	3100	4.1	--	--	--	<10	40	4	--	120
		07/10/96	6.7	<1	**210**	530	<1	3000	--	100	--	--	<10	41000	10	--	41	5000	--	--	8	--	4.3	--	--	--	1800	5.2	--	--	--	<10	40	4	--	23
		12/03/96	1.1	<1	**93**	320	<1	3200	<0.1	110	10	--	<10	8500	3	--	38	3200	--	--	9	--	9.6	--	--	--	2700	3.9	--	--	--	<10	20	4	--	100
		05/07/97	0.74	<1	**170**	400	<1	3800	0.1	110	30	4	<10	14000	2	--	40	2900	--	--	19	--	8.5	--	--	--	3000	4.3	--	--	--	<10	20	4	--	130
KIF-J3		07/02/76	2	--	--	--	<10	--	<1	27	<5	--	80	9300	11	--	--	--	<0.2		<50	--	--	<1	--	--	--	--	--	--	--	--	90	--	--	--
KIF-J3A		07/02/76	520	--	--	--	**70**	--	<1	280	<5	--	1400	2000000	**44**	--	--	--	**2.9**	--	**820**	--	--	5	--	--	--	--	--	--	--	--	1300	--	--	--
KIF-6A	6A	07/02/76	2.3	--	--	--	<10	--	1	160	6	--	60	12000	**42**	--	--	--	<0.2	--	60	--	--	<1	--	--	--	--	--	--	--	--	50	--	--	--
		03/09/77	<0.2	--	<4	<100	<10	<500	<1	110	<5	--	<10	1600	<10	--	15	3500	<2	--	<50	--	--	<1	--	--	--	--	--	--	--	--	<10	--	--	120
		01/11/89	2.9	--	**12**	40	--	1200	0.7	350	5	--	30	92000	7	--	42	15000	--	--	--	0.05	21	<1	20000	--	2400	8.6	--	--	--	30	100	4	<0.1	630
		03/29/89	8.7	--	**13**	480	--	4600	0.6	390	3	--	70	1300000	8	--	87	63000	--	--	--	0.16	18	<1	42000	--	1600	7.6	--	--	--	60	140	3	<0.1	2000
		06/28/89	2.7	--	<1	310	--	3500	0.1	270	6	--	50	790000	2	--	72	54000	--	--	--	<0.01	18	1	7200	--	1800	8.1	--	--	--	160	180	2	<0.1	1800
		09/13/89	1.3	--	3	500	--	42000	<0.1	340	4	--	30	1500000	<1	--	110	80000	--	--	4	0.06	17	<1	10000	--	2300	9.7	--	--	--	<10	170	3	<0.1	2800
		11/29/89	1.7	--	<1	--	--	2600	0.6	350	--	--	40	1100000	--	--	88	61000	--	--	--	0.13	18	<1	5100	--	--	9.3	--	--	--	--	260	5	0.8	3000
		03/07/90	<0.05	--	<1	--	--	4100	1	300	--	--	70	1100000	--	--	80	64000	--	--	--	0.14	17	<1	11000	--	--	8.2	--	--	--	--	160	4	<0.1	3200
		06/05/90	1.7	--	6	420	--	5000	0.5	310	3	--	40	1300000	8	30	83	71000	--	--	--	<0.01	13	<1	12000	--	1700	7.9	--	--	--	310	200	4	<0.1	2400
		09/05/90	<0.05	--	4	460	--	4500	0.5	350	<1	--	40	1200000	<1	50	95	74000	--	--	--	<0.1	14	<1	9400	--	1900	8.8	--	--	--	<10	160	4	<0.1	3100
		12/04/90	0.89	--	4	510	--	4900	<0.1	370	<1	--	70	1500000	9	50	100	71000	--	--	--	<0.01	17	<1	13000	--	2100	8.7	--	--	--	210	120	2	<0.1	3400
		03/20/91	1.4	--	2	440	--	4500	0.1	340	2	--	<10	1500000	2	50	93	77000	--	--	--	<0.01	17	<1	12000	--	2300	8.2	--	--	--	<10	130	<1	<0.1	3700
		12/17/91	0.43	--	4	630	--	2100	<0.1	380	5	--	20	1400000	2	50	93	83000	--	160	--	--	17	--	12000	--	2600	8.5	--	--	--	<10	120	6	--	3200
		06/02/92	0.8	--	5	70	--	3200	0.8	280	2	--	70	1300000	1	21	86	7800	--	<20	--	--	13	--	12000	--	1100	8.1	--	--	--	<10	210	4	--	2900
		12/07/92	10	<1	4	210	<1	3500	2	380	13	--	<10	1300000	**37**	50	69	76000	--	<20	12	--	17	--	--	--	3500	8.8	--	--	--	<10	240	5	--	2800
		06/08/93	<0.5	<1	3	40	<1	<500	<0.1	300	<1	--	<10	120000	<1	30	76	86000	--	<20	<1	--	13	--	--	--	2000	8.1	--	--	--	<10	<10	5	--	2300
		12/09/93	0.29	<1	7	80	<1	<500	<0.1	340	4	--	<10	870000	1	40	76	83000	--	<20	2	--	16	--	--	--	3700	8.5	--	--	--	<10	110	<1	--	2400

Well ID	Historical Well ID Ref.	Date	Inorganics 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)	Anions 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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-6A (cont.)	6A	06/13/94	0.25	4	4	30	<1	500	0.6	260	6	--	<10	570000	4	60	50	56000	--	<20	7	--	20	--	--	--	2000	8.2	--	--	--	<10	70	5	--	1800
		12/08/94	0.64	<1	4	50	<1	800	--	340	--	--	<10	180000	<1	--	31	20000	--	--	<1	--	26	<1	--	--	2000	8.1	--	--	--	<10	20	4	--	1300
		06/21/95	0.06	<1	2	10	<1	700	--	260	--	--	<10	1800	6	--	14	1800	--	--	5	--	25	--	--	--	1900	8.2	--	--	--	<10	<10	26	--	680
		12/11/95	0.06	<1	<1	10	<1	600	--	230	--	--	<10	2400	2	--	13	1600	--	--	4	--	23	--	--	--	1700	7.9	--	--	--	<10	10	4	--	600
		12/04/96	0.62	1	4	30	<1	<500	0.4	230	3	--	<10	68000	6	--	21	11000	--	--	7	--	21	--	--	--	1600	7.6	--	--	--	<10	20	5	--	830
		05/08/97	0.8	<1	2	40	<1	<500	3	270	4	--	<10	150000	3	--	29	26000	--	--	8	--	19	--	--	--	1500	8.8	--	--	--	<10	30	12	--	1300
		12/10/97	0.27	<1	3	40	<1	<500	4	240	1	--	<10	210000	4	--	32	32000	--	--	5	--	19	--	--	--	1400	8.8	--	--	--	<10	40	2	--	850
		06/30/98	0.74	<1	4	50	<1	<200	<0.1	280	2	3	<10	140000	<1	--	75	120000	--	--	4	--	11	--	--	--	1500	8.7	--	--	--	10	120	5	--	2800
		12/02/98	0.08	<1	2	20	<1	200	1	150	4	--	<10	100000	<1	--	18	14000	--	--	4	--	19	--	--	--	1100	7.9	--	--	--	<10	30	5	--	1200
		12/06/99	0.11	<1	<1	23	<1	600	0.3	170	2	--	<10	11000	2	--	14	2200	--	--	<1	--	20	--	--	--	1200	8	--	--	--	<10	10	5	--	580
		12/14/00	0.2	<2	3	34	<1	510	0.83	210	1.7	2.2	10	120000	6.2	--	26	23000	<0.2	<20	2	--	18	<1	--	<10	1300	8.4	<2	72	--	<10	32	8	<0.1	520
		06/28/01	0.09	<1	<1	51	<1	<200	2.2	250	<1	5.6	<10	160000	15	--	34	39000	<0.2	<20	<1	--	20	<1	17000	<10	1400	8.9	<2	<50	6.5	<10	56	7	<0.1	1300
		12/31/01	0.18	<1	**11**	33	<1	780	1.1	210	<1	<1	<10	360000	3.3	--	43	65000	<0.1	<20	<1		14	<1	--	40	960	9.2	<2	110	<5	20	100	6.4	<0.1	1700
		06/28/02	0.42	<1	8	28	<1	<200	0.77	190	3	14	<10	370000	2.6	--	40	60000	<0.1	<20	11	<0.01	9.6	<1	--	<10	67	5.4	<2	<50	9.2	<10	60	7	<0.1	1500
		01/08/03	0.86	<1	6	40	<1	<200	1.4	170	<1	6.6	<10	230	<1	--	27	35000	<0.1	<20	<1	0.03	16	4.1	--	40	1100	8.4	<2	<50	<5	<10	340	6.7	<0.1	990
		06/16/03	0.85	<1	<1	40	<1	610	0.7	240	<1	3	<10	780000	<1	--	71	140000	<0.1	--	2	<0.01	9.8	4	--	0.1	780	9.8	<2	--	--	80	1300	7	<0.1	1800
		09/02/03	1	<0.1	**11.5**	60	<1	1300	0.98	190	0.1	11.9	<10	630000	5.6	--	53	88000	0.1	--	7.7		17	2	--	70	790	9.8	0.2	--	--	140	<10	7.2	<0.1	2000
		12/29/03	0.22	<0.6	5	80	<1	<200	0.46	180	<0.5	6.6	<10	450000	1.2	--	50	77000	<0.1	<20	6.7	0.13	27	1.4	--	70	830	11.8	<0.1	--	--	40	<10	9	<0.1	2000
		03/10/04	0.25	<0.6	5.7	90	<1	<200	0.5	220	<0.1	3	<10	840000	2.8	--	66	120000	<0.1	<20	4.8	<0.01	11	3.1	--	**120**	750	9.8	<0.1	--	--	80	<10	7.5	<0.1	2400
		06/07/04	0.28	<3	**11**	100	<1	<200	0.4	240	<1	13	<10	940000	1	--	79	170000	<0.1	<20	7	<0.01	6.9	<1	--	<10	700	8.9	<2	--	--	<10	<10	6.6	<0.1	2700
		09/14/04	<0.05	<3	**13**	160	<1	600	<0.1	250	1	10	<10	1500000	<1	--	100	200000	<0.1	<20	3	<0.01	6.2	<1	--	**190**	800	11	<2	<50	<5	150	<10	9.2	<0.1	4000
		12/08/04	0.45	6	**14**	110	<1	<200	0.6	220	4	17	<10	840000	3	--	68	140000	<0.1	<20	9	<0.01	13	4	--	<10	730	8.7	<2	--	--	<10	50	7.7	<0.1	2600
		03/15/05	<0.05	4	6	80	<1	300	0.2	180	3	12	<10	650000	<1	--	57	100000	<0.1	<20	3	<0.01	11	<1	--	<10	670	5.7	<2	<50	<5	50	<10	5.3	<0.1	1883
		05/31/05	<0.05	4	4	70	<1	200	0.4	200	2	17	<10	740000	<1	--	66	140000	<0.1	<20	5	0.02	9.3	<1	--	<10	630	11	<2	--	--	70	<10	10	<0.1	2350
		12/13/05	<0.05	<3	5	80	<1	1600	0.3	220	6	4	<10	760000	<1	--	76	140000	<0.1	<20	13	<0.01	10	<1	--	**110**	740	9.2	<2	--	--	<10	<10	13	<0.1	2800
		06/06/06	<0.2	4	3	90	<1	700	0.1	240	1	<1	<10	1100000	<1	--	85	200000	<0.2	<21	<1	<0.02	8.4	<2	--	<10	710	10	2	--	--	<10	<10	7.3	<0.1	3000
		12/15/06	<0.2	<3	4	100	<1	800	<0.1	230	<1	<1	<10	1100000	<1	--	80	170000	<0.1	<20	<1	<0.01	8.8	<1	--	**130**	770	10	<2	--	--	100	<10	8.1	<0.1	2794
		06/05/07	0.22	<1	6.4	100	<1	<200	<0.5	250	<5	<5	<5	1000000	<1	--	94	220000	<0.2	<5	<5	<0.1	7.2	<5	--	<0.5	680	10	<1	--	--	<10	<50	4.7	<0.1	4300
		12/03/07	<0.1	<1	<5	170	<2	5200	<0.5	240	<5	<5	<5	930000	<1	--	93	180000	<0.2	<5	<5	<0.1	8.4	<5	--	<0.5	660	11	<1	--	--	64	<100	10	<0.1	3300
		06/02/08	0.24	<1	6.3	140	<1	1900	<0.5	250	2.6	1.7	5.6	1000000	<1	--	96	220000	<0.2	<25	8.2	<0.1	7.5	<1	--	<0.5	690	11	<1	--	--	<50	<10	4.8	<0.1	2500
		12/02/08	0.12	<1	**11**	210	<1	1500	<0.5	220	<20	<20	48	940000	1.1	--	90	130000	<0.2	<25	<10	<0.1	9.3	<10	--	<0.5	700	11	<1	--	--	<10	<100	8	0.23	2900
		02/11/09	--	--	<5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		06/11/09	<1	<2	6.46	<100	<2	711	<1	252	<20	<2	<50	1050000	<2	--	94.7	179000	<0.2	<50	<50	<0.1	<10	<20	--	<20	681	20.6	<2			<40	<500	6.12	<0.1	3500
KIF-6B	6B	07/02/76	85	--	--	--	<10	--	3	85	<5	--	70	200000	**89**	--	--	--	<0.2	--	70	--	--	<1	--	--	--	--	--	--	--	--	190	--	--	--
		03/09/77	<0.2	--	<4	<100	<10	<500	<1	100	<5	--	<10	77000	<10	--	18	7300	<2	--	<50	--	--	<1	--	--	--	--	--	--	--	--	20	--	--	150
		01/11/89	30	--	**100**	250	--	1800	<0.1	480	22	--	20	190000	**30**	--	35	7100	--	--	--	0.14	34	1	45000		3000	9.1	--	--	--	100	140	4	0.3	730
		03/29/89	12	--	**40**	180	--	1600	0.3	510	8	--	<10	110000	**20**	--	28	5900	--	--	--	<0.01	33	2	56000		3000	7.5	--	--	--	20	60	3	<0.1	1100
KIF-J7A	7A	07/02/76	7.2	--	--	--	<10	--	<1	39	12	--	40	5600	11	--	--	--	<0.2	--	<50	--	--	<1	--	--	--	--	--	--	--	--	30	--	--	--
		03/09/77	<0.2	--	<2	<100	<10	2000	<1	520	<5	--	<10	7000	<10	--	96	18000	<2	--	80	--	--	<1	--	--	--	--	--	--	--	--	10	--	--	1700
KIF-8	8	07/02/76	5.4	--	--	--	<10	--	1	360	12	--	70	13000	**26**	--	--	--	<0.2	--	<50	--	--	<1	--	--	--	--	--	--	--	--	80	--	--	--
		03/09/77	<0.2	--	<2	<100	<10	<500	<1	360	<5	--	<10	240	<10	--	70	2200	<2	--	<50	--	--	<1	--	--	--	--	--	--	--	--	20	--	--	890
		01/11/89	0.75	--	2	10	--	<500	<0.1	260	2	--	<10	1200	**41**	--	49	460	--	--	--	0.02	5.4	2	11000	--	990	16	--	--	--	10	<10	5	0.1	750

Well ID	Historical Well ID Ref.	Date	Inorganics																															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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-8 (cont.)	8	03/30/89	0.49	--	4	10	--	<500	<0.1	250	1	--	<10	1500	6	--	38	380	--	--	--	0.02	5.3	<1	13000	--	730	12	--	--	--	<10	10	5	0.1	440
		06/28/89	2.2	--	1	10	--	<500	<0.1	230	4	--	20	1400	3	--	40	220	--	--	--	<0.01	4.8	<1	12000	--	800	14	--	--	--	10	<10	6	<0.1	580
		09/14/89	1.3	--	<1	20	--	<500	0.3	180	2	--	<10	1600	6	--	32	500	--	--	--	<0.01	4.5	<1	7600	--	650	14	--	--	--	<10	50	9	0.2	300
		11/29/89	1.6	--	<1	--	--	<500	<0.1	200	--	--	<10	1100	--	--	38	1400	--	--	--	<0.01	4.1	<1	6200	--	--	13	--	--	--	--	50	6	0.5	400
		03/07/90	0.38	--	2	--	--	<500	0.2	190	--	--	20	2700	--	--	33	1100	--	--	--	<0.01	3.8	<1	12000	--	--	12	--	--	--	--	50	6	<0.1	430
		06/07/90	0.32	--	7	20	--	<500	0.2	230	2	--	<10	1400	3	40	35	1200	--	--	--	<0.01	4.1	2	12000	--	710	13	--	--	--	<10	20	6	<0.1	480
		09/06/90	<0.05	--	<1	30	--	<500	0.4	270	<1	--	20	930	<1	30	44	2000	--	--	--	<0.01	4.2	<1	12000	--	840	14	--	--	--	20	50	5	<0.1	550
		12/05/90	<0.05	--	3	10	--	<500	<0.1	320	3	--	<10	970	1	40	56	2100	--	--	--	<0.01	4.5	<1	13000	--	930	14	--	--	--	<10	<10	6	<0.1	1700
		03/21/91	<0.05	--	<1	<10	--	<500	<0.1	200	<1	--	<10	290	<1	40	26	850	--	--	--	0.01	4.5	<1	8200	--	770	14	--	--	--	<10	<10	6	<0.1	480
		06/04/91	15	--	**12**	250	--	<500	0.6	280	13	--	<10	21000	**32**	40	56	2400	--	--	--	<0.01	5	<1	34000	--	890	14	--	--	--	30	60	6	0.1	650
		09/10/91	2	--	**12**	70	--	<500	0.5	320	4	--	<10	4000	4	40	49	2500	--	--	--	0.03	5.3	<1	16000	--	1000	14	--	--	--	<10	30	5	0.1	690
		12/17/91	0.76	--	2	60	--	<500	<0.1	310	5	--	<10	3000	4	40	43	2300	--	<20	--	--	4.7	--	14000	--	830	13	--	--	--	<10	<10	4	--	670
		06/02/92	0.65	--	5	20	--	<500	<0.1	290	2	--	10	2800	<1	26	48	1300	--	<20	--	--	4.5	--	13000	--	860	14	--	--	--	<10	50	5	--	--
		12/08/92	0.31	<1	1	70	<1	<500	<0.1	340	<1	--	<10	1400	1	40	53	2400	--	<20	5	--	4.9	--	--	--	1000	16	--	--	--	<10	<10	6	--	700
		06/08/93	0.09	<1	<1	<10	<1	<500	<0.1	250	<1	--	<10	560	<1	30	39	1100	--	<20	<1	--	4.3	--	--	--	770	13	--	--	--	<10	<10	6	--	460
		12/08/93	0.12	<1	<1	10	<1	<500	<0.1	220	1	--	<10	670	<1	20	34	1000	--	<20	2	--	4	--	--	--	710	12	--	--	--	<10	<10	5	--	410
		06/14/94	0.18	2	<1	10	<1	<500	0.1	230	2	--	<10	530	8	30	37	610	--	<20	2	--	4.2	<1	--	--	740	12	--	--	--	<10	<10	6	--	390
		12/06/94	0.09	<1	<1	10	<1	<500	--	250	--	--	<10	680	<1	--	40	1500	--	--	1	--	4.2	--	--	--	830	13	--	--	--	<10	<10	6	--	480
		06/21/95	0.26	<1	1	10	<1	<500	--	250	--	--	<10	860	1	--	42	540	--	--	5	--	4.5	--	--	--	820	14	--	--	--	<10	<10	<1	--	540
		12/11/95	0.63	<1	2	20	<1	<500	--	260	--	--	<10	2000	2	--	41	1300	--	--	3	--	4.4	--	--	--	780	14	--	--	--	<10	10	6	--	570
KIF-9A	9A	01/05/89	0.95	--	**170**	110	--	1200	<0.1	150	2	--	<10	20000	<1	--	25	9800	--	--	--	0.07	10	<1	12000	--	1800	14	--	--	--	10	10	8	0.3	460
		03/28/89	3	--	**140**	100	--	1200	<0.1	130	3	--	<10	26000	2	--	25	11000	--	--	--	0.01	7.4	1	17000	--	1700	11	--	--	--	<10	10	6	0.3	420
		06/29/89	2.5	--	**140**	110	--	1300	<0.1	130	4	--	<10	22000	1	--	24	10000	--	--	--	<0.01	9.1	<1	13000	--	1900	9.1	--	--	--	40	40	7	<0.1	400
		09/14/89	2.2	--	**120**	100	--	13000	0.1	140	3	--	<10	32000	1	--	31	14000	--	--	--	0.24	7	<1	8800	--	1700	13	--	--	--	<10	60	8	0.4	400
		12/04/89	3.4	--	**91**	--	--	1000	0.1	140	--	--	<10	37000	--	--	29	14000	--	--	--	0.05	6.8	<1	6800	--	--	14	--	--	--	--	120	9	0.3	400
		03/13/90	3.5	--	**34**	--	--	1400	0.5	150	--	--	<10	46000	--	--	31	20000	--	--	--	0.14	8	<1	15000	--	--	9.8	--	--	--	--	20	8	<0.1	560
		06/12/90	1.4	--	**66**	110	--	1400	0.2	160	5	--	<10	44000	1	30	34	19000	--	--	--	<0.1	9.9	<1	15000	--	2100	12	--	--	--	<10	50	9	0.1	550
		09/12/90	2.3	--	**86**	110	--	1500	0.7	110	2	--	80	32000	1	30	24	13000	--	--	--	0.5	8.9	<1	15000	--	1800	13	--	--	--	20	50	9	<0.1	580
		12/10/90	25	--	**120**	310	--	1400	0.6	200	18	--	30	56000	**17**	50	38	19000	--	--	--	0.06	9.6	<1	29000	--	2000	13	--	--	--	60	80	--	0.2	2000
		03/25/91	2	--	**94**	140	--	1500	<0.1	180	<1	--	30	38000	<1	60	36	21000	--	--	--	0.12	35	<1	13000	--	2000	16	--	--	--	40	40	12	<0.1	570
		06/06/91	1.7	--	**81**	110	--	1600	0.2	200	<1	--	<10	46000	1	50	40	23000	--	--	--	<0.01	15	<1	15000	--	2200	14	--	--	--	<10	120	12	0.15	650
		09/11/91	16	--	**190**	310	--	1700	1	240	16	--	260	79000	8	40	52	33000	--	--	--	<0.01	13	3	38000	--	3200	13	--	--	--	110	100	10	0.2	760
		12/18/91	4.8	--	**150**	100	--	1400	0.5	250	<1	--	<10	62000	4	40	49	29000	--	<20	--	--	14	--	11000	--	3000	15	--	--	--	20	50	3	--	730
		06/03/92	2	--	**85**	50	--	1700	0.2	280	<1	--	10	54000	<1	19	56	29000	--	<20	--	--	10	--	16000	--	3100	15	--	--	--	20	10	17	--	1000
		12/09/92	3.9	<1	**120**	70	**6**	1600	0.4	300	2	--	<50	47000	2	30	57	35000	--	<20	53	--	11	--	--	--	3100	17	--	--	--	10	50	16	--	1100
		12/08/93	1.2	<1	**69**	20	<1	1800	0.2	380	4	--	<10	31000	<1	20	76	49000	--	<20	43	--	9	--	--	--	3700	18	--	--	--	<10	40	19	--	1200
		12/08/93	1.3	<1	**71**	20	<1	1800	0.3	380	4	--	<10	32000	<1	20	76	51000	--	<20	44	--	9	--	--	--	4000	18	--	--	--	<10	40	19	--	1200
		12/08/94	1.6	<1	**60**	10	<1	2400	--	460	--	--	<10	31000	<1	--	93	69000	--	--	68	--	8.5	<1	--	--	4200	18	--	--	--	<10	50	26	--	1400
		12/13/95	1.8	<1	**33**	10	<1	2500	--	480	--	--	<10	36000	<1	--	94	60000	--	--	90	--	11	--	--	--	5000	19	--	--	--	<10	70	23	--	1400
		07/10/96	2.1	<1	**39**	10	<1	2900	--	430	--	--	<10	40000	3	--	88	57000	--	--	85	--	13	--	--	--	5400	19	--	--	--	<10	70	22	--	1100
		05/08/97	1.3	<1	**32**	10	<1	2500	2	430	8	--	<10	33000	<1	--	87	57000	--	--	71	--	11	--	--	--	4500	19	--	--	--	<10	70	5	--	1300
KIF-9B	9B	01/05/89	<0.05	--	2	280	--	<500	<0.1	33	<1	--	<10	150	<1	--	7.2	110	--	--	--	0.05	3.4	<1	8700	--	520	61	--	--	--	10	<10	6	0.2	88

Well ID	Historical Well ID Ref.	Date	Inorganics																														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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-9B (cont.)	9B	03/28/89	0.15	--	<1	240	--	<500	<0.1	29	1	--	<10	160	<1	--	5.9	72	--	--	--	<0.01	6.8	<1	8000	--	450	51	--	--	--	<10	<10	1	0.2	55
		06/29/89	0.33	--	1	280	--	<500	<0.1	28	3	--	<10	190	1	--	4.9	36	--	--	--	<0.01	11	<1	8300	--	520	62	--	--	--	30	10	2	<0.1	50
		09/14/89	1.3	--	1	310	--	1500	<0.1	27	3	--	20	260	<1	--	8.5	78	--	--	--	<0.01	5.5	<1	5300	--	450	69	--	--	--	<10	30	2	0.3	43
		12/04/89	1.5	--	3	--	--	<500	<0.1	16	--	--	<10	350	--	--	6.3	<5	--	--	--	0.01	8.8	<1	3800	--	--	71	--	--	--	--	150	2	0.2	18
		03/13/90	0.05	--	2	--	--	<500	<0.1	18	--	--	<10	180	--	--	4	6	--	--	--	<0.01	13	<1	7100	--	--	62	--	--	--	--	<10	2	0.4	38
		06/12/90	0.08	--	1	380	--	<500	<0.1	37	<1	--	<10	70	<1	40	7.6	97	--	--	--	<0.1	5.4	<1	8800	--	600	58	--	--	--	<10	10	2	0.1	92
		09/12/90	<0.05	--	4	360	--	<500	0.4	39	<1	--	110	250	<1	40	7.7	120	--	--	--	<0.1	5.1	<1	8400	--	480	60	--	--	--	<10	10	3	0.2	84
		12/10/90	<0.05	--	<1	320	--	<500	<0.1	19	1	--	<10	130	<1	40	4.6	44	--	--	--	<0.01	5.8	<1	7900	--	320	70	--	--	--	<10	<10	2	<0.1	360
		03/25/91	<0.05	--	<1	380	--	<500	<0.1	31	<1	--	40	120	<1	50	5.8	41	--	--	--	<0.01	8.1	<1	7000	--	520	61	--	--	--	<10	<10	3	<0.1	55
		06/06/91	<0.05	--	5	320	--	<500	0.2	36	<1	--	<10	640	<1	50	7.6	110	--	--	--	<0.01	5	<1	8500	--	450	60	--	--	--	<10	40	12	0.18	650
		12/18/91	0.06	--	2	260	--	<500	<0.1	37	<1	--	<10	210	<1	40	7.4	90	--	<20	--	--	4.8	--	4400	--	670	5.7	--	--	--	<10	<10	5	--	74
		06/03/92	<0.05	--	2	240	--	<500	0.2	41	<1	--	<10	2000	<1	25	8	49	--	<20	--	--	4.8	--	8600	--	540	63	--	--	--	<10	<10	4	--	60
		12/09/92	<0.05	<1	1	320	<1	<500	0.5	34	<1	--	<10	110	3	40	6.3	92	--	30	2	--	4.9	--	--	--	530	64	--	--	--	<10	<10	3	--	600
		12/08/93	0.08	<1	4	220	<1	<500	<0.1	19	6	--	<10	240	<1	30	4.2	100	--	<20	4	--	6.4	--	--	--	410	78	--	--	--	<10	<10	3	--	47
		12/08/93	<0.05	<1	1	260	<1	<500	<0.1	44	3	--	<10	200	<1	30	8.7	100	--	<20	1	--	4.6	--	--	--	610	59	--	--	--	<10	<10	4	--	100
		12/08/94	<0.05	<1	<1	230	<1	<500	--	41	--	--	<10	170	<1	--	8.7	130	--	--	<1	--	4.7	<1	--	--	530	62	--	--	--	<10	<10	4	--	90
		12/13/95	<0.05	1	1	280	<1	<500	--	46	--	--	<10	170	<1	--	9.4	110	--	--	1	--	4.2	--	--	--	590	62	--	--	--	<10	<10	5	--	120
		07/10/96	<0.05	<1	<1	280	<1	<500	--	48	--	--	<10	100	<1	--	9.4	100	--	--	<1	--	4.2	--	--	--	630	62	--	--	--	<10	<10	5	--	100
		12/03/96	<0.05	2	<1	260	<1	<500	<0.1	51	<1	--	<10	160	6	--	10	110	--	--	2	--	4.8	--	--	--	630	65	--	--	--	<10	<10	5	--	94
KIF-10	10	01/04/89	1.8	--	**180**	110	--	<500	<0.1	160	5	--	<10	21000	2	--	19	880	--	--	--	0.14	7.4	<1	9000	--	1500	9.4	--	--	--	10	<10	4	0.4	440
		03/28/89	3.2	--	**180**	150	--	<500	<0.1	140	6	--	<10	21000	2	--	18	780	--	--	--	0.02	7.2	<1	11000	--	1500	8.7	--	--	--	<10	10	4	0.4	380
		07/05/89	2.6	--	**200**	50	--	<500	<1	200	<1	--	10	23000	0.8	--	23	990	--	--	--	0.02	8.2	<1	8100	--	1800	10	--	--	--	10	80	5	0.1	550
		09/14/89	3.4	--	**190**	130	--	4800	<0.1	180	4	--	<10	24000	1	--	24	1000	--	--	--	0.22	9.1	<1	7300	--	1800	11	--	--	--	<10	40	6	0.5	500
		11/30/89	2.5	--	**200**	--	--	<500	<0.1	230	--	--	<10	42000	--	--	32	1500	--	--	--	0.05	9.4	<1	4000	--	--	11	--	--	--	--	80	7	1	700
		03/13/90	2.5	--	**240**	--	--	540	<0.1	190	--	--	<10	52000	--	--	25	1600	--	--	--	0.15	8.2	<1	11000	--	--	9	--	--	--	--	<10	4	0.6	600
		06/06/90	2.1	--	**250**	90	--	610	<0.1	180	5	--	<10	56000	4	170	25	1500	--	--	--	<0.01	7.3	<1	11000	--	2100	9	--	--	--	10	40	6	0.5	730
		09/11/90	1.6	--	**210**	80	--	670	0.3	180	2	--	20	460000	8	200	23	1500	--	--	--	0.5	9	<1	12000	--	1800	10	--	--	--	<10	30	6	0.7	500
		12/10/90	2.3	--	**230**	80	--	510	0.2	90	2	--	<10	24000	2	150	13	800	--	--	--	0.02	7.1	<1	11000	--	960	6.7	--	--	--	<10	<10	2	0.2	300
		03/20/91	2.8	--	**230**	120	--	<500	<0.1	80	7	--	<10	25000	6	140	11	660	--	--	--	0.01	8.2	<1	11000	--	910	6.2	--	--	--	<10	10	4	0.2	230
		06/04/91	1.9	--	**280**	120	--	<500	0.1	90	<1	--	<10	27000	3	140	12	760	--	--	--	<0.01	7.1	<1	11000	--	910	7	--	--	--	<10	20	4	0.41	240
		09/10/91	2.2	--	**180**	70	--	<500	0.3	78	5	--	<10	18000	<1	140	11	560	--	--	--	<0.01	7.6	<1	12000	--	810	6.8	--	--	--	<10	<10	2	0.5	170
		12/18/91	1.1	--	**180**	80	--	<500	<0.1	61	<1	--	<10	14000	<1	130	9.9	430	--	30	--	--	6.9	--	9100	--	690	9.2	--	--	--	<10	<10	4	--	120
		03/03/92	<0.05	--	**190**	40	--	<500	<0.1	62	<1	--	130	11000	4	99	8.8	360	--	100	--	--	6.5	--	9200	--	810	10	--	--	--	<10	<10	3	--	150
		06/03/92	<0.05	--	**170**	30	--	<500	0.1	71	<1	--	<10	11000	<1	120	9.1	330	--	120	--	--	7.2	--	8300	--	710	13	--	--	--	<10	<10	3	--	90
		09/01/92	<0.05	--	**240**	40	--	<500	<0.1	55	<1	--	<10	7000	1	110	7.9	250	--	80	--	--	7.4	--	7800	--	620	11	--	--	--	<10	<10	4	--	120
		12/08/92	1	<1	**180**	60	<1	<500	<0.1	66	<1	--	<10	11000	2	110	8.2	310	--	70	4	--	7.7	--	--	--	700	12	--	--	--	<10	<10	4	--	100
		06/08/93	<0.05	<1	**240**	30	<1	<500	<0.1	66	<1	--	<10	8700	<1	80	9.3	290	--	90	<1	--	7.1	--	--	--	710	11	--	--	--	<10	<10	5	--	100
		12/08/93	<0.05	<1	**210**	30	<1	<500	<0.1	68	<1	--	<10	7800	<1	80	11	290	--	120	<1	--	6.7	--	--	--	750	10	--	--	--	<10	<10	3	--	140
		06/13/94	<0.05	2	**244**	30	<1	<500	<0.1	62	<1	--	<10	8200	<1	80	10	300	--	140	<1	--	7.2	--	--	--	700	11	--	--	--	<10	<10	4	--	130
		12/07/94	<0.05	<1	**210**	20	<1	<500	--	56	--	--	<10	6500	<1	--	10	270	--	--	1	--	6.4	--	--	--	560	9.9	--	--	--	<10	<10	3	--	140
		06/21/95	<0.05	<1	**310**	20	<1	<500	--	70	--	--	<10	8300	<1	--	11	370	--	--	<1	--	7.2	--	--	--	740	13	--	--	--	<10	<10	<1	--	180
		12/12/95	<0.05	<1	**200**	10	<1	<500	--	58	--	--	<10	6600	<1	--	9.5	330	--	--	<1	--	6.2	--	--	--	580	18	--	--	--	<10	<10	4	--	140

Well ID	Historical Well ID Ref.	Date	Inorganics																															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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-10 (cont.)	10	07/09/96	0.08	<1	**400**	20	<1	<500	--	59	--	--	<10	10000	<1	--	9.7	300	--	--	<1	--	7	--	--	--	620	22	--	--	--	<10	<10	4	--	150
		05/08/97	0.07	<1	**540**	20	<1	<500	<0.1	120	<1	--	<10	29000	<1	--	20	420	--	--	<1	--	7.9	--	--	--	1200	15	--	--	--	<10	10	4	--	330
		05/08/97	0.09	<1	**520**	20	<1	<500	<0.1	120	<1	--	<10	27000	<1	--	19	410	--	--	<1	--	8	--	--	--	1100	15	--	--	--	<10	<10	4	--	330
KIF-10A	10A	01/04/89	15	--	2	120	--	2000	<0.1	150	8	--	30	104000	15	--	28	12000	--	--	--	0.08	8.4	<1	25000	--	2000	9	--	--	--	30	140	2	<0.1	640
		03/28/89	7.5	--	2	70	--	2200	<0.1	110	6	--	<10	69000	6	--	22	10000	--	--	--	<0.01	7.1	1	23000	--	1800	6.8	--	--	--	10	100	3	<0.1	420
		07/05/89	9.8	--	5	90	--	1900	1	120	2	--	40	68000	8	--	21	12000	--	--	--	0.08	7.5	1	19000	--	1700	7.5	--	--	--	20	300	4	<0.1	440
		09/14/89	16	--	3	100	--	17000	0.2	110	7	--	20	70000	**16**	--	24	10000	--	--	--	0.35	7.5	<1	17000	--	1800	8.8	--	--	--	<10	200	4	0.2	400
		11/30/89	8.2	--	2	--	--	1600	0.3	130	--	--	10	63000	--	--	26	10000	--	--	--	0.07	7.7	1	7600	--	--	9	--	--	--	--	290	4	0.7	510
		03/13/90	9.5	--	2	--	--	1900	0.3	120	--	--	10	63000	--	--	22	9300	--	--	--	0.17	7.2	<1	19000	--	--	8	--	--	--	--	110	4	<0.1	520
		06/06/90	94	--	**20**	490	--	2300	1	140	64	--	210	180000	**68**	100	36	10000	--	--	--	<0.01	9.3	1	45000	--	2200	8.6	--	--	--	120	320	5	0.2	530
		09/11/90	19	--	6	140	--	2000	0.3	150	8	--	70	810000	**19**	90	29	9600	--	--	--	0.6	7.8	<1	34000	--	2100	11	--	--	--	30	210	4	<0.1	530
		12/10/90	130	--	2	750	--	2000	0.1	160	80	--	180	190000	**86**	160	40	7400	--	--	--	<0.01	12	<1	49000	--	2200	9.7	--	--	--	150	350	6	<0.1	560
		03/20/91	7.5	--	4	100	--	1800	0.3	100	6	--	40	55000	7	60	19	8900	--	--	--	0.04	9.5	<1	18000	--	1700	7.5	--	--	--	<10	180	4	<0.1	360
		06/04/91	64	--	**17**	360	--	2000	0.3	94	44	--	100	110000	**54**	90	25	7900	--	--	--	<0.01	7.2	<1	53000	--	2000	6.9	--	--	--	70	220	5	0.16	370
		09/10/91	29	--	**13**	200	--	3100	0.4	110	19	--	60	86000	**18**	80	26	13000	--	--	--	--	8.2	1	43000	--	2400	5.4	--	--	--	<10	220	3	0.2	480
		12/18/91	7.9	--	4	100	--	2800	0.2	110	<1	--	<10	56000	5	70	22	15000	--	<20	--	--	7.3	--	12000	--	2200	5.9	--	--	--	<10	170	6	--	300
		03/03/92	4	--	4	80	--	1700	0.1	80	<1	--	110	29000	8	55	15	8400	--	<20	--	--	6.1	--	17000	--	1300	7	--	--	--	20	90	4	--	250
		06/03/92	7.7	--	7	70	--	1600	0.2	91	3	--	30	36000	5	46	16	9500	--	<20	--	--	6.9	--	21000	--	1200	7	--	--	--	<10	120	3	--	340
		09/01/92	3	--	4	30	--	1400	0.1	64	<1	--	<10	24000	2	50	12	7500	--	<20	--	--	5.8	--	13000	--	1100	7	--	--	--	<10	90	4	--	40
		12/08/92	6.9	<1	4	40	<1	1300	<0.1	67	<1	--	<10	26000	6	50	10	7700	--	<20	56	--	5.8	--	--	--	1100	7.7	--	--	--	<10	100	4	--	200
		06/08/93	2.8	<1	5	40	<1	<500	<0.1	49	<1	--	<10	22000	2	30	7.1	2800	--	<20	20	--	4.9	--	--	--	820	8.4	--	--	--	<10	60	5	--	150
		12/08/93	7.4	<1	7	60	**8**	860	0.2	75	2	--	<10	53000	6	20	12	5100	--	<20	42	--	5.1	--	--	--	1000	8.4	--	--	--	<10	170	4	--	180
		06/13/94	4.5	<1	7	40	4	600	0.4	52	<1	--	<10	25000	6	30	8.7	3100	--	<20	25	--	4.9	--	--	--	860	8.8	--	--	--	<10	70	4	--	170
		12/07/94	4.8	<1	5	10	3	800	--	48	--	--	<10	18000	7	--	8.8	3300	--	--	26	--	4.9	--	--	--	810	8.8	--	--	--	<10	50	4	--	170
		06/21/95	7.7	<1	6	30	**7**	900	--	54	--	--	<10	21000	4	--	9.3	4000	--	--	32	--	4.8	--	--	--	840	8.6	--	--	--	<10	50	<1	--	170
		12/12/95	3.2	<1	5	20	1	800	--	49	--	--	<10	13000	3	--	8	3300	--	--	24	--	4.9	--	--	--	730	8.7	--	--	--	<10	40	4	--	150
		12/05/96	3.8	<1	5	20	<1	600	<0.1	50	<1	--	<10	13000	8	--	8	3100	--	--	24	--	4.9	--	--	--	760	12	--	--	--	<10	70	4	--	170
		12/05/96	3.9	<1	4	30	<1	700	<0.1	53	<1	--	<10	13000	8	--	8.5	3400	--	--	23	--	4.9	--	--	--	840	12	--	--	--	<10	70	4	--	170
KIF-10B	10B	01/04/89	11	--	3	220	--	540	0.2	210	19	--	<10	38000	10	--	37	9800	--	--	--	0.03	7.3	<1	22000	--	1000	41	--	--	--	20	20	14	<0.1	660
		03/28/89	25	--	5	320	--	540	0.2	180	30	--	<10	49000	**20**	--	40	10000	--	--	--	<0.01	3.7	1	49000	--	840	34	--	--	--	50	100	14	<0.1	550
		07/05/89	7	--	4	130	--	<500	0.3	200	2	--	40	39000	4	--	34	9900	--	--	--	0.02	3.5	<1	12000	--	890	39.7	--	--	--	20	60	16	<0.1	660
		09/14/89	7	--	2	130	--	5900	0.1	190	6	--	<10	32000	4	--	37	10000	--	--	--	0.26	3.4	<1	11000	--	1100	41	--	--	--	<10	60	17	0.1	500
		11/30/89	2.6	--	2	--	--	<500	<0.1	200	--	--	<10	28000	--	--	39	11000	--	--	--	0.06	4	<1	4400	--	--	37	--	--	--	--	70	15	0.5	560
		03/13/90	0.06	--	<1	--	--	600	<0.1	190	--	--	<10	26000	--	--	33	11000	--	--	--	0.11	2.7	<1	8200	--	--	33	--	--	--	--	<10	14	<0.1	600
		06/06/90	0.33	--	1	50	--	520	4	190	1	--	20	25000	<1	<10	33	9800	--	--	--	<0.01	2.4	<1	8700	--	790	39	--	--	--	10	30	16	<0.1	640
		09/11/90	0.28	--	3	40	--	590	0.4	180	<1	--	50	23000	<1	<10	31	10000	--	--	--	0.4	2.8	<1	10000	--	700	42	--	--	--	<10	20	10	<0.1	560
		12/10/90	<0.05	--	<1	40	--	540	<0.1	180	<1	--	<10	22000	<1	<10	31	10000	--	--	--	0.02	2.4	<1	8200	--	670	32	--	--	--	<10	<10	12	<0.1	550
		03/20/91	0.07	--	2	40	--	520	0.2	180	2	--	<10	21000	<1	<10	29	10000	--	--	--	0.04	2.8	<1	8100	--	850	33	--	--	--	<10	20	12	<0.1	510
		12/23/91	0.58	--	2	90	--	<500	<0.1	150	<1	--	160	20000	1	<10	27	9900	--	<20	--	--	2.6	--	9700	--	630	31	--	--	--	20	<10	12	--	460
		12/08/92	0.34	<1	5	60	<1	<500	0.1	150	<1	--	<10	18000	1	10	23	8400	--	<20	4	--	2.9	--	--	--	670	38	--	--	--	<10	<10	15	--	400
		12/08/93	0.08	<1	1	40	<1	<500	<0.1	130	<1	--	<10	16000	<1	<10	22	7100	--	<20	4	--	2.7	--	--	--	570	31	--	--	--	<10	<10	11	--	320
		12/07/94	<0.05	<1	<1	30	<1	500	--	120	--	--	<10	15000	<1	--	23	7400	--	--	2	--	2.6	--	--	--	520	34	--	--	--	<10	<10	13	--	300

Well ID	Historical Well ID Ref.	Date	Inorganics																														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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-10B (cont.)	10B	12/12/95	0.2	<1	1	50	<1	<500	--	130	--	--	<10	17000	<1	--	21	7100	--	--	2	--	2.5	--	--	--	520	33	--	--	--	<10	<10	13	--	270
		07/09/96	0.14	<1	2	50	<1	<500	--	120	--	--	<10	26000	<1	--	19	6500	--	--	2	--	2.5	--	--	--	510	33	--	--	--	<10	<10	12	--	270
KIF-11B	11B	01/04/89	0.08	--	2	40	--	<500	<0.1	480	<1	--	<10	310	<1	--	76	400	--	--	--	0.57	2.8	<1	9800	--	540	9.9	--	--	--	10	<10	4	<0.1	1400
		03/28/89	0.09	--	<1	20	--	<500	<0.1	440	2	--	<10	240	<1	--	67	160	--	--	--	0.05	2.5	<1	9200	--	530	9	--	--	--	<10	<10	6	<0.1	1000
		06/28/89	3.4	--	<1	30	--	<500	<0.1	420	1	--	20	1400	6	--	69	390	--	--	--	0.07	2.6	<1	9600	--	680	10.6	--	--	--	20	<10	6	<0.1	1100
		09/14/89	2.4	--	<1	40	--	520	0.1	490	4	--	<10	1800	<1	--	79	780	--	--	--	<0.01	2.8	<1	7100	--	520	12	--	--	--	<10	40	8	0.2	950
		11/30/89	1.5	--	<1	--	--	<500	<0.1	540	--	--	<10	730	--	--	90	470	--	--	--	0.03	2.6	<1	5600	--	--	9.9	--	--	--	--	50	7	<0.1	1100
		03/07/90	<0.05	--	<1	--	--	<500	<0.1	430	--	--	30	210	--	--	68	210	--	--	--	<0.01	2.2	<1	9700	--	--	9.4	--	--	--	--	20	7	<0.1	1000
		06/06/90	9.2	--	6	130	--	<500	<0.1	520	12	--	<10	12000	5	20	83	1100	--	--	--	<0.01	3.3	1	23000	--	570	9.6	--	--	--	20	30	7	<0.1	1100
		09/11/90	3.5	--	2	100	--	<500	0.3	470	5	--	70	4800	2	40	55	660	--	--	--	<0.1	2.7	<1	21000	--	520	12	--	--	170	<10	20	6	<0.1	780
		12/10/90	0.49	--	<1	30	--	<500	0.2	350	<1	--	<10	980	<1	30	49	740	--	<20	--	<0.01	2.2	<1	11000	--	410	9.7	--	--	--	<10	<10	7	<0.1	650
		03/20/91	1.5	--	2	40	--	<500	<0.1	420	4	--	<10	2500	1	40	67	620	--	--	--	0.01	3.2	<1	12000	--	480	10	--	--	--	<10	10	7	<0.1	900
		12/23/91	0.65	--	<1	50	--	<500	<0.1	440	<1	--	80	1300	<1	<10	61	850	--	40	--	--	2.6	--	12000	--	480	9.3	--	--	--	<10	<10	7	--	1000
		12/08/92	0.97	<1	<1	20	<1	<500	<0.1	400	<1	--	<10	1500	3	40	54	820	--	<20	6	--	2.6	--	--	--	470	9.6	--	--	--	<10	<10	7	--	900
		12/08/93	<0.05	<1	<1	10	<1	<500	<0.1	460	<1	--	<10	500	<1	20	62	1100	--	<20	<1	--	2.5	--	--	--	490	9.2	--	--	--	<10	<10	6	--	930
		12/06/94	0.1	<1	<1	<10	<1	<500	--	430	--	--	<10	430	<1	--	59	1200	--	--	1	--	2.5	--	--	--	390	8.7	--	--	--	<10	<10	6	--	820
		12/11/95	<0.05	<1	<1	<10	<1	<500	--	380	--	--	<10	510	<1	--	51	920	--	--	<1	--	2.3	--	--	--	360	9	--	--	--	<10	<10	6	--	720
		07/09/96	0.35	<1	<1	10	<1	<500	--	350	--	--	<10	440	4	--	50	920	--	--	<1	--	2	--	--	--	360	9	--	--	--	<10	<10	7	--	690
KIF-12A	12A	01/04/89	1.6	--	3	110	--	<500	<0.1	82	1	--	<10	11000	2	--	28	9100	--	--	--	0.09	2.6	<1	6500	--	230	6.2	--	--	--	20	<10	2	0.2	190
		03/29/89	5.5	--	4	90	--	<500	<1	140	1	--	110	15000	3	--	36	10000	--	--	--	0.02	2.4	<1	11000	--	250	5.7	--	--	--	<10	10	3	0.2	220
		06/28/89	3.8	--	<1	70	--	<500	<0.1	140	6	--	20	8000	6	--	38	6800	--	--	--	<0.01	2.8	<1	5300	--	290	7.4	--	--	--	40	30	3	0.2	240
		09/18/89	<0.05	--	1	<10	--	<500	<0.1	0.1	4	--	<10	<10	2	--	<0.01	<5	--	--	--	0.13	3.1	<1	<20	--	<50	8	--	--	--	<10	<10	4	0.3	230
		03/14/90	0.24	--	<1	--	--	<500	<0.1	150	--	--	<10	2400	--	--	36	4100	--	--	--	<0.01	2.7	<1	600	--	--	6.5	--	--	--	--	<10	4	0.4	240
		06/14/90	0.19	--	<1	20	--	<500	<0.1	130	<1	--	<10	3100	<1	<10	34	5000	--	--	--	<0.1	2.7	<1	3100	--	230	6.6	--	--	--	<10	<10	3	0.2	240
		09/10/90	0.07	--	2	30	--	<500	0.5	120	<1	--	20	2100	<1	<10	31	4100	--	--	--	<0.1	2.9	<1	5200	--	230	7.2	--	--	--	<10	10	3	0.4	400
		12/06/90	<0.05	--	<1	30	--	<500	0.3	120	<1	--	<10	2200	1	<10	30	3900	--	--	--	<0.01	2.8	<1	3400	--	220	6.7	--	--	--	<10	<10	4	0.3	230
		03/21/91	<0.05	--	2	<10	--	<500	<0.1	62	<1	--	<10	970	7	<10	16	1900	--	--	--	0.01	2.9	<1	1700	--	250	6.4	--	--	--	<10	<10	4	0.4	230
		12/19/91	0.1	--	2	30	--	<500	<0.1	110	<1	--	<10	1800	<1	<10	27	3500	--	<20	--	--	3.2	--	2000	--	390	6.4	--	--	--	<10	70	4	--	160
		06/03/92	<0.05	--	2	20	--	<500	0.2	110	<1	--	<10	1500	9	<10	27	3100	--	<20	--	--	3.2	--	5200	--	230	7.6	--	--	--	<10	<10	3	--	170
		12/09/92	0.21	<1	<1	30	**6**	<500	<0.1	100	<1	--	<50	2600	<1	<10	23	4200	--	<20	1	--	3.3	--	--	--	220	7.6	--	--	--	<50	<10	4	--	170
		12/08/93	0.63	<1	1	30	<1	<500	<0.1	100	<1	--	<10	1800	<1	<10	24	3000	--	<20	1	--	3.1	--	--	--	240	6.6	--	--	--	<50	<10	3	--	140
		12/06/94	0.21	<1	<1	20	<1	<500	--	98	--	--	<10	1400	<1	--	25	3000	--	--	<1	--	3	--	--	--	190	6.7	--	--	--	<10	<10	3	--	140
		12/13/95	<0.05	<1	<1	20	<1	<500	--	97	--	--	<10	810	<1	--	24	2700	--	--	<1	--	3.4	--	--	--	230	7.1	--	--	--	<10	<10	4	--	140
KIF-12B	12B	01/04/89	<0.05	--	<1	30	--	<500	<0.1	220	<1	--	<10	1700	2	--	47	480	--	--	--	0.04	8.6	<1	11000	--	5300	35	--	--	--	10	<10	1	<0.1	480
		03/29/89	7.1	--	2	50	--	<500	1	60	<1	--	<10	7300	1	--	13	820	--	--	--	0.07	9.5	<1	19000	--	360	31	--	--	--	<10	10	2	<0.1	470
		06/28/89	2	--	<1	20	--	<500	<0.1	220	5	--	<10	1700	1	--	48	470	--	--	--	<0.01	11	<1	12000	--	6100	36.8	--	--	--	20	<10	2	<0.1	450
		09/18/89	1.7	--	<1	<10	--	<500	<0.1	220	4	--	<10	1800	<1	--	70	550	--	--	--	<0.01	8.6	<1	12000	--	5500	38	--	--	--	<10	50	4	<0.1	480
		12/05/89	1.8	--	<1	--	--	<500	<0.1	210	--	--	<10	1600	--	--	51	460	--	--	--	<0.01	9.2	<1	6000	--	--	38	--	--	--	--	70	4	<0.1	500
		03/12/90	0.06	--	<1	--	--	<500	0.2	230	<1	--	<10	1900	2	--	46	420	--	--	1	<0.01	8.6	<1	11000	--	--	34	--	--	--	--	<10	3	<0.1	530
		06/06/90	<0.05	--	3	10	--	<500	<0.1	240	<1	--	<10	1700	<1	70	50	480	--	--	--	<0.01	8.2	<1	13000	--	5400	37	--	--	--	<10	10	4	<0.1	570
		09/10/90	<0.05	--	1	10	--	<500	0.5	230	<1	--	<10	1400	<1	60	44	380	--	--	--	<0.1	8.7	<1	13000	--	4800	37	--	--	--	<10	10	3	<0.1	580
		12/06/90	<0.05	--	<1	20	--	<500	0.2	230	<1	--	<10	1700	<1	60	48	460	--	--	--	0.66	8.6	<1	12000	--	5100	36	--	--	--	<10	<10	4	<0.1	550

Well ID	Historical Well ID Ref.	Date	Inorganics																															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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-12B (cont.)	12B	03/21/91	<0.05	--	<1	20	--	<500	<0.1	220	<1	--	100	1700	<1	60	45	470	--	--	--	0.01	8.4	<1	12000	--	5100	36	--	--	--	<10	30	4	<0.1	510
		12/19/91	<0.05	--	<1	<10	--	<500	<0.1	220	<1	--	<10	1600	2	60	48	430	--	<20	--	--	8.8	--	6200	--	5500	35	--	--	--	<10	<10	4	--	380
		06/03/92	<0.05	--	2	<10	--	<500	<0.1	200	<1	--	<10	3100	<1	56	47	400	--	<20	--	--	8.6	--	12000	--	5000	37	--	--	--	<10	<10	3	--	580
		12/09/92	<0.05	<1	1	10	**6**	<500	0.6	200	<1	--	<50	1500	<1	70	42	360	--	<20	<1	--	9.1	--	--	--	4800	36	--	--	--	<10	<50	3	--	500
		12/08/93	<0.05	<1	<1	<10	<1	<500	<0.1	220	2	--	<10	1600	<1	50	45	400	--	<20	1	--	8.7	--	--	--	5600	33	--	--	--	<10	<10	3	--	410
		12/06/94	<0.05	<1	<1	<10	<1	<500	--	220	--	--	<10	1700	<1	--	49	410	--	--	2	--	8.9	--	--	--	5900	35	--	--	--	<10	<10	4	--	440
		12/13/95	<0.05	<1	<1	10	<1	<500	--	210	--	--	<10	1500	<1	--	46	420	--	--	<1	--	8.7	--	--	--	5200	32	--	--	--	<10	<10	4	--	400
KIF-13A	13A	01/11/89	110	--	**92**	1200	--	670	1	61	86	--	90	120000	**60**	--	20	2400	--	--	--	0.04	5.6	1	56000	--	870	28	--	--	--	240	250	1	0.3	88
		03/29/89	27	--	**170**	360	--	1500	2	150	31	--	10	120000	**19**	--	30	3700	--	--	--	<0.01	25	<1	20000	--	1200	39	--	--	--	50	90	3	0.2	440
		07/05/89	3.6	--	**100**	110	--	740	1	72	5	--	30	30000	3	--	15	1800	--	--	--	0.03	12	1	12000	--	760	36.2	--	--	--	30	50	2	<0.1	230
		12/06/89	7.3	--	**120**	--	--	<500	0.4	50	--	--	<10	50000	--	--	15	1200	--	--	--	0.06	6.4	<1	7600	--	--	34	--	--	--	--	110	2	<0.1	100
		03/14/90	0.56	--	**80**	--	--	<500	0.2	47	--	--	10	44000	--	--	9.5	1100	--	--	--	0.08	5.2	<1	2300	--	--	27	--	--	--	--	20	2	0.2	950
		06/14/90	3.6	--	**110**	200	--	<500	0.2	44	2	--	<10	57000	<1	40	10	1500	--	--	--	<0.1	3.6	<1	13000	--	540	29	--	--	--	10	10	2	0.1	100
		09/10/90	2.3	--	**180**	150	--	1700	0.4	150	2	--	50	220000	2	200	27	4000	--	--	--	1.2	16	<1	18000	--	1300	67	--	--	84	50	40	2	<0.1	650
		12/06/90	25	--	**100**	410	--	750	0.6	63	53	--	<10	110000	**19**	100	15	1900	--	--	--	<0.01	9.5	<1	35000	--	760	27	--	--	--	60	80	2	0.1	240
		03/21/91	1.2	--	**88**	150	--	<500	<0.1	47	<1	--	30	54000	2	60	8.2	1300	--	--	--	0.05	6.9	1	13000	--	580	26	--	--	--	<10	150	2	0.2	130
		06/06/91	1.3	--	**78**	150	--	<500	0.1	45	<1	--	<10	44000	<1	40	8.2	1100	--	--	--	<0.01	5.6	<1	14000	--	890	24	--	--	--	<10	<10	2	0.17	86
		09/11/91	1	--	**120**	270	--	570	0.5	60	4	--	10	70000	4	60	11	1200	--	--	--	<0.01	8.4	3	16000	--	890	27	--	--	--	40	100	2	0.2	130
		12/19/91	0.65	--	**69**	240	--	<500	<0.1	43	30	--	<10	39000	<1	30	8.9	940	--	<20	--	--	4.8	--	12000	--	540	24	--	--	--	10	50	1	--	56
		03/04/92	3.9	--	**85**	270	--	<500	<0.1	42	2	--	10	47000	5	27	8.3	1100	--	<20	--	--	4.9	--	20000	--	590	22	--	--	--	<10	20	<1	--	72
		06/03/92	0.98	--	**68**	190	--	<500	<0.1	48	<1	--	<10	48000	<1	31	8.5	1000	--	<20	--	--	5.4	--	15000	--	560	25	--	--	--	<10	<10	2	--	170
		09/01/92	0.41	--	**58**	180	--	<500	<0.1	35	<1	--	<10	35000	1	30	6.3	840	--	<20	--	--	4.3	--	12000	--	400	23	--	--	--	<10	<10	1	--	20
		12/08/92	3.1	<1	**74**	270	<1	<500	0.2	47	4	--	<10	54000	5	40	7.6	1200	--	<20	4	--	5.2	--	--	--	660	25	--	--	--	20	10	2	--	59
		06/08/93	0.08	<1	**58**	290	<1	<500	<0.1	56	<1	--	<10	50000	<1	30	8.8	1200	--	<20	<1	--	5.2	--	--	--	660	24	--	--	--	<10	<10	2	--	76
		12/08/93	0.59	<1	**58**	160	<1	<500	<0.1	39	<1	--	<10	39000	<1	10	7.2	930	--	<20	<1	--	3.9	--	--	--	520	21	--	--	--	<10	<10	1	--	40
		06/14/94	0.34	<1	**81**	220	<1	<500	0.4	45	<1	--	<10	48000	4	20	8.5	1100	--	<20	1	--	5.3	<1	--	--	630	21	--	--	--	<10	<10	2	--	53
		12/07/94	0.31	<1	**51**	210	<1	<500	--	41	--	--	<10	42000	<1	--	8.3	950	--	--	<1	--	4	--	--	--	510	21	--	--	--	<10	<10	2	--	31
		06/21/95	0.31	<1	**64**	270	<1	<500	--	50	--	--	<10	47000	1	--	9.6	1100	--	--	<1	--	5.1	--	--	--	660	22	--	--	--	<10	<10	<1	--	<2
		12/13/95	0.24	<1	**41**	190	<1	<500	--	39	--	--	<10	37000	<1	--	7.8	890	--	--	<1	--	3.8	--	--	--	450	20	--	--	--	<10	<10	2	--	25
		12/04/96	1	<1	**38**	260	<1	<500	<0.1	47	2	--	<10	46000	3	--	9.2	1100	--	--	<1	--	4.4	--	--	--	570	1.9	--	--	--	<10	<10	2	--	33
		05/08/97	0.24	2	**41**	250	<1	<500	<0.1	46	1	--	<10	45000	<1	--	9.7	630	--	--	<1	--	4.3	--	--	--	560	19	--	--	--	<10	<10	2	--	20
KIF-13B	13B	01/05/89	0.21	--	2	230	--	<500	<0.1	7.1	<1	--	<10	220	<1	--	1.1	<5	--	--	--	0.04	2.2	<1	6600	--	170	65	--	--	--	10	20	1	0.3	6
		03/29/89	0.25	--	<1	200	--	<500	<1	9.1	<1	--	10	160	2	--	1.3	44	--	--	--	<0.01	2	<1	7400	--	170	59	--	--	--	<10	<10	1	0.2	2
		06/29/89	0.12	--	<1	250	--	<500	<0.1	8.2	56	--	<10	190	<1	--	1.1	28	--	--	--	<0.01	2	<1	6900	--	220	70	--	--	--	20	30	<1	<0.1	1
		09/14/89	1.3	--	1	210	--	1000	<0.1	8.8	2	--	<10	150	<1	--	4.3	55	--	--	--	<0.01	2.2	<1	4700	--	170	71	--	--	--	<10	30	1	0.4	2
		12/05/89	1.5	--	<1	--	--	<500	<0.1	8	--	--	<10	160	--	--	3.8	7	--	--	--	<0.01	2.2	<1	3500	--	--	66	--	--	--	--	100	2	0.3	77
		03/12/90	<0.05	--	<1	--	--	<500	0.3	8.4	<1	--	<10	50	1	--	1.2	<5	--	--	2	<0.01	2.1	<1	6000	--	--	67	--	--	--	--	<10	<1	0.5	2
		06/06/90	<0.05	--	9	190	--	<500	<0.1	8.2	<1	--	<10	180	1	30	1.2	19	--	--	--	<0.01	1.9	2	6300	--	170	69	--	--	--	<10	20	1	<0.1	3
		09/10/90	<0.05	--	<1	200	--	<500	0.5	7.9	<1	--	20	80	<1	30	1.2	<5	--	--	--	<0.1	2.6	<1	8600	--	170	77	--	--	--	<10	<10	2	0.4	<1
		12/06/90	<0.05	--	<1	210	--	<500	0.3	8.6	5	--	<10	50	<1	30	1.3	17	--	--	--	0.05	2	<1	6200	--	180	66	--	--	--	<10	<10	2	0.2	5
		03/21/91	<0.05	--	<1	210	--	<500	<0.1	8.1	<1	--	<10	50	<1	30	1.1	16	--	--	--	<0.01	2.1	<1	5200	--	150	62	--	--	--	<10	10	2	0.2	<1
		12/19/91	<0.05	--	1	260	--	<500	<0.1	8.3	<1	--	<10	90	<1	30	1.5	40	--	<20	--	--	2.1	--	6300	--	190	6.3	--	--	--	<10	10	1	--	4

Well ID	Historical Well ID Ref.	Date	Inorganics																														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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-13B (cont.)	13B	03/04/92	<0.05	--	<1	220	--	<500	<0.1	8.4	<1	--	40	60	3	21	1.2	46	--	<20	--	--	2	--	8400	--	180	66	--	--	--	<10	<10	<1	--	2
		06/03/92	<0.05	--	<1	190	--	<500	<1	8.4	<1	--	<10	1900	<1	21	1.1	<5	--	<20	--	--	1.7	--	7400	--	160	66	--	--	--	<10	<10	1	--	2
		09/01/92	<0.05	--	<1	180	--	<500	<0.1	7.3	<1	--	<10	<10	2	30	1	22	--	<20	--	--	2.1	--	6400	--	150	65	--	--	--	<10	<10	1	--	<1
		12/08/92	<0.05	<1	<1	190	<1	<500	0.1	8.8	<1	--	<10	60	1	30	0.9	<5	--	<20	<1	--	2.2	--	--	--	180	66	--	--	--	<10	<10	1	--	<1
		12/08/93	0.09	<1	<1	240	<1	<500	<0.1	9.2	<1	--	<10	120	<1	20	1.3	33	--	<20	<1	--	2.2	--	--	--	190	61	--	--	--	<10	<10	1	--	2
		12/07/94	0.16	<1	<1	240	<1	<500	--	9.6	--	--	<10	170	<1	--	1.5	35	--	--	<1	--	2.2	--	--	--	160	63	--	--	--	<10	<10	1	--	<2
		12/12/95	0.11	<1	<1	260	<1	<500	--	10	--	--	<10	150	<1	--	1.5	36	--	--	<1	--	2.2	--	--	--	210	66	--	--	--	<10	<10	2	--	2
		07/11/96	0.07	2	<1	240	<1	<500	--	10	--	--	<10	90	<1	--	1.4	42	--	--	<1	--	2.1	--	--	--	220	64	--	--	--	<10	<10	1	--	3
		12/04/96	0.13	2	<1	240	<1	<500	<0.1	9.6	<1	--	<10	110	<1	--	1.3	42	--	--	<1	--	1.9	--	--	--	110	66	--	--	--	<10	<10	2	--	2
		05/08/97	<0.05	<1	<1	250	<1	<500	<0.1	11	<1	--	<10	160	<1	--	1.4	46	--	--	<1	--	2.5	--	--	--	200	65	--	--	--	<10	<10	2	--	4
		12/10/97	<0.05	<1	<1	270	<1	<500	<0.1	11	<1	--	<10	90	<1	--	1.4	37	--	--	<1	--	1.9	--	--	--	200	69	--	--	--	<10	<10	2	--	<1
		06/30/98	0.06	<1	<1	260	<1	<200	<0.1	10	<1	<1	<10	560	<1	--	1.4	90	--	--	<1	--	2.3	--	--	--	220	53	--	--	--	<10	10	1	--	<2
		12/02/98	<0.05	<1	<1	260	<1	<200	<0.1	10	<1	--	<10	50	<1	--	1.4	43	--	--	<1	--	2.9	--	--	--	210	65	--	--	--	<10	<10	1	--	2
		12/06/99	<0.05	<1	<1	280	<1	<200	<0.1	10	<1	--	<10	81	<1	--	1.5	53	--	--	<1	--	2.4	--	--	--	210	66	--	--	--	<10	<10	1	--	3
		12/14/00	<0.05	<2	<1	280	<1	280	<0.1	11	<1	<1	<10	50	<1	--	1.7	54	<0.2	<20	1	--	2.6	<1	--	<10	240	75	<2	<50	--	<10	<10	2	0.2	4
		06/28/01	<0.05	<1	<1	290	<1	<200	<0.1	11	<1	<1	<10	75	<1	--	1.6	57	<0.2	<20	<1	--	2.6	<1	6700	<10	240	65	<2	<50	<5	<10	<10	2	0.19	5
		12/31/01	<0.05	<1	<1	300	<1	<200	0.1	12	<1	<1	<10	61	1	--	1.7	61	<0.1	<20	<1	--	1.8	<1	--	<10	240	65	<2	<50	<5	<10	<10	1.5	0.17	3.9
		06/28/02	<0.05	<1	2	30	<1	<200	<0.1	12	<1	<1	<10	50	<1	--	1.7	51	<0.1	<20	<1	<0.01	1.5	<1	--	<10	69	49	<2	<50	9.5	<10	<10	1.6	0.18	3
		01/08/03	<0.05	<1	<1	310	<1	200	<0.1	12	<1	<1	<10	120	<1	--	1.6	59	<0.1	<20	<1	<0.01	2.2	<1	--	<10	250	62	<2	<50	<5	<10	<10	1.5	0.18	3.5
		06/17/03	<0.05	<1	<1	350	<1	<200	<0.1	13	<1	<1	<10	130	<1	--	1.8	69	<0.1	--	<1	<0.01	2.4	<1	--	0.2	270	81	<2	--	--	<10	<10	1.8	0.17	3.5
		09/02/03	<0.05	<0.1	0.2	340	<1	<200	<0.05	13	<0.5	2.2	<10	130	<0.1	--	1.8	70	<0.1	--	<0.5	--	2.4	<0.2	--	<10	260	74	<0.1	--	--	<10	<10	2	0.15	3.8
		12/29/03	<0.05	<0.6	<0.1	310	<1	<200	<0.05	13	<0.1	1.1	<10	110	<0.1	--	1.7	71	<0.1	<20	0.5	<0.01	2.9	<0.2	--	<10	260	76	<0.1	--	--	<10	<10	2.1	0.18	3.1
		03/10/04	<0.05	1.6	<0.1	340	<1	<200	<0.05	14	<0.1	1.8	<10	90	<0.1	--	1.8	76	<0.1	<20	0.5	<0.01	2.2	<0.2	--	<10	270	71	<0.1	--	--	<10	<10	2.2	0.17	2.8
		06/07/04	<0.05	<3	1	340	<1	<200	<0.1	14	<1	3	<10	140	<1	--	1.9	82	<0.1	<20	1	<0.01	0.27	<1	--	<10	270	65	<2	--	--	<10	<10	2.2	0.19	2.1
		09/14/04	<0.05	4	2	330	<1	<200	<0.1	14	<1	6	<10	70	<1	--	1.8	68	<0.1	<20	<1	<0.01	1.6	<1	--	<10	270	74	<2	<50	<5	<10	<10	2.5	0.19	2.7
		12/08/04	<0.05	<3	<1	380	<1	<200	<0.1	15	<1	2	<10	80	<1	--	2	76	<0.1	<20	<1	<0.01	3.1	<1	--	<10	280	69	<2	--	--	<10	40	2.5	0.18	2.6
		03/15/05	<0.05	<3	<1	360	<1	<200	<0.1	15	<1	<1	<10	70	<1	--	2.1	73	<0.1	<20	<1	<0.01	3.7	<1	--	<10	290	73	<2	<50	<5	<10	<10	2.8	0.13	2
		06/01/05	<0.05	<3	<1	360	<1	<200	<0.1	14	<1	1	<10	60	<1	--	1.9	69	<0.1	<20	<1	<0.01	2.5	<1	--	<10	290	74	<2	--	--	<10	<10	2.8	0.19	2
		12/13/05	<0.05	<3	<1	400	<1	<200	<0.1	16	<1	<1	<10	80	<1	--	2.1	82	<0.1	<20	9	<0.01	3.5	<1	--	<10	320	76	<2	--	--	<10	<10	5	0.18	1.8
		06/06/06	<0.2	<3	<1	400	<1	<200	<0.1	16	<1	<1	<10	120	<1	--	2.2	85	<0.1	<20	<1	<0.01	3.5	<1	--	<10	310	81	<2	--	--	<10	<10	2.8	0.18	1.1
		12/15/06	<0.2	<3	<1	420	<1	<200	<0.1	17	<1	<1	<10	90	<1	--	2.2	85	<0.1	<20	<1	0.01	3	<1	--	<10	310	77	<2	--	--	<10	<10	3.3	0.18	1
		06/05/07	<0.1	<1	1.3	390	<1	<200	<0.5	16	<1	<1	<1	110	<1	--	2.2	80	<0.2	<5	<1	<0.1	2.6	<1	--	<0.5	320	69	<1	--	--	<10	12	2.4	0.17	<5
		12/04/07	<0.1	<1	<1	430	<2	<200	<0.5	18	<1	<1	1.1	350	<1	--	2.4	120	<0.2	<5	<1	<0.1	2.2	1.2	--	<0.5	340	75	<1	--	--	<10	13	3.6	0.13	<5
		06/02/08	<0.1	<1	1.1	410	<1	<200	<0.5	17	<1	<1	<1	1200	<1	--	2.4	280	<0.2	<5	<1	<0.1	2.7	<1	--	<0.5	340	73	<1	--	--	<10	11	2.5	<0.1	6
		12/02/08	<0.1	<1	1.1	400	<1	<200	<0.5	17	<1	<1	<1	310	<1	--	2.3	120	<0.2	<5	1.3	<0.1	2.4	<1	--	<0.5	350	70	<1	--	--	<10	15	4.5	0.14	<5
		06/11/09	<0.1	<2	3.26	485	<2	144	<1	21.5	<2	<2	<5	107	<2	--	2.85	<95	<0.2	<5	<5	<0.1	3.73	<2	--	<2	451	93.9	<2	--	--	<4	<50	3.43	0.15	45.8
		09/14/09	<0.1	<2	<2	458	<2	125	<1	17.7	<2	<2	<5	111	<2	--	2.46	81.6	<0.2	<5	<5	<0.1	3.15	<2	--	<2	389	91.4	<2	--	--	<4	<50	3.61	<0.15	15.1
		10/19/09	<0.1	<2	<2	401	<2	109	<1	15.3	<2	<2	<5	52.6	<2	--	2.06	62.7	<0.2	<5	<5	<0.1	2.88	<2	--	<2	328	90	<2	--	--	<4	<50	3.1	0.2	12.2
		11/17/09	<0.1	<2	3.48	415	<2	123	<1	19	<2	<2	<5	569	<2	--	2.54	103	<0.2	5.43	<5	<0.5	3.26	<2	--	<2	392	77.3	<2	--	--	<4	<50	3.34	0.2	14.2
		12/15/09	<0.1	<2	2.39	356	<2	128	<1	21.2	<2	<2	<5	559	<2	--	2.75	112	<0.2	<5	<5	<0.1	3.8	<2	--	<2	409	86.1	<2	--	--	<4	686	9.67	0.23	13.7
KIF-15A	15A	01/03/89	0.06	--	<1	170	--	<500	<0.1	60	<1	--	<10	20	1	--	9.7	61	--	--	--	1	2.6	<1	8300	--	220	8	--	--	--	<10	<10	2	0.2	26
		03/30/89	5.4	--	34	110	--	950	0.2	680	7	--	10	210000	5	--	180	25000	--	--	--	<0.01	62	1	33000	--	2000	27	--	--	--	40	50	14	0.1	1900

Well ID	Historical Well ID Ref.	Date	Inorganics																															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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-15A (cont.)	15A	07/05/89	0.81	--	2	130	--	<500	<0.1	63	<1	--	10	260	1	--	9.6	93	--	--	--	<0.01	5.5	<1	7400	--	180	8.7	--	--	--	20	10	2	<0.1	20
		09/18/89	1.3	--	<1	90	--	<500	<0.1	72	3	--	10	230	1	--	14	100	--	--	--	<0.01	3.4	<1	7500	--	150	10	--	--	--	<10	50	3	0.1	21
		12/05/89	1.6	--	<1	--	--	<500	<0.1	64	--	--	<10	90	--	--	13	35	--	--	--	0.03	2.4	<1	4600	--	--	8.9	--	--	--	--	50	4	<0.1	22
		03/12/90	0.08	--	1	--	--	<500	3	70	--	--	<10	130	--	--	9.9	9	--	--	--	<0.01	2.2	<1	7500	--	--	11	--	--	--	--	<10	3	<0.1	24
		06/07/90	0.7	--	10	130	--	<500	<0.1	63	2	--	<10	1300	2	20	10	170	--	--	--	0.16	2.2	2	8500	--	210	12	--	--	--	<10	<10	4	<0.1	34
		09/06/90	1.3	--	1	190	--	<500	0.5	67	2	--	40	2600	5	20	11	300	--	--	--	<0.01	2.2	<1	9300	--	220	14	--	--	--	<10	10	2	0.1	34
		12/05/90	0.99	--	<1	160	--	<500	10	71	2	--	<10	1600	3	--	12	150	--	--	--	<0.01	2	<1	10000	--	240	11	--	--	<5	<10	<10	4	<0.1	39
		03/15/91	11	--	<1	330	--	<500	<0.1	72	14	--	30	4800	14	20	10	1200	--	--	--	0.01	5.1	<1	11000	--	290	11	--	--	--	10	20	1	<0.1	22
		06/04/91	1.4	--	7	160	--	<500	0.5	69	<1	--	<10	3300	6	20	11	480	--	--	--	<0.01	1.9	<1	9700	--	210	8.9	--	--	--	<10	10	4	0.14	26
		09/11/91	0.71	--	2	190	--	<500	<0.1	67	<1	--	<10	1000	2	10	11	110	--	--	--	<0.01	2.3	<1	9800	--	450	8.2	--	--	--	<10	<10	2	0.2	22
		12/23/91	<0.05	--	<1	170	--	<500	<0.1	66	<1	--	40	160	<1	<10	10	110	--	30	--	--	2.1	--	8500	--	90	10	--	--	--	<10	20	4	--	12
		12/10/92	0.07	<1	<1	150	<1	<500	0.5	71	<1	--	<10	130	<1	10	9	110	--	<20	<1	--	1.9	--	--	--	140	7.9	--	--	--	<10	<10	3	--	16
		06/09/93	0.1	<1	1	40	<1	<500	<0.1	290	<1	--	<10	1300	<1	<10	37	820	--	<20	<1	--	1.8	--	--	--	610	11	--	--	--	<10	<10	3	--	17
		12/07/93	<0.05	<1	<1	130	<1	<500	<0.1	70	<1	--	<10	110	<1	<10	11	120	--	<20	2	--	1.9	--	--	--	240	12	--	--	--	<10	<10	3	--	20
		06/14/94	<0.05	<1	<1	120	<1	<500	<0.1	58	<1	--	<10	50	<1	10	9.2	48	--	<20	<1	--	1.8	<1	--	--	200	10	--	--	--	<10	<10	3	--	17
		12/08/94	<0.05	<1	<1	110	<1	<500	--	66	--	--	<10	80	<1	--	11	82	--	--	<1	--	2	<1	--	--	210	10	--	--	--	<10	<10	3	--	19
		06/22/95	<0.05	<1	2	130	<1	<500	--	66	--	--	<10	20	<1	--	11	65	--	--	<1	--	1.9	--	--	--	190	9.7	--	--	--	<10	<10	3	--	17
		12/14/95	<0.05	<1	<1	110	<1	<500	--	59	--	--	<10	40	<1	--	10	25	--	--	<1	--	1.8	--	--	--	200	10	--	--	--	<10	<10	3	--	22
		07/09/96	<0.001	<1	<1	110	<1	<500	--	59	--	--	<10	50	<1	--	10	52	--	--	<1	--	1.6	--	--	--	180	14	--	--	--	<10	<10	3	--	21
		05/08/97	<0.05	<1	<1	120	<1	<500	0.6	58	1	--	<10	90	<1	--	10	64	--	--	<1	--	1.7	--	--	--	190	11	--	--	--	<10	10	2	--	14
KIF-15B	15B	03/30/89	0.07	--	1	30	--	<500	<0.1	190	<1	--	<10	420	5	--	27	330	--	--	--	<0.01	3.4	<1	10000	--	390	5.9	--	--	--	10	<10	3	<0.1	310
		07/05/89	1.2	--	<1	40	--	<500	<0.1	100	<1	--	<10	2000	5	--	20	140	--	--	--	0.01	3.3	<1	11000	--	720	12.3	--	--	--	10	280	7	<0.1	58
		09/18/89	1.4	--	<1	10	--	<500	<0.1	110	3	--	<10	630	<1	--	25	160	--	--	--	<0.01	3.7	<1	11000	--	730	14	--	--	--	<10	50	7	0.1	51
		09/18/89	1.4	--	<1	<10	--	<500	<0.1	100	3	--	<10	660	<1	--	25	180	--	--	--	<0.01	3.8	<1	11000	--	670	14	--	--	--	<10	50	7	0.1	52
		12/05/89	<0.05	--	2	--	--	<500	<0.1	87	--	--	<10	630	--	--	19	86	--	--	--	0.01	3.5	<1	5500	--	--	13	--	--	--	--	30	8	<0.1	66
		03/08/90	<0.05	--	<1	--	--	<500	0.1	81	<1	--	150	430	<1	--	15	140	--	--	1	<0.01	3.5	1	11000	--	--	11	--	--	--	--	20	6	0.1	55
		06/07/90	0.7	--	<1	50	--	<500	<0.1	84	1	--	<10	1400	<1	30	18	160	--	--	--	<0.01	3.5	<1	11000	--	650	12	--	--	--	<10	<10	7	<0.1	55
		09/06/90	0.65	--	1	80	--	<500	0.6	100	5	--	60	4800	2	30	22	230	--	--	--	<0.01	3.7	<1	12000	--	790	12	--	--	--	<10	320	7	0.1	60
		12/05/90	0.26	--	<1	50	--	<500	0.3	92	<1	--	<10	1100	<1	30	21	150	--	--	--	<0.01	3.3	<1	11000	--	720	12	--	--	--	<10	<10	7	<0.1	73
		03/15/91	<0.05	--	<1	60	--	<500	<0.1	74	1	--	10	730	<1	20	16	140	--	--	--	0.01	3.6	1	10000	--	680	11	--	--	--	<10	<10	5	<0.1	52
		12/23/91	0.08	--	<1	90	--	<500	<0.1	89	<1	--	30	940	10	<10	19	140	--	20	--	--	3.3	--	11000	--	610	11	--	--	--	<10	<10	6	--	64
		12/10/92	<0.05	<1	<1	60	<1	<500	0.6	100	<1	--	<10	640	<1	20	19	170	--	<20	<1	--	3.7	--	--	--	680	12	--	--	--	<10	<10	7	--	65
		06/09/93	0.06	<1	<1	130	<1	<500	<0.1	61	<1	--	<10	320	<1	20	8.3	240	--	<20	<1	--	3.6	--	--	--	200	11	--	--	--	<10	<10	6	--	66
		12/07/93	<0.05	<1	<1	10	<1	<500	<0.1	91	1	--	<10	560	<1	20	19	130	--	<20	<1	--	3.4	--	--	--	640	11	--	--	--	<10	<10	5	--	50
		06/14/94	<0.05	<1	<1	40	<1	<500	<0.1	84	<1	--	<10	760	<1	20	18	140	--	<20	<1	--	3.4	<1	--	--	610	11	--	--	--	<10	<10	6	--	56
		12/08/94	<0.05	<1	<1	30	<1	<500	--	85	--	--	<10	470	<1	--	19	130	--	--	<1	--	3.5	<1	--	--	640	11	--	--	--	<10	<10	6	--	58
		06/22/95	<0.05	<1	<1	40	<1	<500	--	95	--	--	<10	620	<1	--	21	170	--	--	<1	--	3.6	--	--	--	680	11	--	--	--	<10	<10	6	--	58
		12/14/95	<0.05	<1	<1	30	<1	<500	--	89	--	--	<10	530	<1	--	19	120	--	--	<1	--	3.4	--	--	--	660	11	--	--	--	<10	<10	6	--	57
		07/09/96	<0.05	<1	<1	40	<1	<500	--	85	--	--	<10	480	<1	--	18	150	--	--	<1	--	3.2	--	--	--	650	11	--	--	--	<10	<10	5	--	52
KIF-6AR	6AR	09/14/09	0.2	<2	<2	43.2	<2	664	2.25	43.1	<2	85.8	<5	326	<2	--	12.9	33400	<0.2	<5	41.2	<0.1	<1	<2	--	<2	126	7.18	<2	--	--	<4	<50	10.1	0.189	18.9
		12/17/09	0.2	<2	<2	34	<2	588	1.01	41.8	<2	89	<5	619	<2	--	12.3	27600	<0.2	<5	42.2	<0.1	<1	<10	--	<2	128	6.97	<2	--	--	<4	<50	4.17	0.11	202
		03/10/10	0.22	<2	<2	31.9	<2	621	1.89	41	<2	88.5	<5	652	<2	--	12.5	26800	<0.2	<5	41.2	<0.1	<1	<2	--	<2	126	7.3	<2	--	--	<4	<50	4.57	0.13	218

Well ID	Historical Well ID Ref.	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)
			Inorganics																															Anions		
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-6AR (cont.)	6AR	04/19/10	0.21	<2	<2	31	<2	623	2.12	48.2	<2	90.7	<5	593	<2	--	13.6	27200	<0.2	<5	41.6	<0.1	<1	<2	--	<2	125	7.2	<2	--	--	<4	<50	4.59	0.15	219
		06/16/10	0.17	<2	<2	30.2	<2	632	2.24	46.8	<2	99.1	<5	955	<2	--	13	31800	<0.2	<5	45.3	<0.1	<1	<2	--	<2	126	7.12	<2	--	--	<4	<50	4.7	0.13	214
		08/25/10	--	--	--	--	<2	--	2.89	--	--	99.7	--	--	--	--	--	--	--	--	41.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		09/28/10	0.18	<2	<2	27.5	<2	643	2.12	47.5	<2	92	<5	384	<2	--	13	32200	<0.2	<5	39.2	<0.1	<1	<2	--	<2	117	6.76	<2	--	--	<4	<50	4.95	0.24	253
		11/29/10	--	--	--	--	<2	--	2.4	--	--	106	--	--	--	--	--	--	--	--	44.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		12/15/10	0.24	<2	<2	26.2	<2	664	2.19	47.5	<2	104	<5	575	<2	--	14.1	33200	<0.2	<5	43.8	<0.1	<1	<2	--	<2	128	7.45	<2	--	--	<4	<50	4.56	0.14	215
		02/08/11	--	--	--	--	<2	--	2.42	--	--	102	--	--	--	--	--	--	--	--	42.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		06/29/11	0.29	<2	<2	25.1	<2	634	2.23	45.2	<2	111	<5	1430	<2	--	8.4	35800	<0.2	<5	42.8	<0.1	<1	<2	--	<2	119	6.84	<2	--	--	<4	<50	4.02	<0.1	229
		08/03/11	--	--	--	--	<2	--	2.38	--	--	89.8	--	--	--	--	--	--	--	--	37	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		12/05/11	0.22	<2	<2	22.1	<2	583	2.25	42.5	<2	84.2	<5	1090	<2	--	11.6	30600	<0.2	<5	35.3	<0.1	<1	<2	--	<2	109	6.34	<2	--	--	<4	<50	4.32	<0.1	212
		01/25/12	--	--	--	--	<2	--	2.3	--	--	96.4	--	--	--	--	--	--	--	--	40.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		06/18/12	0.16	<2	<2	22.7	<2	620	2.53	44.2	<2	96.2	<5	1680	<2	--	13.3	36400	<0.2	<5	39	<0.1	<1	<2	--	<2	118	6.8	<2	--	--	<4	<50	5.11	<0.1	245
		12/10/12	0.2	<2	<2	22.9	<2	684	2.41	45.8	<2	106	<5	1160	<2	--	13.7	36400	<0.2	<5	42.1	<0.1	<1	<2	--	<2	124	7.31	<2	--	--	<4	<50	4.38	<0.1	255
		06/24/13	0.14	<2	<2	25.8	<2	723	2.21	49.7	<2	117	<2	2010	<2	--	14.7	38600	<0.2	<2	44.1	<0.1	<1	<2	--	<2	131	7.32	<2	--	--	<2	36.2	5.93	0.13	242
		12/04/13	0.14	<2	<2	22.8	<2	634	2.39	49.7	<2	111	<2	1820	<2	--	13.9	40600	<0.2	<2	41.8	<0.1	<1	<2	--	<2	126	7.27	<2	--	--	<2	33.7	5.64	<0.1	233
		06/11/14	<1	<2	<2	<100	<2	708	2.48	55.6	<2	117	<2	3580	<2	--	16.4	42800	<0.2	<2	41.9	<0.1	<10	<2	--	<2	<500	<10	<2	--	--	2.55	35.6	5.38	<0.1	289
		12/10/14	--	<2	<2	23	<2	--	2.56	--	<2	120	<2	--	<2	--	--	--	<0.2	--	44.1	--	--	<2	--	<2	--	--	<2	--	--	<2	37.7	--	<0.5	--
		06/18/15	--	<2	<2	23.1	<2	--	2.91	--	<2	121	<2	--	<2	--	--	--	<0.2	--	44.2	--	--	<2	--	<2	--	--	<2	--	--	<2	40.1	--	0.12	--
		09/22/15	--	<2	0.75	22	0.72	--	2.64	--	<2	119	<2	--	<2	--	--	--	<0.2	--	47.7	--	--	<2	--	<2	--	--	<2	--	--	0.23	37.3	--	<0.1	--
		12/02/15	--	<10	<10	23.7	<10	--	3.1	--	<10	127	<10	--	<10	--	--	--	<0.2	--	51.1	--	--	<10	--	<10	--	--	<10	--	--	<20	<125	--	<0.1	--
		03/23/16	--	<2	<2	21.5	<2	<1000	3.42	55.8	<2	140	<2	--	<2	<50	--	--	<0.2	<2	51.3	--	--	<2	--	<2	--	--	<2	--	--	<4	44.7	5.97	<0.1	263
		06/15/16	--	<2	<2	22.5	<2	<1000	3.17	60.5	<2	130	<2	--	<2	<50	--	--	<0.2	<2	48.5	--	--	<2	--	<2	--	--	<2	--	--	<4	49.7	8.4	<0.1	297
		09/22/16	--	<2	<2	23	<2	<1000	3.22	60.3	<2	131	<2	--	<2	<50	--	--	<0.2	<2	53.3	--	--	<2	--	<2	--	--	<2	--	--	<4	47.4	7.15	<0.1	311
		12/01/16	--	<2	<2	21.7	<2	<1000	3.03	56.4	<2	132	<2	--	<2	<50	--	--	<0.2	<2	50.9	--	--	<2	--	<2	--	--	<2	--	--	<4	48.5	5.23	<0.1	267
		03/02/17	--	0.19	0.27	23.2	0.89	639	3.24	66.6	<2	153	<2	--	<2	2.94	--	--	<0.2	<2	59.8	--	--	0.95	--	<2	--	--	0.06	--	--	<4	54.9	7.63	<0.1	327
		06/07/17	--	<2	<2	21.5	<2	<1000	1.88	61.9	<2	136	<2	--	<2	<50	--	--	<0.2	<2	53.8	--	--	<2	--	<2	--	--	<2	--	--	<4	46.9	7.52	<0.1	305
KIF-AD1	AD-1	06/11/09	1.17	<2	<2	101	<2	116	<1	8.85	2.9	<2	<5	920	<2	--	2.16	<176	<0.2	<5	<5	<0.1	2.84	<2	--	<2	201	94.3	<2	--	--	<5.22	<50	1.56	0.23	28.7
		09/15/09	2.43	<2	<2	102	<2	129	<1	4.98	4.35	<2	15.1	2230	<2	--	1.49	115	<0.2	<5	<5	<0.1	2.79	<2	--	<2	137	83.4	<2	--	--	<5.09	<50	1.65	<0.213	23.7
		10/14/09	1.52	<2	<2	77.3	<2	130	<1	3.92	2.76	<2	8.86	1760	<2	--	1.15	78	<0.2	<5	5.31	<0.1	2.56	<2	--	<2	104	85.4	<2	--	--	<4	<50	1.41	0.25	23.5
		11/17/09	0.2	<2	<2	55.3	<2	132	<1	4.49	<2	<2	<5	172	<2	--	1.05	67.5	<0.2	<5	<5	<0.1	2.09	<2	--	<2	120	93.4	<2	--	--	<4	<50	1.49	0.32	24.4
		12/15/09	0.17	<2	<2	61	<2	134	<1	6.17	<2	<2	<5	161	<2	--	1.44	107	<0.2	<5	<5	<0.1	2.33	<2	--	<2	150	87.2	<2	--	--	<4	<50	<1.66	0.3	25.2
		01/11/10	0.11	<2	<2	47.4	<2	130	<1	3.38	<2	<2	<5	<50	<2	--	<1	41.7	<0.2	<5	<5	<0.1	1.73	<2	--	<2	98.1	93.2	<2	--	--	<4	<50	<1.56	0.31	23.5
		02/16/10	<0.237	<2	<2	54.9	<2	137	<1	4	<2	<2	<5	150	<2	--	<1	55.9	<0.2	<5	<5	<0.1	1.99	<2	--	<2	111	82.8	<2	--	--	<4	<50	1.58	0.32	25.7
		02/16/10	<0.198	<2	<2	54.6	<2	136	<1	3.98	<2	<2	<5	146	<2	--	<1	57.4	<0.2	<5	<5	<0.1	1.97	<2	--	<2	111	80.4	<2	--	--	<4	<50	1.54	0.3	25.2
		03/08/10	0.4	<2	<2	47.5	<2	129	<1	3.07	<2	<2	<5	159	<2	--	<1	34.4	<0.2	<5	<5	<0.1	1.7	<2	--	<2	91.6	89.8	<2	--	--	<4	<50	1.5	0.3	23.9
		04/13/10	0.13	<2	<2	45.9	<2	134	<1	3.18	<2	<2	<5	92.6	<2	--	<1	41.9	<0.2	<5	<5	<0.1	1.5	<2	--	<2	92.4	86	<2	--	--	<4	<50	<1.55	0.3	23.7
		05/10/10	0.11	<2	<2	49.2	<2	136	<1	3.7	<2	<2	<5	85.4	<2	--	<1	52	<0.2	<5	<5	<0.1	1.56	<2	--	<2	107	88.9	<2	--	--	<4	<50	1.43	0.29	23.8
		06/15/10	<0.1	<2	<2	45.6	<2	134	<1	3.15	<2	<2	<5	68.4	<2	--	<1	45.7	<0.2	<5	<5	<0.1	1.5	<2	--	<2	92.4	88.7	<2	--	--	<4	<50	<1.62	0.31	20.9
		07/13/10	<0.1	<2	<2	43.9	<2	130	<1	3.11	<2	<2	<5	66.1	<2	--	<1	35.8	<0.2	<5	<5	<0.1	1.37	<2	--	<2	94.5	89.9	<2	--	--	<4	<50	<5.1	0.33	24
		09/27/10	<0.1	<2	<2	51.5	<2	128	<1	4.47	<2	<2	<5	69	<2	--	1.07	98.5	<0.2	<5	<5	<0.1	1.53	<2	--	<2	119	85	<2	--	--	<4	<50	1.76	0.43	25.2
		12/16/10	<0.1	<2	<2	59.2	<2	128	<1	6.49	<2	<2	<5	72.6	<2	--	1.53	146	<0.2	<5	<5	<0.1	1.58	<2	--	<2	162	92.9	<2	--	--	<4	<50	<1.85	0.32	23.6
		01/20/11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well ID	Historical Well ID Ref.	Date	Inorganics																													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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-AD1 (cont.)	AD-1	03/08/11	0.14	<2	<2	68.7	<2	139	<1	6.92	<2	<2	<5	89.6	<2	--	1.7	149	<0.2	<5	<5	<0.1	1.65	<2	--	<2	177	91.1	<2	--	--	<4	<50	<1.96	0.32	24.4
		06/28/11	0.12	<2	<2	47.9	<2	136	<1	3.54	<2	<2	<5	74.4	<2	--	<1	59.3	<0.2	<5	<5	<0.1	1.37	<2	--	<2	101	86.2	<2	--	--	<4	<50	1.66	0.33	21.4
		09/27/11	<0.1	<2	<2	49.7	<2	110	<1	4.8	<2	<2	<5	78.7	<2	--	1.16	90.2	<0.2	<5	<5	<0.1	1.42	<2	--	<2	128	74.5	<2	--	--	<4	<50	<1.73	0.24	21.8
		12/06/11	<0.1	<2	<2	55.9	<2	124	<1	5.04	<2	<2	<5	124	<2	--	1.18	99.2	<0.2	<5	<5	<0.1	1.34	<2	--	<2	133	79.2	<2	--	--	<4	<50	<1.76	<0.257	22.7
		03/20/12	<0.1	<2	<2	64.3	<2	133	<1	5.07	<2	<2	<5	91.1	<2	--	1.28	98.2	<0.2	<5	<5	<0.1	1.48	<2	--	<2	135	85.1	<2	--	--	<4	<50	<3.24	0.25	23.4
		06/19/12	0.12	<2	<2	49.2	<2	106	<1	2.94	<2	<2	<5	88.1	<2	--	<1	32	<0.2	<5	<5	<0.1	1.4	<2	--	<2	91.2	91.6	<2	--	--	<4	<50	1.56	0.25	21.6
		09/17/12	<0.1	<2	<2	48.4	<2	126	<1	2.92	<2	<2	<5	<115	<2	--	<1	28.3	<0.2	<5	<5	<0.1	<1.64	<2	--	<2	89.5	85.9	<2	--	--	<4	<50	1.19	0.26	19
		12/11/12	<0.1	<2	<2	49.2	<2	143	<1	2.79	<2	<2	<5	103	<2	--	<1	22.5	<0.2	<5	<5	<0.1	1.34	<2	--	<2	88.1	87.3	<2	--	--	<4	<50	1.29	<0.1	<1
		03/18/13	0.15	<2	<2	80.4	<2	148	<1	6.75	<2	<2	<5	142	<2	--	1.62	167	<0.2	<5	<5	<0.1	1.62	<2	--	<2	169	95.6	<2	--	--	<4	<50	1.64	0.24	22.9
		06/25/13	<0.1	<2	<2	71.8	<2	140	<1	5.15	<2	<2	<2	135	<2	--	1.3	126	<0.2	<2	<2	<0.1	1.46	<2	--	<2	146	92.7	<2	--	--	<2	<25	1.46	0.23	22.6
		09/04/13	0.18	<2	<2	58.6	<2	148	<1	3.4	<2	<2	<2	257	<2	--	<1	42.6	<0.2	<2	<2	<0.1	1.29	<2	--	<2	106	91.9	<2	--	--	<2	<25	1.23	0.21	20
		12/02/13	<0.1	<2	<2	89.8	<2	126	<1	9.45	<2	<2	<2	<109	<2	--	2.18	208	<0.2	<2	<2	<0.1	2.15	<2	--	<2	239	86.5	<2	--	--	<2	<25	1.77	0.24	28.4
		03/05/14	0.15	<2	<2	66.8	<2	138	<1	5.52	<2	<2	<2	143	<2	--	1.33	107	<0.2	<2	<2	<0.1	1.46	<2	--	<2	143	87	<2	--	--	<2	<25	1.46	0.17	23.1
		06/10/14	<0.1	<2	<2	54.4	<2	135	<1	3.03	<2	<2	<2	<100	<2	--	<1	33.9	<0.2	<2	<2	<0.1	1.23	<2	--	<2	92.8	91.6	<2	--	--	<2	<25	1.21	0.21	21.5
		09/16/14	--	<2	<2	54	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<2	--	<2	--	1.33	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.25	--
		12/09/14	--	<2	<2	70.4	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.22	--
		03/10/15	--	<2	<2	74	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.22	--
		06/16/15	--	<2	<2	52.1	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.25	--
		09/22/15	--	<2	<2	51.6	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	0.22	<25	--	0.24	--
		11/30/15	--	<10	<10	65.7	<10	--	<5	--	<10	<10	13.8	--	<10	--	--	--	<0.2	--	4.08	--	--	<10	--	<10	--	--	<10	--	--	<20	<125	--	0.27	--
		03/21/16	--	<2	<2	87.2	<2	<1000	<1	7.42	<2	<2	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.56	0.24	24.3
		06/13/16	--	<2	<2	60.5	<2	<1000	<1	5.54	<2	<2	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.36	0.27	23
		09/20/16	--	<2	<2	62.8	<2	<1000	<1	4.25	<2	<2	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.44	0.25	21.7
		11/28/16	--	<2	<2	74.8	<2	<1000	<1	6.74	<2	<2	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.72	0.28	27.5
		02/28/17	--	<2	0.45	63.8	<2	131	<1	5.95	<2	<2	<2	--	<2	12.9	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.36	0.16	27.1
		06/05/17	--	<2	<2	56.1	<2	<1000	<1	3.31	<2	<2	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.53	0.25	24.1
KIF-AD2	AD-2	06/11/09	<0.1	<2	**29.7**	41.9	<2	412	<1	25.7	<2	3.72	<5	1040	<2	--	3.81	<500	<0.2	<5	<5	<0.1	3.14	<2	--	<2	260	12	<2	--	--	<4	<50	16.9	<0.1	69.6
		07/23/09	--	--	**14**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		09/15/09	<0.1	<2	7.09	41	<2	416	<1	26	<2	2.83	<5	971	<2	--	4.15	468	<0.2	<5	82.7	<0.1	3.46	<2	--	<2	278	12.5	<2	--	--	<4	<50	15	<0.1	79.5
		10/13/09	<0.1	<2	9.22	41.1	<2	403	<1	27.5	<2	3.46	<5	1040	<2	--	4.32	515	<0.2	<5	<5	<0.5	3.55	<2	--	<2	284	12.1	<2	--	--	<4	<50	13.4	<0.1	81.2
		11/16/09	<0.1	<2	3.97	47.3	<2	442	<1	35	<2	3.49	<5	918	<2	--	5.47	612	<0.2	<5	<5	<0.1	4.23	<2	--	<2	350	17.3	<2	--	--	<4	<50	11.9	<0.1	83.4
		12/14/09	<0.1	<2	3.76	43.1	<2	408	<1	33.9	<2	4.33	<5	1090	<2	--	5.27	722	<0.2	<5	<5	<0.1	4.16	<2	--	<2	334	15.8	<2	--	--	<4	<50	10.6	<0.1	--
		01/12/10	<0.1	<2	5.09	41.5	<2	372	<1	33.3	<2	4.74	<5	1380	<2	--	5.15	742	<0.2	<5	<5	<0.1	3.66	<2	--	<2	346	13.3	<2	--	--	<4	<50	9.47	0.14	96.5
		02/17/10	<0.1	<2	4.38	43.6	<2	374	<1	35.8	<2	4.85	<5	1320	<2	--	5.61	739	<0.2	<5	<5	<0.1	3.8	<2	--	<2	362	13.8	<2	--	--	<4	<50	10.2	0.12	108
		03/08/10	<0.1	<2	2.54	42.1	<2	358	<1	37.4	<2	4.66	<5	1190	<2	--	5.85	832	<0.2	<5	<5	<0.1	3.55	<2	--	<2	385	12.7	<2	--	--	<4	<50	8.64	0.11	121
		04/12/10	<0.1	<2	2.21	44.9	<2	384	<1	43.9	<2	5.43	<5	1260	<2	--	6.72	861	<0.2	<5	<5	<0.1	4.32	<2	--	<2	431	14.6	<2	--	--	<4	<50	8.22	0.12	130
		05/11/10	<0.1	<2	3.91	45.5	<2	389	<1	46.3	<2	5.67	<5	2240	<2	--	7.13	950	<0.2	<5	<5	<0.1	4.18	<2	--	<2	451	14.2	<2	--	--	<4	<50	8.18	0.11	138
		06/15/10	<0.1	<2	2.72	48.6	<2	426	<1	54.4	<2	5.21	<5	1440	<2	--	8.1	931	<0.2	<5	<5	<0.1	4.66	<2	--	<2	531	14.8	<2	--	--	<4	<50	--	--	--
		07/12/10	<0.1	<2	2.43	47.5	<2	438	<1	53.9	<2	6.4	<5	1570	<2	--	8.37	933	<0.2	<5	<5	<0.1	4.67	<2	--	<2	563	14.7	<2	--	--	<4	<50	8.74	0.11	185
		09/22/10	<0.1	<2	<2	48.2	<2	550	<1	65	<2	6.1	<5	1730	<2	--	10.5	918	<0.2	<5	<5	<0.1	5.22	<2	--	<2	654	15	<2	--	--	<4	<50	8.61	0.12	198
		12/16/10	0.12	<2	3.34	45.3	<2	636	<1	73.2	<2	8.41	<5	2920	<2	--	12.1	1340	<0.2	<5	<5	<0.1	5.48	<2	--	<2	742	15.3	<2	--	--	<4	<50	10.8	0.13	212
		01/20/11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well ID	Historical Well ID Ref.	Date	Inorganics																															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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-AD2 (cont.)	AD-2	03/07/11	<0.1	<2	<2	44.2	<2	668	<1	82.6	<2	7.94	<5	2060	<2	--	13.6	1650	<0.2	<5	<5	<0.1	5.54	<2	--	<2	798	14.1	<2	--	--	<4	<50	8.77	0.13	226
		06/28/11	<0.1	<2	4.4	38	<2	728	<1	79.8	<2	7.68	<5	3320	<2	--	13.3	1350	<0.2	<5	<5	<0.1	5.27	<2	--	<2	781	12.7	<2	--	--	<4	<50	7.98	0.16	226
		09/28/11	<0.1	<2	<2	30.4	<2	772	<1	69.8	<2	6.9	<5	1860	<2	--	11.8	1170	<0.2	<5	<5	<0.1	4.92	<2	--	<2	705	10.7	<2	--	--	<4	<50	7.98	<0.1	244
		12/06/11	<0.1	<2	<2	33.9	<2	878	<1	85.7	<2	8.58	<5	2090	<2	--	13.4	1290	<0.2	<5	<5	<0.1	5.15	<2	--	<2	831	11.8	<2	--	--	<4	<50	8.19	<0.1	304
		03/19/12	<0.1	<2	<2	32.9	<2	896	<1	86.4	<2	9.96	<5	2720	<2	--	14.5	1360	<0.2	<5	<5	<0.1	5.14	<2	--	<2	828	11.8	<2	--	--	<4	<50	9.27	<0.1	447
		06/20/12	<0.1	<2	3.14	46	<2	1160	<1	96	<2	6.76	<5	4410	<2	--	17	1080	<0.2	<5	<5	<0.1	6.04	<2	--	<2	945	12.8	<2	--	--	<4	<50	8.04	0.11	282
		09/17/12	0.12	<2	3.79	36.3	<2	1360	<1	95.3	<2	10.1	<5	3110	<2	--	17.9	1670	<0.2	5.17	<5	<0.1	5.98	<2	--	<2	957	11.9	<2	--	--	<4	<50	7.96	<0.1	269
		12/12/12	<0.1	<2	<2	31.8	<2	1300	<1	82.9	<2	11.3	<5	2490	<2	--	14.4	1550	<0.2	5.03	<5	<0.1	5.44	<2	--	<2	789	10.3	<2	--	--	<4	<50	7.07	<0.1	246
		03/19/13	<0.1	<2	<2	25.4	<2	1270	<1	67.2	<2	10.8	<5	2590	<2	--	12.1	1510	<0.2	5.82	<5	<0.1	4.85	<2	--	<2	666	9.68	<2	--	--	<4	<50	7.38	<0.1	208
		06/25/13	<0.1	<2	<2	23.8	<2	1310	<1	58.7	<2	8.87	<2	2700	<2	--	10.4	1010	<0.2	3.63	3.33	<0.1	4.74	<2	--	<2	599	8.89	<2	--	--	<2	<25	6.73	<0.1	165
		09/03/13	<0.1	<2	<2	28.1	<2	1330	<1	53.6	<2	6.94	<2	2540	<2	--	9.12	1010	<0.2	4.76	2.77	<0.1	4.28	<2	--	<2	543	8.62	<2	--	--	<2	<25	6.13	<0.1	166
		12/03/13	<0.1	<2	2.48	24.8	<2	1250	<1	49.1	<2	7.46	<2	1550	<2	--	8.32	967	<0.2	7.77	3.03	<0.1	4.91	<2	--	<2	492	8.46	<2	--	--	<2	<25	5.68	<0.1	133
		03/05/14	<0.1	<2	4.9	22.4	<2	983	<1	42.1	<2	7.98	<2	2890	<2	--	7.1	973	<0.2	9.76	3.74	<0.1	3.97	<2	--	<2	413	7.15	<2	--	--	<2	<25	5.94	<0.1	119
		06/09/14	<0.1	<2	<2	22	<2	888	<1	37.8	<2	6.39	<2	1670	<2	--	6.69	701	<0.2	2.58	2.58	<0.1	3.78	<2	--	<2	392	6.91	<2	--	--	3.3	<25	5.89	<0.1	131
		09/15/14	--	<2	<2	26.4	<2	--	<1	--	<2	5.18	<2	--	<2	--	--	--	<2	--	2	--	3.89	<2	--	<2	--	--	<2	--	--	<2	<25	--	<0.1	--
		12/09/14	--	<2	<2	25	<2	--	<1	--	<2	7.02	<2	--	<2	--	--	--	<0.2	--	5.11	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	<0.1	--
		03/09/15	--	<2	<2	24.6	<2	--	<1	--	<2	6.9	<2	--	<2	--	--	--	<0.2	--	2.82	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	<0.1	--
		06/18/15	--	<2	<2	24.4	<2	--	<1	--	<2	4.93	<2	--	<2	--	--	--	<0.2	--	2.45	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.12	--
		09/22/15	--	<2	1.04	25.1	<2	--	<1	--	<2	5.11	<2	--	<2	--	--	--	<0.2	--	2.9	--	--	<2	--	<2	--	--	<2	--	--	0.2	<25	--	<0.1	--
		12/02/15	--	<10	<10	28.4	<10	--	<5	--	<10	5.27	<10	--	<10	--	--	--	<0.2	--	3.52	--	--	<10	--	<10	--	--	<10	--	--	<20	<125	--	0.12	--
		03/23/16	--	<2	<2	28.1	<2	<1000	<1	41	<2	5.36	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	4.91	<0.1	115
		06/14/16	--	<2	<2	26.1	<2	<1000	<1	40.5	<2	4.64	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	6.53	<0.1	124
		09/21/16	--	<2	<2	31.1	<2	<1000	<1	45.8	<2	5.29	<2	--	<2	<50	--	--	<0.2	<2	2.49	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	6.78	0.15	119
		12/01/16	--	<2	<2	26.7	<2	1030	<1	37.8	<2	5.53	<2	--	<2	<50	--	--	<0.2	<2	2.56	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	5.79	0.14	103
		03/01/17	--	1.3	9.39	28.2	<2	729	<1	42.9	<2	5.55	<2	--	<2	5.24	--	--	<0.2	2.19	3.07	--	--	<2	--	<2	--	--	0.07	--	--	<4	4.06	7.27	<0.1	136
		06/07/17	--	<2	<2	32.4	<2	<1000	<1	53.9	<2	5.79	<2	--	<2	<50	--	--	<0.2	<2	2.74	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	8.15	<0.1	187
KIF-AD3	AD-3	06/11/09	<0.1	<2	2.05	39.6	<2	587	<1	261	<2	3.26	<5	331	<2	--	35.1	<7820	<0.2	<5	<5	<0.1	3.81	<2	--	<2	550	18.1	<2	--	--	<4	<50	7.73	0.14	574
		09/15/09	<0.1	<2	<2	32.4	<2	734	<1	126	<2	2.73	<5	139	<2	--	17.4	6000	<0.2	<5	<5	<0.1	4.31	<2	--	<2	697	11.7	<2	--	--	<4	<50	10.1	0.191	185
		10/13/09	<0.1	<2	<2	33.8	<2	720	<1	131	<2	3.23	<5	<50	<2	--	17.6	5500	<0.2	<5	<5	<0.1	4.67	<2	--	<2	722	11.8	<2	--	--	<4	<50	9.08	0.18	178
		11/16/09	<0.1	<2	<2	37.8	<2	691	<1	144	<2	3.17	<5	165	<2	--	20.2	5490	<0.2	<5	<5	<0.1	5.07	<2	--	<2	812	15.8	<2	--	--	<4	<50	8.77	0.25	173
		12/14/09	<0.1	<2	<2	31.9	<2	532	<1	132	<2	3.25	<5	198	<2	--	18	5620	<0.2	<5	<5	<0.1	4.33	<2	--	<2	728	11.7	<2	--	--	<4	<50	8.63	0.25	252
		01/13/10	<0.1	<2	<2	29.1	<2	436	<1	124	<2	2.97	<5	155	<2	--	17	5600	<0.2	<5	<5	<0.1	3.55	<2	--	<2	694	11.1	<2	--	--	<4	<50	8.43	0.27	202
		02/17/10	<0.1	<2	<2	27.8	<2	388	<1	122	<2	2.96	<5	186	<2	--	16.7	5130	<0.2	<5	<5	<0.1	3.36	<2	--	<2	685	9.53	<2	--	--	<4	<50	7.46	0.24	213
		03/09/10	<0.1	<2	<2	26.2	<2	364	<1	120	<2	2.79	<5	140	<2	--	16.4	5380	<0.2	<5	<5	<0.1	3.06	<2	--	<2	684	8.72	<2	--	--	<4	<50	6.97	0.22	221
		04/13/10	<0.1	<2	<2	28.9	<2	443	<1	140	<2	2.99	<5	<50	<2	--	18.1	5210	<0.2	<5	<5	<0.1	3.6	<2	--	<2	743	9.16	<2	--	--	<4	<50	6.84	0.24	248
		05/11/10	<0.1	<2	<2	32.6	<2	554	<1	149	<2	3.33	<5	<50	<2	--	19.5	6660	<0.2	<5	<5	<0.1	3.85	<2	--	<2	780	9.02	<2	--	--	<4	<50	6.01	0.26	253
		06/14/10	<0.1	<2	<2	36.6	<2	731	<1	156	<2	3.71	<5	<50	<2	--	20.4	6680	<0.2	<5	<5	<0.1	4.48	<2	--	<2	847	10.1	<2	--	--	<4	<50	3.37	0.31	245
		07/13/10	<0.1	<2	<2	37.5	<2	841	<1	162	<2	4.1	<5	62.9	<2	--	20.2	7450	<0.2	<5	<5	<0.1	4.56	<2	--	<2	809	9.74	<2	--	--	<4	<50	<3.96	0.31	186
		09/23/10	<0.1	<2	<2	48.3	<2	1060	<1	175	<2	3.86	<5	57.5	<2	--	22.4	7900	<0.2	<5	<5	<0.1	5	<2	--	<2	903	12.3	<2	--	--	<4	<50	6.94	0.43	259
		11/29/10	--	--	--	--	--	--	--	--	--	3.99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		12/17/10	<0.1	<2	<2	36.2	<2	795	<1	170	<2	3.49	<5	139	<2	--	22.2	6540	<0.2	<5	<5	<0.1	4.17	<2	--	<2	924	9.64	<2	--	--	<4	<50	7.51	0.27	265
		01/20/11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well ID	Historical Well ID Ref.	Date	Inorganics																															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	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
KIF-AD3 (cont.)	AD-3	02/08/11	--	--	--	--	--	--	--	--	--	3.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		03/07/11	<0.1	<2	<2	31.3	<2	709	<1	159	<2	3.11	<5	523	<2	--	21.2	8190	<0.2	<5	<5	<0.1	3.57	<2	--	<2	821	8.24	<2	--	--	<4	<50	7.27	0.26	255
		06/27/11	<0.1	<2	<2	35.6	<2	1270	<1	304	<2	6.3	<5	124	<2	--	41	13900	<0.2	<5	<5	<0.1	3.76	<2	--	<2	632	9.33	<2	--	--	<4	<50	5.26	0.25	545
		08/03/11	--	--	--	--	--	--	--	--	--	8.57	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		09/27/11	<0.1	<2	<2	23.5	<2	1250	<1	153	<2	3.02	<5	131	<2	--	21.2	6380	<0.2	<5	<5	<0.1	3.96	<2	--	<2	624	7.35	<2	--	--	<4	<50	6.6	0.2	279
		12/07/11	<0.1	<2	<2	26.9	<2	1060	<1	156	<2	3.2	<5	211	<2	--	19.5	6530	<0.2	<5	<5	<0.1	3.73	<2	--	<2	768	6.83	<2	--	--	<4	<50	6.6	0.24	253
		01/25/12	--	--	--	--	--	--	--	--	--	2.63	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		03/20/12	<0.1	<2	<2	25	<2	884	<1	126	<2	2.56	<5	139	<2	--	17.1	5160	<0.2	<5	<5	<0.1	3.27	<2	--	<2	634	5.47	<2	--	--	<4	<50	<6.04	0.21	206
		06/20/12	<0.1	<2	<2	57.9	<2	1790	<1	390	<2	8.31	<5	120	<2	--	56.5	13500	<0.2	<5	<5	<0.1	5.11	<2	--	<2	952	10.3	<2	--	--	<4	<50	4.92	0.25	696
		09/18/12	<0.1	<2	<2	30.9	<2	1870	<1	148	<2	3.66	<5	<100	<2	--	21.3	7060	<0.2	<5	<5	<0.1	4.46	<2	--	<2	724	6.36	<2	--	--	<4	<50	5.63	0.21	251
		12/11/12	<0.1	<2	<2	32.4	<2	1500	<1	168	<2	3.41	<5	191	<2	--	22.2	7270	<0.2	<5	<5	<0.1	4.32	<2	--	<2	852	6.12	<2	--	--	<4	<50	<1	<0.1	<1
		03/19/13	<0.1	<2	<2	24.7	<2	1100	<1	132	<2	2.57	<5	<100	<2	--	18.3	6100	<0.2	<5	<5	<0.1	3.28	<2	--	<2	691	5.27	<2	--	--	<4	<50	6	0.19	230
		06/26/13	<0.1	<2	<2	43.1	<2	1680	<1	287	<2	7.24	<2	100	<2	--	39.8	10300	<0.2	<2	2.94	<0.1	3.82	<2	--	<2	738	7.74	<2	--	--	<2	<25	4.79	0.16	550
		09/04/13	<0.1	<2	<2	47.4	<2	1780	<1	397	<2	7.72	<2	<100	<2	--	54.2	15900	<0.2	<2	3.6	<0.1	4.19	<2	--	<2	801	9.79	<2	--	--	<2	<25	5.96	0.14	739
		12/03/13	<0.1	<2	<2	32.3	<2	1460	<1	164	<2	3.87	<2	<148	<2	--	21.5	6920	<0.2	<2	<2	<0.1	4.73	<2	--	<2	778	6.49	<2	--	--	<2	<25	8.45	0.19	208
		03/04/14	<0.1	<2	<2	23.6	<2	829	<1	127	5.64	2.35	<2	119	<2	--	16.6	6140	<0.2	<2	<2	<0.1	3.13	<2	--	<2	625	4.47	<2	--	--	<2	<25	6.01	0.14	188
		06/10/14	<0.1	<2	2.57	44.7	<2	1540	<1	200	<2	4.99	<2	630	<2	--	27.4	8630	<0.2	<2	<2	<0.1	4.45	<2	--	<2	1030	6.24	<2	--	--	2.56	<25	3.89	0.2	412
		09/15/14	--	<2	<2	42.7	<2	--	<1	--	<2	5.26	<2	--	<2	--	--	--	<2	--	2.93	--	4.5	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.26	--
		12/08/14	--	<2	<2	30.4	<2	--	<1	--	<2	3.42	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.23	--
		03/11/15	--	<2	<2	23	<2	--	<1	--	<2	2.98	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.21	--
		06/17/15	--	<2	<2	57.5	<2	--	<1	--	<2	7.7	<2	--	<2	--	--	--	<0.2	--	3.26	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.17	--
		09/22/15	--	<2	0.72	38	<2	--	<1	--	<2	6.44	<2	--	<2	--	--	--	<0.2	--	11.1	--	--	<2	--	<2	--	--	<2	--	--	0.21	<25	--	0.15	--
		12/02/15	--	2.64	<10	29.4	<10	--	<5	--	<10	3.23	<10	--	<10	--	--	--	<0.2	--	<10	--	--	<10	--	<10	--	--	<10	--	--	<20	<125	--	0.26	--
		03/22/16	--	<2	<2	28.4	<2	<1000	<1	145	<2	3.14	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	4.88	0.32	217
		06/13/16	--	<2	<2	46.5	<2	1450	<1	380	<2	6.31	<2	--	<2	<50	--	--	<0.2	<2	2.78	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	<20	<2	971
		09/21/16	--	<2	<2	33	<2	1550	<1	307	<2	5.98	<2	--	<2	<50	--	--	<0.2	<2	2.6	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	7.14	0.15	661
		11/30/16	--	<2	<2	32.8	<2	1460	<1	177	<2	4.21	<2	--	<2	<50	--	--	<0.2	<2	7.78	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	4.89	0.19	189
		03/02/17	--	0.2	<2	26.9	<2	820	<1	137	<2	2.93	<2	--	<2	10.2	--	--	<0.2	<2	1.46	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	7.58	0.13	225
		06/06/17	--	<2	<2	36.7	<2	1370	<1	348	<2	6.32	<2	--	<2	<50	--	--	<0.2	<2	3.26	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	7.14	0.11	809

Well ID	Historical Well ID Ref.	Date	Inorganics																															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	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
KIF-GW01	GW-01	10/05/10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		09/17/14	--	<2	<2	67.3	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<2	--	<2	--	1.88	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.94	--
		12/08/14	--	<2	<2	63.7	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.79	--
		03/10/15	--	<2	<2	63.8	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.8	--
		06/17/15	--	<2	<2	71	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<2	<25	--	0.86	--
		09/22/15	--	<2	1.23	64.9	<2	--	<1	--	<2	<2	2.22	--	<2	--	--	--	<0.2	--	3.6	--	--	<2	--	<2	--	--	<2	--	--	0.41	<25	--	0.89	--
		11/30/15	--	<10	<10	71.3	<10	--	<5	--	<10	<10	<10	--	<10	--	--	--	<0.2	--	<10	--	--	<10	--	<10	--	--	<10	--	--	<20	<125	--	0.93	--
		03/22/16	--	<2	<2	99.2	<2	<1000	<1	7.76	<2	<2	2.71	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	8.2	<25	1.54	0.41	56.3
		06/14/16	--	<2	<2	79.6	<2	<1000	<1	7.3	<2	<2	<2	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	5.39	<25	1.61	0.5	77.1
		09/20/16	--	<2	<2	83.9	<2	<1000	<1	7.41	<2	<2	2.05	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.6	0.66	56.4
		11/29/16	--	<2	<2	66.4	<2	<1000	<1	5.83	<2	<2	2.87	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.53	0.79	58.1
		02/28/17	--	0.37	1.55	66.5	<2	207	<1	5.84	0.3	0.08	1.51	--	1.46	27.9	--	--	<0.2	0.78	0.745	--	--	<2	--	<2	--	--	<2	--	--	0.52	6.81	1.76	0.53	64
		06/06/17	--	<2	<2	76.3	<2	<1000	<1	6.06	<2	<2	2.27	--	<2	<50	--	--	<0.2	<2	<2	--	--	<2	--	<2	--	--	<2	--	--	<4	<25	1.77	0.8	60.3

~ Action Level
^ nitrate MCL (MCL has not been established for nitrite)
^^ nitrite MCL (more conservative MCL of nitrate and nitrite)
-- no data
Bold numbers indicate that measured values exceed TDEC MCLs
cont. - continued
EPA - Environmental Protection Agency; MCLs established in 40 CFR Part 141 Appendix I
Grey cells indicate that measured values exceed EPA MCLs or Action Levels
MCL - Maximum Contaminant Level
mg/L - milligrams per liter
N/A - not applicable
Ref. - reference
TDEC - Tennessee Department of Environment and Conservation; MCLs established in Rules of TDEC Solid Waste Management Appendix III
ug/L - microgram per liter
Well ID - well identification

Table 1B
Groundwater Physical Data

Well ID	Historical Well ID Ref.	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
KIF-2	2	07/02/76	--	--	--	--	--	6.6	--	--	450	--
		03/09/77	--	390	--	--	--	7.1	790	--	1400	--
		01/11/89	--	535	--	-0.009	0.3	6.8	872	14.9	480	--
		03/30/89	--	480	--	-70	0.1	6.5	840	16	470	--
		06/29/89	--	476	--	-100	0.1	6.5	850	16.9	430	66
		09/14/89	--	480	--	-80	0.5	6.7	800	16.8	260	--
		11/29/89	--	502	--	-120	0.2	6.5	800	16.7	430	--
		03/07/90	--	454	--	50	0.3	6.3	800	15.8	430	--
		06/05/90	--	470	--	-80	0.2	6.7	870	17.1	280	270
		09/05/90	--	430	--	-97	0.2	6.6	914	17.7	540	560
		12/04/90	--	474	--	-70	0.5	6.6	852	15.1	480	510
		03/20/91	--	456	--	-80	0.5	6.6	863	16.4	460	700
		06/04/91	--	42	--	96	0.3	6.6	835	17.1	460	400
		09/10/91	--	490	--	-56	0.3	6.6	808	17.4	440	480
		12/17/91	--	445	--	-61	0.2	6.5	817	16	350	510
		06/02/92	--	--	--	-77	0.2	6.5	848	16.2	460	220
		12/07/92	--	508	--	-95	0.3	6.4	906	15.3	490	1000
		12/09/93	--	211	--	-97	0.3	6.6	855	17	450	210
		12/06/94	--	430	--	135	0.2	6.5	846	16.3	240	200
		12/11/95	--	346	--	166	0.1	6.5	869	16.3	410	280
		07/10/96	--	460	--	144	2.5	6.6	908	16.5	430	310
		12/03/96	--	470	--	368	1.5	6.6	923	15.4	510	88
		05/07/97	--	408	--	176	0.3	6.6	959	21.6	540	73
KIF-6A	6A	07/02/76	--	--	--	--	--	10	--	--	530	--
		03/09/77	--	237	--	--	--	7.4	520	--	950	--
		01/11/89	--	--	--	429	1.7	3.11	2360	14.9	1900	--
		03/29/89	--	--	--	130	0	5.1	2010	17.7	4200	--
		06/28/89	--	58	--	40	0.2	5.3	3400	18.6	5200	--
		09/13/89	--	244	--	140	1.3	5.5	3300	20.5	4900	--
		11/29/89	--	142	--	-10	0.9	5.8	3700	15.1	5000	--
		03/07/90	--	250	--	20	0.4	5.7	3680	16.8	4700	--
		06/05/90	--	191	--	-16	0.2	5.9	3743	17.2	4500	180
		09/05/90	--	179	--	14	0.3	5.8	428	18.6	5100	170
		12/04/90	--	210	--	62	0.4	5.8	4330	16.3	5200	210
		03/20/91	--	210	--	-27	0.3	5.9	4282	17.1	5500	230
		12/17/91	--	148	--	6	0.3	5.8	3621	17	5500	210
		06/02/92	--	192	--	11	0.3	5.9	3885	16.1	4700	160
		12/07/92	--	180	--	101	0.8	5.7	3680	15.4	4200	470
		06/08/93	--	220	--	20	0.3	5.7	4200	19.6	5300	150
		12/09/93	--	213	--	-20	0.7	5.8	3875	17.8	5000	140
		06/13/94	--	110	--	250	0.6	5.2	2895	24.4	3300	63
		12/08/94	--	182	--	163	0.5	6	2282	17.5	1500	93
		06/21/95	--	0	--	586	5.4	4.2	1294	18.2	850	10
		12/11/95	--	0	--	532	5.6	3.7	1254	16.8	760	12
		12/04/96	--	44	--	444	5.4	5.9	1668	16	1100	72
		05/08/97	--	48	--	552	3.6	5.6	1675	18	2000	100
		12/10/97	--	51	--	360	3.8	5.9	1684	16	1200	17
		06/30/98	--	195	--	180	0.4	5.7	3061	20.2	4800	75
		12/02/98	--	119	--	358		5.9	1330	17.7	1900	48
		12/06/99	--	21	--	419	4.6	5.7	1211	16.6	910	20
		12/14/00	--	0	--	493	7.2	5.6	982	17.3	1000	24
		06/28/01	--	37	--	456	5	5.3	1904	21	2200	42
		12/31/01	--	108	--	335	5	5.7	2364	15.8	2900	45
		06/28/02	--	87	--	376	4.3	5.8	1887	20.2	2500	68
		01/08/03	--	34	--	419	3.6	5.7	1840	16.6	1700	55
		06/16/03	--	85	--	406	3.7	6	2344	19.1	2600	88
		09/02/03	--	131	--	104	3.7	6	3030	23.5	3300	150
		12/29/03	--	132	--	270	3.2	5.9	3066	17.5	2800	61
		03/10/04	--	134	--	250	1.7	5.9	2045	16.9	4000	64
		06/07/04	--	116	--	172	2.3	5.8	3495	18.4	4500	67
		09/14/04	--	199	--	300	0.5	5.7	4161	19.5	6000	71
		12/08/04	--	131	--	221	2.4	5.5	3172	17.7	4100	81
		03/15/05	--	113	--	273	2.6	5.7	2144	16.7	3100	91

Well ID	Historical Well ID Ref.	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
KIF-6A (cont.)	6A	05/31/05	--	132	--	205	2.2	5.6	2909	17.8	3900	57
		12/13/05	--	--	--	210	0.3	5.6	3694	18.1	4300	170
		01/24/06	--	--	--	225	0.5	5.7	3939	17.9	--	--
		06/06/06	--	211	--	119	0.2	5.7	4544	17.5	5500	120
		12/15/06	--	210	--	132	0.3	5.7	4070	17.8	4500	100
		06/05/07	--	175	--	153	0.4	5.9	4625	18.5	5500	190
		12/03/07	--	182	--	185	0.4	6	4014	18.1	4400	160
		06/02/08	--	196	--	162	0.5	5.8	4553	18.5	4600	41
		12/02/08	--	190	--	170	0.4	5.8	4076	18.6	4900	40
		02/11/09	--	--	--	168	0.4	5.5	3805	20.7	--	--
		06/11/09	--	194	--	145	0.4	5.5	4443	18.4	5280	131
KIF-6B	6B	07/02/76	--	--	--	--	--	9.2	--	--	270	--
		03/09/77	--	320	--	--	--	6.9	680	--	1200	--
		01/11/89	--	17	--	280	0.4	5.3	2040	14	2300	--
		03/29/89	--	--	--	140	0	5.1	2020	17	1900	--
KIF-J7A	7A	07/02/76	--	--	--	--	--	9.7	--	--	190	--
		03/09/77	--	320	--	--	--	7	1900	--	3400	--
KIF-8	8	07/02/76	--	--	--	--	--	8	--	--	1800	--
		03/09/77	--	295	--	--	--	7.6	1460	--	2700	--
		01/11/89	--	211	--	303	1.6	7.08	1279	15.6	1200	--
		03/30/89	--	236	--	-20	1.1	7	1160	17.5	940	--
		06/28/89	--	221	--	50	1.8	7.1	1220	17	980	--
		09/14/89	--	--	--	30	0.5	7.1	1020	19.6	580	--
		11/29/89	--	234	--	100	0.9	7	1030	17.2	860	--
		03/07/90	--	244	--	-20	0.8	6.8	1040	15.8	830	--
		06/07/90	--	260	--	289	0.5	7.1	1170	17.3	920	15
		09/06/90	--	260	--	288	0.3	6.9	1360	18.6	1200	8
		12/05/90	--	281	--	166	0.5	6.9	1520	17.3	1300	2
		03/21/91	--	279	--	267	0.9	7	1440	17.6	1200	5
		06/04/91	--	260	--	-56	1.3	6.96	1442	18	1300	360
		09/10/91	--	296	--	-27	0.5	6.9	1451	18.6	1400	110
		12/17/91	--	271	--	15	0.5	6.9	1420	17.4	1100	22
		06/02/92	--	275	--	36	0.6	6.9	1482	17	1200	12
		12/08/92	--	284	--	244	0.5	6.8	1680	16.4	1400	14
		06/08/93	--	263	--	18	0.5	6.9	1363	19.4	1100	10
		12/08/93	--	250	--	-17	0.6	7	1181	20	960	7
		06/14/94	--	242	--	372	1.2	7	1150	19.4	640	23
		12/06/94	--	259	--	203	1.2	6.9	1293	17.4	620	6
		06/21/95	--	231	--	194	1.1	6.9	1379	18.1	950	11
		12/11/95	--	234	--	432	5.4	7.1	1456	17.7	790	48
KIF-9A	9A	01/05/89	--	103	--	-0.005	0.2	6.6	840	17.2	700	--
		03/28/89	--	82	--	-80	0.1	6.6	920	18.9	740	140
		06/29/89	--	73	--	-90	0.2	6.5	940	19.2	730	59
		09/14/89	--	74	--	-70	0.3	6.5	920	18.7	670	--
		12/04/89	--	68	--	-90	0.2	6.4	900	17.2	710	220
		03/13/90	--	40	--	-70	0.2	6.1	1060	19.9	800	--
		06/12/90	--	52	--	-18	0.5	6.3	1104	19.3	850	64
		09/12/90	--	98	--	-14	0.3	6.2	1116	18	910	100
		12/10/90	--	61	--	-32	0.4	6.3	1143	17.4	930	790
		03/25/91	--	95	--	207	0.1	6.7	1316	18.3	1000	150
		06/06/91	--	80	--	-93	0.3	6.4	1218	18.1	1100	64
		09/11/91	--	81	--	-9	0.3	6.2	1397	18.2	1200	340
		12/18/91	--	87	--	-48	0.4	6.2	1553	16.4	1300	150
		06/03/92	--	80	--	30	0.2	6.2	1668	17.3	1500	100
		12/09/92	--	74	--	163	0.3	5.9	1830	16.5	1700	170
		12/08/93	--	59	--	-54	0.3	5.9	2020	18.9	2100	27
		12/08/93	--	59	--	-54	0.3	5.9	2020	18.9	2000	24
		12/08/94	--	55	--	200	0.2	5.8	2273	18.1	1900	46
		12/13/95	--	40	--	243	0.1	5.3	2551	16.5	2200	14
		07/10/96	--	34	--	245	0.2	5.4	--	18.4	2400	6
		05/08/97	--	42	--	320	0.2	5.3	2477	17.6	2200	7
KIF-9B	9B	01/05/89	--	168	--	-0.006	0.2	7.8	440	17.3	290	--
		03/28/89	--	172	--	-140	0.2	8.6	430	18.5	280	2

Well ID	Historical Well ID Ref.	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
KIF-9B (cont.)	9B	06/29/89	--	177	--	-170	0.2	8.9	440	18.5	230	4
		09/14/89	--	155	--	-170	0.2	8.2	420	18.2	80	--
		12/04/89	--	181	--	-190	0.3	8.9	380	16.8	240	5
		03/13/90	--	167	--	-110	0.3	9.1	390	19.5	250	--
		06/12/90	--	161	--	65	0.5	8.4	479	19	300	<1
		09/12/90	--	168	--	-125	0.3	8	451	18.1	300	<1
		12/10/90	--	182	--	50	0.4	8.3	390	17.3	250	3
		03/25/91	--	170	--	68	0.5	8.9	432	17.8	260	6
		06/06/91	--	171	--	-127	0.8	8.1	459	17.9	260	<1
		09/11/91	--	--	--	-97	0.4	8	466	17.9	--	--
		12/18/91	--	170	--	-42	0.3	7.8	490	16.3	310	2
		06/03/92	--	168	--	-74	0.2	7.9	534	17.4	360	1
		12/09/92	--	175	--	188	0.5	7.9	474	16.2	320	<1
		12/08/93	--	192	--	-35	0.7	7.8	472	18.2	290	1
		12/08/93	--	169	--	-145	0.3	7.8	506	18.6	340	<1
		12/08/94	--	175	--	454	0.2	7.8	508	18.2	290	<1
		12/13/95	--	174	--	77	0.1	7.7	579	18.5	250	<1
		07/10/96	--	179	--	80	0.3	7.6	560	20.9	340	<1
		12/03/96	--	176	--	223	0.2	7.6	600	18.4	340	<1
		05/08/97	--	--	--	182	0.3	7.5	548	19.4	--	--
KIF-10	10	01/04/89	--	85	--	-0.02	0.1	6.5	845	16.5	680	--
		03/28/89	--	84	--	-20	0.3	6.7	900	20.7	680	--
		07/05/89	--	87	--	-60	0.2	6.6	1090	21.8	850	--
		09/14/89	--	87	--	-90	0.3	6.7	1050	24	780	--
		11/30/89	--	78	--	-50	0.3	6.7	1190	17	1000	--
		03/13/90	--	76	--	-70	0.4	6.7	1160	17.9	870	--
		06/06/90	--	79	--	-85	0.2	6.5	1128	20.8	830	130
		09/11/90	--	55	--	-46	0.3	6.5	1015	21.9	720	88
		12/10/90	--	81	--	-34	0.3	6.7	610	20	340	87
		03/20/91	--	86	--	-70	0.2	6.8	580	19.4	390	130
		06/04/91	--	68	--	63	0.5	6.7	606	21.5	430	130
		09/10/91	--	77	--	-51	0.3	6.7	554	22.6	360	120
		12/18/91	--	102	--	-63	0.3	6.6	472	19.4	260	43
		03/03/92	--	108	--	-102	0.1	6.9	479	19.2	280	10
		06/03/92	--	122	--	-78	0.1	6.9	503	20.5	320	4
		09/01/92	--	110	--	-29	0.1	6.8	471	23.1	330	14
		12/08/92	--	120	--	-86	0.2	6.8	488	18.5	280	90
		06/08/93	--	135	--	-76	0.2	6.9	489	20.2	290	20
		12/08/93	--	98	--	-94	0.4	7	475	18.5	300	11
		12/07/94	--	75	--	128	0.2	7	220	19	260	7
		06/21/95	--	82	--	102	0.1	6.8	523	20.6	260	10
		12/12/95	--	78	--	99	0.1	6.8	490	18.9	230	8
		07/09/96	--	78	--	77	0.1	6.5	542	22.7	330	19
		05/08/97	--	90	--	114	0.1	6.6	892	18.4	610	35
KIF-10A	10A	01/04/89	--	0.5	--	380	0.2	4.9	1020	19.2	1000	--
		03/28/89	--	0	--	250	0.3	4.3	980	21.5	820	--
		07/05/89	--		--	200	0.2	4.3	950	21.6	800	--
		09/14/89	--	0	--	240	0.4	4.3	870	22.9	660	--
		11/30/89	--	0	--	260	0.4	4.2	890	19.3	820	--
		03/13/90	--	2	--	230	0.4	4.6	980	20	710	--
		06/06/90	--	4	--	278	0.3	4.5	997	20.9	780	450
		09/11/90	--	0	--	417	0.5	4.3	979	21	770	830
		12/10/90	--	1	--	378	3.3	4.4	926	20.4	660	690
		03/20/91	--	6	--	219	0.2	4.8	841	21.8	630	310
		06/04/91	--	0	--	293	1.6	4.3	932	21.6	640	2100
		09/10/91	--	0	--	455	1.9	4.3	753	21.1	750	1300
		12/18/91	--	8	--	218	0.3	4.8	722	20	620	180
		03/03/92	--	29	--	122	0.7	5.5	659	21.7	490	76
		06/03/92	--	38	--	151	0.2	5.7	692	20.9	550	250
		09/01/92	--	15	--	410	0.2	5.2	605	22.4	490	26
		12/08/92	--	17	--	229	0.4	5.2	568	19.7	390	78
		06/08/93	--	28	--	121	0.1	5.5	419	20.8	260	52
		12/08/93	--	44	--	31	0.4	5.8	464	17.9	330	170

Well ID	Historical Well ID Ref.	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
KIF-10A (cont.)	10A	06/13/94	--	24	--	327	0.1	5	426	19.8	300	68
		12/07/94	--	15	--	303	0.3	5.4	437	18.8	230	38
		06/21/95	--	21	--	318	0.2	5.3	485	20	200	58
		12/12/95	--	18	--	356	0.4	5.3	419	18.2	230	22
		12/05/96	--	21	--	376	0.4	5.2	469	17.8	290	45
KIF-10B	10B	01/04/89	--	126	--	0.005	0.1	6.1	1210	18.4	1000	--
		03/28/89	--	115	--	-2	0.2	6	1290	20.5	1100	--
		07/05/89	--	114	--	0	0.2	6	1300	20.4	1000	--
		09/14/89	--	127	--	-30	0.4	6.1	1190	20.8	760	--
		11/30/89	--	115	--	-90	0.4	6.1	1150	17.9	1000	--
		03/13/90	--	113	--	0	0.4	6.1	1240	20.1	940	--
		06/06/90	--	117	--	13	0.3	6	1202	21	930	16
		09/11/90	--	119	--	-4	0.2	5.9	1166	20.5	890	24
		12/10/90	--	110	--	100	0.5	6.1	1077	19.3	770	6
		03/20/91	--	113	--	24	0.3	6.1	1150	20.2	860	17
		12/23/91	--	124	--	12	0.5	6	1035	19.4	750	36
		12/08/92	--	138	--	41	0.3	6	1000	19	660	47
		12/08/93	--	--	--	-75	0.4	6.3	861	20	640	20
		12/07/94	--	146	--	150	0.2	6.2	871	19.3	370	7
		12/12/95	--	145	--	172	0.1	5.9	885	19.3	470	24
		07/09/96	--	155	--	154	0.2	5.9	879	22.7	560	51
KIF-11B	11B	03/28/89	--	265	--	190	0.3	7	2180	16.9	2000	--
		06/28/89	--	237	--	40	0.2	6.2	2040	17.2	1800	--
		09/14/89	--	275	--	20	0.4	6.8	1900	19	1900	--
		11/30/89	--	356	--	110	0.4	6.6	2000	16.5	1900	--
		03/07/90	--	326	--	160	0.3	6.5	1880	16	1800	--
		06/06/90	--	348	--	52	0.5	6.6	2131	16.9	2000	320
		09/11/90	--	310	--	151	0.3	6.7	1910	17.1	1800	67
		12/10/90	--	264	--	283	0.5	6.8	1510	17.3	1300	230
		03/20/91	--	302	--	118	0.5	6.9	1857	16.8	1600	89
		12/23/91	--	320	--	206	0.6	6.6	2000	16.7	1900	42
		12/08/92	--	300	--	289	1	6.7	1790	16.1	1600	110
		12/08/93	--	320	--	32	0.4	6.7	1907	18.4	1800	2
		12/06/94	--	320	--	254	0.3	6.6	1908	18.6	1300	6
		12/11/95	--	302	--	290	0.6	6.5	1851	16.7	1100	<1
		07/09/96	--	302	--	316	0.3	6.5	--	18.6	1200	9
KIF-12A	12A	01/04/89	--	195	--	180	0.4	6.2	630	14.8	450	--
		03/29/89	--	220	--	-20	0.1	6.5	780	15.3	540	--
		06/28/89	--	175	--	-30	0.1	6.6	900	17.1	610	--
		09/18/89	--	226	--	-30	0.3	6.5	830	19	940	--
		03/14/90	--	239	--	-40	0.1	6.8	920	14.2	600	--
		06/14/90	--	245	--	-41	0.3	6.7	883	16.6	610	15
		09/10/90	--	253	--	76	0.2	6.7	863	20.8	590	7
		12/06/90	--	217	--	20	0.2	6.6	690	16.4	520	3
		03/21/91	--	208	--	37	0.2	6.7	783	17.7	540	5
		12/19/91	--	186	--	18	0.7	6.5	703	15.7	500	2
		06/03/92	--	218	--	5	0.2	6.7	739	16.5	520	2
		12/09/92	--	200	--	136	0.3	6.4	737	16.2	470	10
		12/08/93	--	194	--	-28	0.4	6.7	621	17.4	420	23
		12/06/94	--	206	--	143	0.2	6.5	660	16.9	300	8
		12/13/95	--	211	--	188	0.1	6.4	695	17.2	330	2
KIF-12B	12B	01/04/89	--	301	--	150	0.5	6.8	1260	14.8	1000	--
		03/29/89	--	296	--	-50	0.2	7	1330	16.4	1000	--
		06/28/89	--	46	--	-80	0.1	7	1360	16.5	1000	--
		09/18/89	--	322	--	-90	0.3	7	1300	16.7	1400	--
		12/05/89	--	300	--	-100	0.4	7	1200	15.8	1000	--
		03/12/90	--	318	--	-40	0.2	7	1390	18.7	1100	--
		06/06/90	--	322	--	-69	0.2	6.9	1359	17.2	1100	5
		09/10/90	--	321	--	27	0.3	7	1334	17	1100	4
		12/06/90	--	319	--	30	0.4	6.9	1200	15.5	1100	4
		03/21/91	--	323	--	-60	0.3	7	1357	16.9	1000	3
		12/19/91	--	320	--	-26	0.2	7	1345	14.3	1100	<1
		06/03/92	--	324	--	-33	0.2	7.1	1352	16.1	1100	6

Well ID	Historical Well ID Ref.	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
KIF-12B (cont.)	12B	12/09/92	--	328	--	159	0.4	6.9	1375	14.9	1000	4
		12/08/93	--	312	--	-54	0.3	7	1252	17.1	1000	3
		12/06/94	--	330	--	161	0.3	6.9	1353	17	590	4
		12/13/95	--	315	--	149	0.1	6.8	1335	17	750	2
KIF-13A	13A	01/11/89	--	208	--	-0.08	0.1	6.7	500	15.7	370	--
		03/29/89	--	249	--	-120	0.03	6.5	1190	21	760	--
		07/05/89	--	211	--	-100	0.2	6.5	660	18.7	460	--
		12/06/89	--	220	--	-110	0.1	6.6	650	15.8	340	--
		03/14/90	--	218	--	-120	0.2	6.7	550	16.9	270	--
		06/14/90	--	195	--	-112	0.2	6.6	621	18.6	280	270
		09/10/90	--	182	--	-130	0.1	6.4	1470	21.8	990	190
		12/06/90	--	185	--	-128	0.2	6.6	640	16.4	400	1200
		03/21/91	--	186	--	151	0.2	6.6	575	19	300	120
		06/06/91	--	180	--	-123	0.3	6.7	489	18.5	280	100
		09/11/91	--	--	--	--	--	--	--	--	310	160
		12/19/91	--	204	--	-71	0.7	6.6	486	14.8	200	22
		03/04/92	--	211	--	-120	0.3	6.5	531	16.6	270	170
		06/03/92	--	217	--	-96	0.2	6.6	571	17.8	350	60
		09/01/92	--	194	--	-49	0.1	6.6	467	19.4	290	65
		12/08/92	--	229	--	-138	0.2	6.5	552	15.2	260	280
		06/08/93	--	258	--	-98	0.2	6.4	619	22.3	330	72
		12/08/93	--	--	--	-117	0.3	6.6	449	16.8	250	74
		06/14/94	--	230	--	96	0.1	6.5	513	18.8	180	140
		12/07/94	--	214	--	73	0.1	6.6	427	16.1	160	70
		06/21/95	--	236	--	91	0.1	6.4	545	16.7	190	52
		12/13/95	--	205	--	98	0.1	6.4	461	15.6	110	42
		12/04/96	--	237	--	96	0.1	6.4	536	15.9	230	98
		05/08/97	--	260	--	127	0.1	6.2	540	17.5	210	45
KIF-13B	13B	01/05/89	--	159	--	110	0.2	8	280	15.1	190	--
		03/29/89	--	166	--	-160	0.1	8.3	310	16.6	210	--
		06/29/89	--	--	--	-150	0.2	8.3	320	16.6	180	3
		09/14/89	--	249	--	-160	0.1	8.2	320	16.8	90	--
		12/05/89	--	159	--	-160	0.3	8.3	290	15.9	200	--
		03/12/90	--	165	--	-100	0.4	8.2	320	18.6	200	--
		06/06/90	--	167	--	-92	0.3	8.3	322	17	210	<1
		09/10/90	--	164	--	-73	0.3	8.4	310	17.7	200	<1
		12/06/90	--	168	--	-170	0.4	8.3	277	16.2	160	<1
		03/21/91	--	171	--	-80	0.3	8.3	321	17.1	200	<1
		12/19/91	--	168	--	91	0.3	8.2	317	15.1	230	<1
		03/04/92	--	170	--	-60	0.4	8.3	320	16	200	<1
		06/03/92	--	170	--	-70	0.1	8.4	320	16.6	210	<1
		09/01/92	--	165	--	573	0.1	8.3	319	18	210	<1
		12/08/92	--	168	--	-140	0.3	8.4	322	15.6	180	<1
		12/08/93	--	164	--	-8	1.5	8.3	307	16	200	4
		12/07/94	--	170	--	69	0.7	8.3	317	15.7	140	7
		12/12/95	--	171	--	54	0.4	8	339	15.5	160	3
		07/11/96	--	188	--	194	0.3	8.2	338	16.8	200	2
		12/04/96	--	174	--	-8	0.2	8.1	340	15.8	200	3
		05/08/97	--	180	--	260	0.2	7.8	343	16.4	200	<1
		12/10/97	--	182	--	116	0.1	8.2	342	15.8	180	<1
		06/30/98	--	177	--	51	0.1	7.7	324	17.3	230	<1
		12/02/98	--	91	--	169	0	8	352	16.1	210	<1
		12/06/99	--	182	--	218	0.8	7.9	343	15.4	230	<1
		12/14/00	--	180	--	189	1	8.1	298	16.2	220	<1
		06/28/01	--	183	--	163	2.6	7.9	354	16.3	230	<1
		12/31/01	--	186	--	164	0.2	8.1	352	15.6	240	<1
		06/28/02	--	181	--	156	0.1	8	350	16.7	220	<1
		01/08/03	--	184	--	206	0.6	7.9	362	16	230	2
		06/17/03	--	193	--	210	0.2	7.7	361	16.5	230	<1
		09/02/03	--	194	--	-139	0.1	7.9	364	17.5	250	2
		12/29/03	--	186	--	178	0	7.8	378	16.7	220	<1
		03/10/04	--	186	--	170	0	7.8	368	16.6	220	2
		06/07/04	--	186.5	--	12	0.1	8.1	370	17.3	250	<1

Well ID	Historical Well ID Ref.	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
KIF-13B (cont.)	13B	09/14/04	--	190	--	165	0	7.9	328	17.3	240	3
		12/08/04	--	192.5	--	62	0.2	7.8	352	16.9	230	1
		03/15/05	--	18.8	--	235	0.1	7.4	354	16.6	240	<1
		06/01/05	--	194.5	--	30	0	7.9	336	16.9	240	<1
		12/13/05	--	195	--	80	0.2	7.9	387	16.6	250	<1
		06/06/06	--	202.5	--	-17	0.1	7.7	394	--	250	<1
		12/15/06	--	204	--	-12	0.1	8	421	16.6	240	<1
		06/05/07	--	209.5	--	38	0.2	7.8	396	16.7	230	<1
		12/04/07	--	209	--	83	0.1	7.7	407	16.6	280	<1
		06/02/08	--	209	--	8	0.2	8	405	16.8	240	<1
		12/02/08	--	208	--	35	0.2	7.9	411	16.7	250	<1
		06/11/09	--	206	--	-62	0.2	7.6	485	16.4	300	<1.33
		09/14/09	--	207	--	-31	0.2	7.8	430	17.4	274	<1
		10/19/09	--	196	--	84	0.8	7.9	400	17.6	245	<1
		11/17/09	--	216	--	-75	0.3	7.3	414	16.5	255	1.6
		12/15/09	--	225	--	-35	0.4	7.3	444	16.3	255	12.4
KIF-15A	15A	01/03/89	--	188	--	--	0.4	7.7	340	15.5	240	--
		03/30/89	--	221	--	-40	0.6	7.3	420	15	3500	--
		07/05/89	--	192	--	10	0.4	7.4	410	18.5	230	--
		09/18/89	--	195	--	-70	0.3	7.3	420	20.2	550	--
		12/05/89	--	190	--	-50	0.9	7.4	380	17.2	260	--
		03/12/90	--	193	--	90	0.6	7.3	420	17.3	250	--
		06/07/90	--	191	--	207	0.9	7.4	407	17	250	73
		09/06/90	--	191	--	185	0.5	7.3	408	18.6	250	130
		12/05/90	--	205	--	116	0.9	7.4	427	17.5	250	46
		03/15/91	--	209	--	250	1	7.5	415	15.8	250	390
		06/04/91	--	180	--	171	1.3	7.4	399	17.1	250	120
		09/11/91	--	199	--	301	0.7	7.4	425	17.9	250	41
		12/23/91	--	198	--	308	2	7.3	384	16.5	240	8
		12/10/92	--	203	--	77	0.4	7.2	418	15.8	200	3
		06/09/93	--	183	--	107	0.8	7.4	407	243	230	9
		12/07/93	--	204	--	104	0.7	7.3	416	16.8	250	<1
		06/14/94	--	188	--	250	0.2	7.1	383	17.7	200	1
		12/08/94	--	200	--	262	0.3	7.4	394	17.3	210	<1
		06/22/95	--	191	--	258	0.4	7	412	16.4	200	<1
		12/14/95	--	179	--	387	0.6	7.2	418	16.9	150	<1
		07/09/96	--	195	--	217	0.4	6.8	420	19.1	210	<1
		05/08/97	--	197	--	366	0.5	6.9	420	17.2	220	<1
KIF-15B	15B	03/30/89	--	254	--	-40	0.3	7	590	16.3	640	--
		07/05/89	--	255	--	-60	0.2	7.1	620	17.4	380	--
		09/18/89	--	252	--	-70	0.2	7.1	610	17.3	580	--
		09/18/89	--	252	--	-70	0.2	7.1	610	17.3	700	--
		12/05/89	--	246	--	-60	0.5	7.2	540	15.8	350	--
		03/08/90	--	264	--	-30	0.4	6.98	550	15	340	--
		06/07/90	--	260	--	-25	0.5	7.2	591	16.4	370	31
		09/06/90	--	246	--	20	0.3	7.1	590	16.6	370	150
		12/05/90	--	260	--	70	0.4	7.2	587	15.6	380	12
		03/15/91	--	241	--	68	0.3	7.3	560	16.4	340	3
		12/23/91	--	250	--	23	0.6	7.1	584	15.7	360	6
		12/10/92	--	259	--	52	0.4	7	618	15.2	360	3
		06/09/93	--	247	--	-31	0.3	7.1	582	19.9	360	2
		12/07/93	--	247	--	-52	0.4	7.2	551	17.2	350	<1
		06/14/94	--	246	--	184	0.1	6.8	541	18.9	270	2
		12/08/94	--	260	--	160	0.2	7.2	557	17.1	310	<1
		06/22/95	--	245	--	185	0.7	6.8	590	18.8	310	<1
		12/14/95	--	247	--	354	0.2	7	586	16.7	240	<1
		07/09/96	--	246	--	123	0.2	6.7	591	21.7	290	<1
KIF-6AR	6AR	09/14/09	--	10	--	425	0.6	4.6	501	17.5	376	1.5
		12/17/09	--	20	--	306	0.4	4.7	476	15	319	2
		03/10/10	--	11.5	--	480	0.4	4.5	461	16	328	2.3
		04/19/10	--	18	--	533	0.4	4.5	475	16.2	349	3.9
		06/16/10	--	18	--	259	0.3	4.5	493	17.8	398	2.5
		08/25/10	--	--	--	305	0.3	4.5	500	17.5	--	--

Well ID	Historical Well ID Ref.	Date	General Chemistry: Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
KIF-6AR (cont.)	6AR	09/28/10	--	19	--	362	0.3	4.4	509	16.4	370	3.1
		11/29/10	--	--	--	--	--	--	--	--	--	--
		12/15/10	--	20	--	198	0.2	4.6	515	14.7	355	4.4
		02/08/11	--	--	--	212	0.3	4.6	521	15.2	--	--
		06/29/11	--	18	--	402	0.2	4.5	504	17.4	361	6.5
		08/03/11	--	--	--	422	0.1	4.5	517	17.7	--	--
		12/05/11	--	15	--	425	0.1	4.6	505	16.3	359	5.8
		01/25/12	--	--	--	--	--	--	--	--	--	--
		06/18/12	--	19	--	432	0.3	4.6	505	18.4	365	<1
		12/10/12	--	17	--	455	0.4	4.4	522	16.6	365	<1
		06/24/13	--	17	--	422	0.4	4.8	529	19	385	1.1
		12/04/13	--	25	--	410	0.3	4.8	529	16.2	375	1
		06/11/14	--	18	--	431	0.1	4.9	573	17.9	428	3.5
		12/10/14	--	18	--	401	0.1	4.8	559	14.7	--	1.6
		06/18/15	--	21	--	461	0.1	4.8	591	20.3	--	1.2
		09/22/15	--	27	--	414	0.1	5.2	594	18.6	--	1.4
		12/02/15	--	24	--	457	0.1	5.2	586	16	--	<1
		03/23/16	--	21.9	--	517	0.2	4.6	622	16.3	454	<1
		06/15/16	--	16.1	--	442	0.1	4.7	636	17.7	482	<1
		09/22/16	--	36.8	--	440	0.1	4.7	617	18	462	1.1
		12/01/16	--	32.5	--	427	0.1	4.6	606	15.8	461	0.5
		03/02/17	--	16.5	--	165	0.1	5.7	650	15.9	509	<0.5
		06/07/17	--	25.9	--	139	0.1	5.27	650	17.4	495	0.5
KIF-AD1	AD-1	06/11/09	--	189	--	66	0.4	8.1	408	15.7	259	5.2
		09/15/09	--	187	--	142	0.4	8.5	400	18.4	318	28.6
		10/14/09	--	187	--	135	1.2	8.6	402	16.5	250	75.6
		11/17/09	--	190	--	28	0.7	8.7	399	14.9	196	4.2
		12/15/09	--	196	--	48	1	8.3	423	13.4	251	3.07
		01/11/10	--	184	--	27	2	8.7	404	9.7	212	3.4
		02/16/10	--	--	--	--	--	--	--	--	238	<1
		02/16/10	--	188.5	--	147	0.7	6.9	411	10	247	<1
		03/08/10	--	183	--	324	0.7	6.3	393	13.1	243	2.4
		04/13/10	--	190	--	156	0.5	8.5	395	15.4	252	2.6
		05/10/10	--	189	--	39	0.5	8.3	395	14.3	251	1.7
		06/15/10	--	188	--	-21	0.5	8.4	386	16.8	248	<1
		07/13/10	--	189	--	17	0.5	8.4	397	17.1	246	<1
		09/27/10	--	--	--	--	--	--	--	--	246	<1
		12/16/10	--	197	--	147	0.4	8.4	337	12.8	246	<1
		01/20/11	--	--	--	30	0.4	8.5	398	12.7	--	--
		03/08/11	--	196	--	103	0.3	8.4	418	13.6	242	<1
		06/28/11	--	189	--	124	0.3	8.4	406	15.7	243	<1
		09/27/11	--	189	--	34	0.1	8.5	420	15.6	252	<1
		12/06/11	--	189	--	152	0.4	8.4	414	14.8	259	1
		03/20/12	--	185	--	294	0.4	8.3	417	150	254	1.1
		06/19/12	--	188	--	245	0.6	9.1	392	17.7	245	1.2
		09/17/12	--	--	--	134	1.1	8.8	411	18.9	256	<1
		12/11/12	--	188	--	293	1.6	8.3	410	8.3	260	1.8
		03/18/13	--	191	--	388	1.2	8.5	413	14.2	260	1
		06/25/13	--	192	--	305	1	8.6	410	20.1	248	1.8
		09/04/13	--	190	--	146	0.9	8.8	402	18.7	246	1.9
		12/02/13	--	192	--	431	0.8	7.7	426	12.7	249	1.2
		03/05/14	--	190	--	257	1	8.7	402	11.2	249	2.1
		06/10/14	--	186	--	425	0.7	8.8	403	18.5	252	<1
		09/16/14	--	191.5	--	85	0.4	8.7	403	19	--	<1
		12/09/14	--	200	--	83	0.3	8.3	414	12.7	--	1.2
		03/10/15	--	211	--	300	1.3	8.8	413	11.1	--	2.8
		06/16/15	--	180	--	349	0.9	8.8	403	19.8	--	<1
		09/22/15	--	191	--	298	1.1	9	400	19.3	--	<1
		11/30/15	--	185	--	270	1.1	9	402	15.8	--	1
		03/21/16	--	195	--	368	2.3	8.6	426	12.8	253	1.1
		06/13/16	--	185	--	238	2.2	8.6	417	19.7	1500	<1
		09/20/16	--	188	--	256	1.3	8.6	414	18.8	238	<1
		11/28/16	--	254	--	195	2.6	8.7	416	15.5	251	<0.5

Well ID	Historical Well ID Ref.	Date	General Chemistry									
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
KIF-AD1 (cont.)	AD-1	02/28/17	--	246	--	229	1.3	8.8	410	13.1	265	<0.5
		06/05/17	--	243	--	203	1.96	8.86	414	18.28	267	<0.5
KIF-AD2	AD-2	06/11/09	--	30	--	233	0.3	5.8	281	21.2	171	<1.33
		07/23/09	--	--	--	--	--	--	--	--	--	--
		09/15/09	--	30	--	266	0.9	5.8	277	21.5	170	1.9
		10/13/09	--	34	--	209	0.9	5.9	292	21.5	165	1.5
		11/16/09	--	40	--	303	0.7	6.1	315	19.7	181	1.1
		12/14/09	--	39	--	309	0.4	5.8	331	17.8	200	<1
		01/12/10	--	42	--	289	1.3	6	337	13.3	28	<3
		02/17/10	--	44	--	393	0.3	4.9	359	15.3	201	2.6
		03/08/10	--	38	--	302	0.4	5.7	359	18.2	231	1.5
		04/12/10	--	34	--	312	0.4	5.6	376	18	236	1.3
		05/11/10	--	37	--	311	0.4	5.7	415	19	272	2.6
		06/15/10	--	35	--	259	0.4	5.6	442	19.8	298	<1
		07/12/10	--	32.5	--	92	0.4	5.5	475	19.8	301	<1
		09/22/10	--	27	--	150	0.4	5.4	515	20.6	337	<1
		12/16/10	--	31	--	338	0.3	5.6	456	17.8	371	3.1
		01/20/11	--	--	--	333	0.3	5.7	584	18.2	--	--
		03/07/11	--	34	--	327	0.3	5.6	599	16.9	392	3
		06/28/11	--	34	--	329	0.2	5.4	614	18.5	414	3.8
		09/28/11	--	28	--	273	0.1	5.5	637	19.6	443	<1
		12/06/11	--	30	--	349	0.1	5.6	674	19.1	451	1.2
		03/19/12	--	29	--	344	0.3	5.6	648	18.3	436	1.2
		06/20/12	--	33	--	308	0.4	5.8	655	19.7	459	3.5
		09/17/12	--	--	--	215	1.1	5.9	714	20.5	498	<1
		12/12/12	--	30	--	344	0.6	5.4	605	15.7	435	<1
		03/19/13	--	30	--	361	0.4	5.7	506	15.6	337	2
		06/25/13	--	26	--	302	0.5	5.8	447	20.5	292	1.7
		09/03/13	--	21.5	--	259	0.4	5.8	411	21.1	270	<1
		12/03/13	--	25	--	300	--	5.8	372	18.1	251	<1
		03/05/14	--	21	--	318	0.7	5.8	333	17	225	3.9
		06/09/14	--	19.5	--	304	0.4	5.8	331	19.8	224	<1
		09/15/14	--	24	--	250	0.3	5.9	321	20.6	--	<1
		12/09/14	--	23	--	301	0.1	5.9	303	16.6	--	1.1
		03/09/15	--	20	--	318	0.7	5.8	301	15	--	1.1
		06/18/15	--	26	--	341	0.6	6	297	20.8	--	2.1
		09/22/15	--	28	--	309	0.9	6.3	293	20.9	--	3.5
		12/02/15	--	23	--	365	1.1	6.1	303	17.9	--	<1
		03/23/16	--	16.1	--	408	0.2	5.9	326	16.7	214	<1
		06/14/16	--	17.2	--	268	0.1	5.8	338	19.4	221	<1
		09/21/16	--	20.6	--	294	0.1	5.7	335	21.4	212	<1
		12/01/16	--	34.5	--	278	0.7	5.9	319	19	204	<0.5
		03/01/17	--	28	--	306	0.4	5.9	341	18.6	222	1.2
		06/07/17	--	25.9	--	267	0.1	6.04	465	19.93	313	0.5
KIF-AD3	AD-3	06/11/09	--	285	--	284	0.9	6.4	1412	18.2	1110	<1.33
		09/15/09	--	263	--	276	0.3	6.6	838	20.7	620	1.4
		10/13/09	--	263.5	--	290	0.7	6.6	815	20.3	536	<1
		11/16/09	--	254.5	--	318	0.5	6.7	798	17	524	<1
		12/14/09	--	239	--	298	0.4	6.6	823	14.3	525	<1
		01/13/10	--	222	--	299	1.2	6.8	795	10	510	<1
		02/17/10	--	210	--	321	0.5	6.6	789	9.2	511	1.1
		03/09/10	--	203.5	--	303	0.5	6.6	763	10.3	536	<1
		04/13/10	--	206	--	287	0.4	6.5	817	13.8	580	<1
		05/11/10	--	216	--	285	0.5	6.4	891	13.9	620	<1
		06/14/10	--	244.5	--	-1	0.4	6.5	890	18.6	643	<1
		07/13/10	--	268	--	29	0.4	6.4	928	20.5	666	<1
		09/23/10	--	295	--	257	0.4	6.4	997	21.5	698	<1
		11/29/10	--	--	--	--	--	--	--	--	--	--
		12/17/10	--	258	--	314	0.2	6.5	953	12.7	655	<1
		01/20/11	--	--	--	275	0.3	6.6	890	10.7	--	--
		02/08/11	--	--	--	277	0.3	6.5	883	9.2	--	--
		03/07/11	--	208	--	271	0.3	6.4	884	10.5	645	1.4
		06/27/11	--	302	--	86	0.2	6.2	1597	17.5	1220	<1

Well ID	Historical Well ID Ref.	Date	Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, Dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
			General Chemistry									
KIF-AD3 (cont.)	AD-3	08/03/11	--	--	--	134	0.2	6.1	2181	20.3	--	--
		09/27/11	--	283	--	59	0.1	6.5	1072	20.6	753	2.2
		12/07/11	--	258.5	--	279	0.2	6.5	970	14	652	<1
		01/25/12	--	--	--	300	0.2	6.5	808	11.5	--	--
		03/20/12	--	195	--	260	0.1	6.5	756	12.7	524	1
		06/20/12	--	314	--	294	0.3	6.3	1959	18.5	1310	<1
		09/18/12	--	--	--	212	0.3	6.6	984	20.9	717	<1
		12/11/12	--	247	--	300	0.4	6.3	945	13.4	650	1.7
		03/19/13	--	190	--	326	0.3	6.5	768	11.9	452	1
		06/26/13	--	299.5	--	326	0.2	6.4	1531	18.1	1110	<1
		09/04/13	--	343	--	289	0.4	6.4	1970	20.3	1600	1.8
		12/03/13	--	278	--	269	2.5	6.6	854	15.5	549	<1
		03/04/14	--	186	--	320	0.1	6.7	705	8.7	506	1.3
		06/10/14	--	260	--	111	0.2	6.6	1163	17.2	865	1.4
		09/15/14	--	302	--	178	0.1	6.5	1304	20.1	--	1.7
		12/08/14	--	240.5	--	234	0.1	6.7	789	14	--	<1.01
		03/11/15	--	181	--	327	0.2	6.7	700	9.6	--	<1
		06/17/15	--	305	--	326	0.1	6.4	1960	19.3	--	1
		09/22/15	--	327	--	336	0.1	6.6	1748	20.1	--	<1
		12/02/15	--	282	--	367	0.1	6.9	857	17	--	<1
		03/22/16	--	177	--	423	2.6	6.9	774	12.2	521	<1
		06/13/16	--	301	--	325	0.1	6.3	2044	19	247	<1
		09/21/16	--	212	--	314	0.1	6.3	1818	21.5	1310	<1
		11/30/16	--	362	--	273	1	6.8	903	18.4	659	<0.5
		03/02/17	--	284	--	356	1.2	7.3	779	12.4	547	<0.5
		06/06/17	--	416	--	321	0.75	6.46	1989	17.28	1610	<0.5
KIF-GW01	GW-01	10/05/10	--	--	--	149	0.7	9	550	15.8	--	--
		09/17/14	--	273	--	-25	0.7	9.2	648	17.2	--	1.8
		12/08/14	--	275	--	73	1.6	9.2	628	13.5	--	<1.05
		03/10/15	--	289	--	113	5.2	9.3	653	11.4	--	2
		06/17/15	--	276	--	270	1.4	9.1	660	24	--	1.6
		09/22/15	--	280	--	31	0.8	9.5	654	19	--	1.4
		11/30/15	--	271	--	72	1.8	9.5	633	16.1	--	<1
		03/22/16	--	281	--	349	4.4	8.7	654	11.1	388	4.6
		06/14/16	--	275	--	250	1.8	8.7	679	19.3	407	13.5
		09/20/16	--	282	--	208	1.8	9.8	685	20.2	393	27.7
		11/29/16	--	380	--	52	1.9	9.5	648	15.7	418	119
		02/28/17	--	368	--	38	2.3	9.8	636	13.4	441	34.3
		06/06/17	--	330	--	55	1.46	8.97	647	18.1	448	28.3
KIF-TWP-06	TWP-06	09/30/10	--	--	--	112	0.3	6.2	389	20.2	--	--
KIF-TWP-26	TWP-26	10/04/10	--	--	--	42	0.3	11.2	1154	20.3	--	--

-- no data
°C - degrees Celsius
CaCO3 - calcium carbonate
cm - centimeters
cont. - continued
mg/L - milligrams per liter
mV - millivolts
N/A - not applicable
NM - not measured
Ref. - reference
Well ID - well identification

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-2	2	3/9/1977	749.90	--	--
		1/11/1989	757.51	49.70	10.30
		3/30/1989	757.94	49.70	9.85
		6/29/1989	758.79	49.70	9.01
		9/14/1989	757.61	49.70	10.20
		11/29/1989	751.15	--	16.66
		3/7/1990	757.94	49.51	9.85
		6/5/1990	757.61	49.70	10.18
		9/5/1990	757.09	49.61	10.70
		12/4/1990	757.35	49.51	10.45
		3/20/1991	758.63	49.51	9.20
		6/4/1991	758.33	49.61	9.46
		9/10/1991	757.58	44.69	10.24
		12/17/1991	759.71	49.70	8.09
		6/2/1992	759.42	49.70	8.40
		12/7/1992	759.48	49.61	8.33
		12/6/1993	759.22	49.64	8.60
		12/6/1994	756.36	49.70	11.45
		6/19/1995	755.68	52.17	12.14
		12/11/1995	756.07	52.30	11.75
		7/8/1996	756.59	52.33	11.22
		12/2/1996	760.07	52.33	10.70
		5/6/1997	760.47	52.20	10.30
		12/8/1997	759.45	52.20	11.32
		6/29/1998	758.99	52.20	11.78
		12/1/1998	758.89	52.03	11.88
KIF-6A	6A	1/11/1989	740.87	26.80	11.33
		3/29/1989	740.45	26.80	11.75
		6/28/1989	744.72	26.80	7.48
		9/13/1989	743.88	26.80	8.32
		11/29/1989	733.00	--	19.20
		3/7/1990	740.32	29.70	11.88
		6/5/1990	743.64	29.80	8.56
		9/5/1990	743.40	26.70	8.80
		12/4/1990	741.16	26.70	11.04
		3/20/1991	729.20	26.70	11.73
		12/17/1991	741.92	26.80	10.26
		6/2/1992	743.53	29.90	8.65
		12/7/1992	740.97	23.60	11.22
KIF-6B	6B	1/11/1989	748.93	38.30	2.87
		3/29/1989	748.79	29.50	3.01

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-8	8	3/9/1977	748.80	--	--
		1/11/1989	750.85	33.10	20.05
		3/30/1989	764.01	33.50	6.88
		6/28/1989	764.04	33.10	6.86
		9/14/1989	762.83	33.10	8.06
		11/29/1989	748.00	--	22.90
		3/7/1990	762.01	33.01	8.90
		6/7/1990	761.98	33.10	8.91
		9/6/1990	761.19	33.01	9.70
		12/5/1990	758.89	33.01	12.00
		3/21/1991	757.55	33.01	13.36
		6/4/1991	752.72	33.01	18.18
		9/10/1991	755.15	33.10	15.75
		12/17/1991	763.48	33.10	7.43
		6/2/1992	762.89	33.10	8.00
		12/8/1992	763.48	33.10	7.40
		6/8/1993	754.82	33.05	16.08
		12/6/1993	763.98	33.07	6.92
		6/14/1994	763.65	33.07	7.25
		12/6/1994	763.75	33.14	7.15
		6/19/1995	762.93	33.04	7.97
		12/11/1995	763.62	33.07	7.28
		7/8/1996	762.83	33.10	8.07
		12/2/1996	764.14	33.07	6.76
		5/6/1997	763.75	33.07	7.15
		12/8/1997	763.35	33.07	7.55
		6/29/1998	763.02	33.07	7.87
		12/1/1998	762.53	32.97	8.37
KIF-9A	9A	1/5/1989	754.18	71.60	18.32
		3/28/1989	754.41	71.60	18.09
		6/29/1989	755.33	71.70	17.17
		9/14/1989	754.66	71.60	17.84
		12/4/1989	749.76		22.74
		3/13/1990	754.94	71.50	17.56
		6/12/1990	755.05	71.60	17.45
		9/12/1990	755.17	71.50	17.33
		12/10/1990	755.18	71.50	17.32
		3/25/1991	729.06	71.50	16.62
		6/6/1991	755.49	71.40	17.01
		9/11/1991	737.28	71.60	16.08
		12/18/1991	757.04	71.60	15.46

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-9A (cont.)	9A	6/3/1992	756.55	71.60	15.95
		12/9/1992	756.36	71.50	16.15
KIF-9B	9B	1/5/1989	753.17	85.00	19.23
		3/28/1989	754.43	85.00	17.97
		6/29/1989	755.35	85.20	17.05
		9/14/1989	754.66	85.00	17.74
		12/4/1989	753.66	--	18.74
		3/13/1990	754.71	84.90	17.69
		6/12/1990	754.59	85.00	17.81
		9/12/1990	754.05	84.90	18.35
		12/10/1990	755.20	84.90	17.20
		3/25/1991	712.56	84.90	16.49
		6/6/1991	756.01	84.80	16.39
		9/11/1991	724.04	85.00	16.73
		12/18/1991	756.57	85.00	15.83
		6/3/1992	757.04	85.00	15.35
		12/9/1992	756.65	85.00	15.76
KIF-10	10	1/4/1989	750.72	17.30	6.08
		3/28/1989	750.99	17.30	5.81
		7/5/1989	751.20	17.30	5.60
		9/14/1989	751.18	17.30	5.62
		11/30/1989	751.16	--	5.64
		3/13/1990	751.22	17.10	5.58
		6/6/1990	751.35	17.10	5.45
		9/11/1990	751.48	17.20	5.32
		12/10/1990	752.27	17.20	4.53
		3/20/1991	751.60	17.10	4.45
		6/4/1991	752.49	17.10	4.31
		9/10/1991	739.56	17.20	0.90
		12/18/1991	756.59	17.30	0.20
		3/3/1992	756.32	17.30	0.45
		6/3/1992	756.42	17.30	0.35
		9/1/1992	755.90	17.20	0.90
		12/8/1992	756.45	17.20	0.33
KIF-10A	10A	1/4/1989	747.00	23.60	9.30
		3/28/1989	747.14	32.70	9.16
		7/5/1989	748.91	23.60	7.39
		9/14/1989	749.17	23.60	7.13
		11/30/1989	744.00	--	12.30
		3/13/1990	747.38	32.20	8.92
		6/6/1990	748.56	32.00	7.74

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-10A (cont.)	10A	9/11/1990	749.72	32.10	6.58
		12/10/1990	747.56	32.00	8.74
		3/20/1991	739.20	32.10	8.08
		6/4/1991	749.34	32.20	6.96
		9/10/1991	741.01	32.20	4.30
		12/18/1991	751.80	32.20	4.50
		3/3/1992	750.98	32.20	5.33
		6/3/1992	752.29	32.30	4.00
		9/1/1992	742.28	52.10	14.00
		12/8/1992	750.45	32.10	5.85
KIF-10B	10B	1/4/1989	749.70	52.10	6.70
		3/28/1989	749.31	52.10	7.09
		7/5/1989	751.90	52.10	4.50
		9/14/1989	751.90	52.10	4.50
		11/30/1989	748.63	--	7.77
		3/13/1990	749.92	52.10	6.48
		6/6/1990	751.12	52.10	5.29
		9/11/1990	750.89	52.00	5.52
		12/10/1990	750.10	52.00	6.31
		3/20/1991	750.49	51.90	5.92
		12/23/1991	751.28	52.10	5.13
		12/8/1992	751.41	52.10	5.00
		12/6/1993	752.85	52.07	3.54
		12/7/1994	751.41	52.03	4.99
		6/22/1995	752.17	51.87	4.27
		12/12/1995	751.08	52.03	5.35
		7/8/1996	752.72	52.03	3.71
		12/2/1996	753.54	52.07	2.89
		5/6/1997	753.28	52.03	3.15
		12/8/1997	754.92	52.03	1.51
		6/29/1998	752.85	52.03	3.58
		12/1/1998	751.67	51.90	4.76
KIF-11B	11B	1/4/1989	761.32	35.01	7.78
		3/28/1989	761.84	35.01	7.26
		6/28/1989	762.50	35.01	6.61
		9/14/1989	757.38	35.01	11.72
		11/30/1989	755.18	--	13.92
		3/7/1990	761.68	34.91	7.41
		6/6/1990	757.64	35.01	11.47
		9/11/1990	757.09	34.91	12.00
		12/10/1990	759.78	34.91	9.32

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-11B (cont.)	11B	3/20/1991	762.43	34.81	6.65
		12/23/1991	760.99	35.01	8.11
		12/8/1992	759.55	35.01	9.56
		12/6/1993	761.78	35.01	7.32
		12/6/1994	758.92	35.01	10.17
		6/19/1995	759.48	34.81	9.61
		12/11/1995	761.02	34.97	8.07
		7/8/1996	760.73	35.01	8.37
		12/2/1996	764.60	35.01	4.49
		5/6/1997	762.76	35.01	6.33
		12/8/1997	761.88	35.01	7.22
		6/29/1998	759.97	35.01	9.12
		12/1/1998	758.27	34.88	10.83
KIF-12A	12A	1/4/1989	761.45	27.30	5.85
		3/29/1989	762.11	27.20	5.84
		6/28/1989	762.11	27.30	5.29
		9/18/1989	761.52	27.30	5.79
		3/14/1990	761.68	27.10	5.62
		6/14/1990	760.93	27.10	6.38
		9/10/1990	760.11	27.00	7.20
		12/6/1990	761.68	27.00	5.62
		3/21/1991	762.01	27.10	5.30
		12/19/1991	762.11	27.20	5.19
		5/27/1992	761.00	--	6.30
		6/3/1992	761.15	27.20	6.15
		12/9/1992	761.78	27.20	5.50
		6/7/1993	761.78	--	5.51
		12/6/1993	762.96	27.07	4.33
		12/6/1994	762.53	27.07	4.76
		6/19/1995	761.48	27.07	5.81
		12/13/1995	762.53	27.10	4.76
		7/8/1996	761.61	27.13	5.68
		12/2/1996	763.68	27.10	3.64
		5/6/1997	763.45	27.13	3.87
		12/8/1997	763.22	27.13	4.10
		6/29/1998	762.60	27.13	4.72
		12/1/1998	761.32	26.97	6.00
KIF-12B	12B	1/4/1989	760.76	56.00	6.35
		3/29/1989	760.79	56.00	6.29
		6/28/1989	761.45	55.91	5.64
		9/18/1989	760.66	56.00	6.43

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-12B (cont.)	12B	12/5/1989	755.12	--	11.99
		3/12/1990	761.09	56.00	6.02
		6/6/1990	760.17	56.00	6.93
		9/10/1990	759.71	55.91	7.40
		12/6/1990	760.99	55.91	6.10
		3/14/1991	761.75	--	5.35
		3/21/1991	761.29	55.81	5.82
		12/19/1991	761.35	56.00	5.75
		5/27/1992	760.37	--	6.73
		6/3/1992	760.43	55.91	6.65
		12/9/1992	760.89	55.91	6.21
		6/7/1993	760.86	--	6.23
		12/6/1993	761.98	55.94	5.12
		12/6/1994	761.42	55.91	5.68
		6/19/1995	760.47	55.84	6.63
		12/13/1995	761.19	55.91	5.91
		7/8/1996	760.56	55.97	6.53
		12/2/1996	762.24	55.97	4.86
		5/6/1997	761.94	55.94	5.15
		12/8/1997	761.65	55.94	5.45
		6/29/1998	761.12	55.94	5.97
		12/1/1998	760.37	55.81	6.73
KIF-13A	13A	1/11/1989	757.91	66.70	11.28
		3/29/1989	758.27	66.60	10.94
		7/5/1989	759.02	66.70	10.19
		12/6/1989	752.99	--	16.20
		3/14/1990	758.53	66.50	10.68
		6/14/1990	758.17	66.50	11.04
		9/10/1990	757.35	66.40	11.85
		12/6/1990	758.14	66.40	11.07
		3/21/1991	759.09	66.40	10.38
		6/6/1991	762.70	66.31	6.50
		9/11/1991	758.66	66.50	10.73
		12/19/1991	759.55	66.50	9.84
		3/4/1992	759.74	66.50	9.64
		6/3/1992	759.51	66.50	9.86
		9/1/1992	756.43	66.50	12.95
		12/8/1992	759.55	66.40	9.85
		6/8/1993	758.89	66.40	10.50
		12/6/1993	759.55	66.44	9.84
		6/14/1994	759.65	66.24	9.74

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-13A (cont.)	13A	12/7/1994	759.06	66.44	10.33
		6/19/1995	758.37	66.14	11.02
		12/13/1995	759.12	66.37	10.27
		7/8/1996	759.38	66.31	10.01
		12/2/1996	759.74	66.34	9.71
		5/6/1997	760.07	66.27	9.38
		12/8/1997	759.19	66.27	10.27
		6/29/1998	759.55	66.27	9.91
		12/1/1998	759.55	66.04	9.91
KIF-13B	13B	1/5/1989	757.45	84.28	13.06
		3/29/1989	757.84	84.42	12.65
		6/29/1989	758.60	84.42	11.90
		9/14/1989	757.68	84.42	12.82
		12/5/1989	755.51	--	14.99
		3/12/1990	758.20	84.19	12.29
		6/6/1990	757.55	84.42	12.94
		9/10/1990	757.45	84.28	13.05
		12/6/1990	757.81	84.19	12.70
		3/21/1991	746.59	84.28	11.92
		12/19/1991	759.25	84.42	11.26
		3/4/1992	759.35	84.42	11.16
		6/3/1992	759.12	84.42	11.37
		9/1/1992	748.39	84.42	22.12
		12/8/1992	761.19	84.42	9.31
		12/8/1993	758.60	84.38	11.91
		12/7/1994	758.56	84.38	11.94
		6/19/1995	757.91	84.38	12.60
		12/12/1995	758.53	84.38	11.98
		7/8/1996	758.99	84.38	11.52
		12/2/1996	758.92	84.38	11.58
		5/6/1997	759.15	84.38	11.35
		12/8/1997	758.23	84.38	12.27
		6/29/1998	758.60	84.38	11.91
		12/1/1998	758.37	84.38	12.14
		12/6/1999	759.22	84.32	11.29
		12/14/2000	759.68	84.38	10.83
		6/27/2001	760.24	84.38	10.27
		12/31/2001	760.66	84.38	9.84
		6/28/2002	760.70	84.38	9.81
		1/8/2003	760.11	84.38	10.40
		6/16/2003	761.32	84.32	9.19

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-13B (cont.)	13B	9/2/2003	758.53	84.38	11.98
		12/29/2003	760.56	84.65	9.94
		3/10/2004	760.96	84.25	9.55
		6/7/2004	760.70	84.25	9.81
		9/13/2004	760.33	84.25	10.17
		12/6/2004	763.45	--	7.05
		3/14/2005	760.83	84.25	9.68
		6/1/2005	760.34	84.25	10.17
		12/13/2005	760.70	84.25	9.81
		6/6/2006	761.38	84.25	9.12
		12/15/2006	761.78	84.25	8.73
		6/5/2007	761.98	84.25	8.53
		12/3/2007	762.24	84.25	8.27
		6/2/2008	762.76	84.25	7.74
		12/2/2008	762.57	84.25	7.94
		6/11/2009	761.81	84.25	8.69
		9/14/2009	761.35	84.25	9.28
		10/14/2009	762.24	--	8.27
		10/19/2009	762.24	84.25	8.04
		11/5/2009	761.75	--	8.76
		11/17/2009	762.40	84.25	8.10
		11/24/2009	761.75	--	8.76
		12/1/2009	761.55	--	8.96
		12/15/2009	762.70	84.25	7.81
		12/22/2009	762.30	--	8.20
		12/28/2009	761.84	--	8.66
KIF-15A	15A	1/3/1989	788.71	28.22	7.40
		3/30/1989	788.12	28.22	7.99
		7/5/1989	788.02	28.22	8.08
		9/18/1989	787.24	28.08	8.87
		12/5/1989	784.15	--	11.95
		3/12/1990	788.71	27.99	7.40
		6/7/1990	785.89	28.22	10.21
		9/6/1990	785.79	27.99	10.32
		12/5/1990	787.66	27.99	8.43
		3/15/1991	788.29	27.99	7.82
		6/4/1991	788.32	27.99	7.79
		9/11/1991	785.50	28.08	10.59
		12/23/1991	787.04	28.22	9.06
		12/10/1992	786.25	28.22	9.84
		6/9/1993	785.27	28.22	10.83

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-15A (cont.)	15A	12/6/1993	788.52	28.18	7.58
		6/14/1994	787.27	28.15	8.83
		12/8/1994	787.14	28.22	8.96
		6/19/1995	785.93	28.15	10.17
		12/14/1995	786.71	28.12	9.38
		7/8/1996	785.79	28.18	10.30
		12/2/1996	789.17	28.08	6.89
		5/6/1997	787.80	28.15	8.27
		12/8/1997	786.88	28.15	9.19
		6/29/1998	785.96	28.15	10.10
		12/1/1998	785.14	28.05	10.93
KIF-15B	15B	1/3/1989	791.31	46.78	4.60
		3/30/1989	791.11	46.69	4.79
		7/5/1989	790.88	46.78	5.03
		9/18/1989	789.63	46.69	6.27
		12/5/1989	787.96	--	7.94
		3/8/1990	790.49	46.49	5.41
		6/7/1990	788.45	46.69	7.44
		9/6/1990	788.02	46.49	7.87
		12/5/1990	789.70	46.49	6.20
		3/15/1991	791.11	46.49	4.79
		12/23/1991	789.30	46.69	6.60
		12/10/1992	788.65	46.69	7.26
		6/9/1993	788.68	46.59	7.22
		12/6/1993	790.49	46.69	5.41
		6/14/1994	789.73	46.65	6.17
		12/8/1994	789.24	46.72	6.66
		6/19/1995	788.25	46.62	7.64
		12/14/1995	789.27	46.65	6.63
		7/8/1996	788.39	46.69	7.51
		12/2/1996	791.80	46.69	4.07
		5/6/1997	790.58	46.69	5.28
		12/8/1997	788.91	46.69	6.96
		6/29/1998	788.62	46.69	7.25
		12/1/1998	786.12	46.56	9.74
KIF-6AR	6AR	9/14/2009	740.55	38.45	11.65
		12/17/2009	737.57	38.45	14.63
		3/10/2010	736.19	38.45	16.01
		4/19/2010	743.24	38.45	13.16
		6/16/2010	741.08	38.45	11.12
		8/25/2010	740.58	38.45	11.61

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-6AR (cont.)	6AR	9/28/2010	740.49	38.45	11.71
		12/15/2010	736.02	38.45	16.17
		2/8/2011	735.53	38.45	16.67
		6/29/2011	736.32	42.81	15.88
		8/3/2011	736.12	38.45	16.08
		12/5/2011	733.17	38.45	19.03
		1/25/2012	736.61	38.45	15.58
		6/18/2012	736.25	38.45	15.94
		12/10/2012	732.74	38.45	19.46
		6/24/2013	736.42	38.45	15.78
		12/4/2013	732.45	38.45	19.75
		6/11/2014	736.52	38.45	15.68
		12/10/2014	732.84	38.45	19.36
		6/18/2015	736.61	38.45	15.58
		9/23/2015	736.22	38.45	15.98
		12/2/2015	736.65	38.45	15.55
		3/23/2016	731.33	38.45	20.87
		6/15/2016	734.51	38.45	17.68
		9/22/2016	734.58	38.45	17.62
		12/1/2016	731.15	38.45	21.03
		3/2/2017	736.78	38.45	21.23
		6/7/2017	740.90	44.70	17.11
KIF-AD1	AD-1	6/11/2009	771.72	35.60	8.27
		9/15/2009	770.08	35.60	9.91
		10/14/2009	773.33	35.60	6.66
		10/19/2009	775.26	--	4.72
		11/5/2009	774.80	--	5.18
		11/10/2009	773.00	--	6.99
		11/17/2009	774.02	35.60	5.97
		11/24/2009	772.51	--	7.48
		12/1/2009	772.34	--	9.88
		12/10/2009	775.69	--	4.30
		12/15/2009	776.05	35.60	4.30
		12/22/2009	776.05	--	3.94
		12/28/2009	775.98	--	4.00
		1/4/2010	774.31	--	5.68
		1/11/2010	773.16	35.60	6.82
		1/19/2010	774.25	--	5.74
		1/25/2010	776.35	--	3.64
		2/1/2010	775.85	--	4.13
		2/9/2010	776.15	--	3.84

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-AD1 (cont.)	AD-1	2/16/2010	774.64	35.60	5.35
		2/22/2010	773.62	--	6.36
		3/8/2010	772.97	35.60	7.02
		4/13/2010	773.43	35.60	6.56
		5/10/2010	774.41	35.60	5.58
		6/15/2010	773.03	35.60	6.96
		7/13/2010	772.08	35.60	7.91
		9/27/2010	771.42	35.60	8.56
		12/16/2010	773.33	35.60	6.66
		1/20/2011	773.82	35.60	6.17
		3/8/2011	776.38	35.60	3.61
		6/28/2011	772.05	35.60	7.94
		9/27/2011	772.77	35.60	7.22
		12/6/2011	775.07	35.60	4.82
		3/20/2012	776.08	35.60	3.94
		6/19/2012	770.34	35.60	9.65
		9/17/2012	770.47	35.60	9.51
		12/11/2012	771.33	35.60	8.66
		3/18/2013	775.39	35.60	4.59
		6/25/2013	772.83	35.60	7.15
		9/4/2013	771.56	35.60	8.43
		12/2/2013	773.49	35.60	6.50
		3/5/2014	775.82	35.60	4.17
		6/10/2014	771.52	35.60	8.46
		9/16/2014	771.75	35.60	8.23
		12/9/2014	775.69	35.60	4.30
		3/10/2015	776.01	35.60	3.97
		6/16/2015	771.06	35.60	8.92
		9/22/2015	771.65	35.60	8.33
		11/30/2015	773.98	35.60	6.00
		3/21/2016	773.00	35.60	6.99
		6/13/2016	770.44	35.60	9.55
		9/20/2016	768.31	35.60	11.68
		11/28/2016	766.79	35.60	13.19
		2/28/2017	774.08	35.60	7.05
		6/5/2017	722.13	35.70	9.00
KIF-AD2	AD-2	6/11/2009	749.67	26.31	6.99
		9/15/2009	748.98	26.31	7.68
		10/13/2009	749.25	26.31	7.41
		10/19/2009	749.54	--	7.12
		11/5/2009	749.02	--	7.64

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-AD2 (cont.)	AD-2	11/10/2009	748.29	--	8.37
		11/16/2009	748.88	26.31	7.78
		11/24/2009	748.03	--	8.63
		12/1/2009	746.78	--	7.81
		12/10/2009	749.48	--	7.19
		12/14/2009	749.15	26.31	7.48
		12/22/2009	748.23	--	8.43
		12/28/2009	747.38	--	9.28
		1/4/2010	746.56	--	10.10
		1/12/2010	746.33	26.31	10.33
		1/19/2010	746.59	--	10.07
		1/25/2010	749.44	--	7.22
		2/1/2010	747.77	--	8.89
		2/9/2010	748.82	--	7.84
		2/17/2010	746.92	26.31	9.74
		2/22/2010	746.59	--	10.07
		3/8/2010	746.06	26.31	10.60
		4/12/2010	747.34	26.31	9.32
		5/11/2010	748.33	26.31	8.33
		6/15/2010	748.46	26.31	8.20
		7/12/2010	748.20	26.31	8.46
		9/22/2010	747.97	26.31	8.69
		12/16/2010	746.23	26.31	10.43
		1/20/2011	746.13	26.31	10.53
		3/7/2011	748.06	26.31	8.60
		6/28/2011	747.93	26.31	8.73
		9/28/2011	747.80	26.31	8.83
		12/6/2011	745.90	26.31	10.63
		3/19/2012	746.72	26.31	9.94
		6/20/2012	747.57	26.31	9.09
		9/17/2012	747.70	26.31	8.96
		12/12/2012	746.00	26.31	10.66
		3/19/2013	745.90	26.31	10.76
		6/25/2013	747.38	26.31	9.28
		9/3/2013	747.44	26.31	9.22
		12/3/2013	745.64	26.31	11.02
		3/5/2014	746.42	26.31	10.24
		6/9/2014	748.16	26.31	8.50
		9/15/2014	747.93	26.31	8.73
		12/9/2014	746.33	26.31	10.33
		3/9/2015	746.62	26.31	10.04

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-AD2 (cont.)	AD-2	6/18/2015	747.93	26.31	8.73
		9/21/2015	747.83	26.31	8.83
		12/2/2015	748.33	26.31	8.33
		3/23/2016	745.28	26.31	11.38
		6/14/2016	746.82	26.31	9.84
		9/21/2016	747.44	26.31	9.22
		12/1/2016	745.02	26.31	11.65
		3/1/2017	744.70	26.31	12.40
		6/7/2017	746.86	28.60	10.24
KIF-AD3	AD-3	6/11/2009	744.32	18.50	7.41
		9/15/2009	743.90	18.50	7.84
		10/13/2009	744.39	18.50	7.35
		10/19/2009	744.32	--	7.41
		11/5/2009	744.19	--	7.55
		11/10/2009	744.06	--	7.68
		11/16/2009	744.09	18.50	7.64
		11/24/2009	743.90	--	7.84
		12/1/2009	743.93	--	8.96
		12/10/2009	744.29	--	7.45
		12/14/2009	744.36	18.50	7.41
		12/22/2009	743.83	--	7.91
		12/28/2009	743.73	--	8.01
		1/4/2010	743.54	--	8.20
		1/13/2010	743.34	18.50	8.40
		1/19/2010	743.80	--	7.94
		1/25/2010	744.46	--	7.28
		2/1/2010	744.16	--	7.58
		2/9/2010	744.19	--	7.55
		2/17/2010	743.60	18.50	8.14
		2/22/2010	744.06	--	7.68
		3/9/2010	743.41	18.50	8.33
		4/13/2010	743.77	18.50	7.97
		5/10/2010	744.19	18.50	7.55
		6/14/2010	744.23	18.50	7.51
		7/13/2010	744.49	18.50	7.25
		9/23/2010	743.93	18.50	7.81
		12/17/2010	744.00	18.50	7.74
		1/20/2011	743.83	18.50	7.91
		2/8/2011	743.64	18.50	--
		3/7/2011	744.36	18.50	7.38
		6/27/2011	744.23	18.50	7.51

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-AD3 (cont.)	AD-3	8/3/2011	743.70	18.50	8.04
		9/27/2011	744.46	18.50	7.28
		1/25/2012	744.39	18.50	7.35
		3/20/2012	744.39	18.50	7.38
		6/20/2012	743.57	18.50	8.17
		9/18/2012	745.70	18.50	6.04
		12/11/2012	744.78	18.50	6.96
		3/19/2013	744.32	18.50	7.41
		6/26/2013	743.93	18.50	7.81
		9/4/2013	743.67	18.50	8.07
		12/3/2013	743.93	18.50	7.81
		3/4/2014	744.32	18.50	7.41
		6/10/2014	743.41	18.50	8.33
		9/15/2014	744.09	18.50	7.64
		12/8/2014	744.26	18.50	7.48
		3/11/2015	744.62	18.50	7.12
		6/17/2015	744.03	18.50	7.71
		9/23/2015	743.77	18.50	7.97
		12/1/2015	744.62	18.50	7.12
		3/22/2016	743.31	18.50	8.43
		6/13/2016	743.18	18.50	8.56
		9/21/2016	743.41	18.50	8.33
		11/30/2016	743.05	18.50	8.69
		3/2/2017	743.31	18.50	8.99
		6/6/2017	743.88	18.90	8.42
KIF-GW01	GW-01	10/5/2010	773.00	56.30	8.30
		9/17/2014	773.98	56.30	7.32
		12/8/2014	779.53	56.30	1.77
		3/10/2015	780.42	56.30	0.89
		6/17/2015	773.82	56.30	7.48
		9/22/2015	774.28	56.30	7.02
		11/30/2015	776.21	53.58	5.09
		3/22/2016	777.03	53.58	4.27
		6/14/2016	773.59	53.58	7.71
		9/20/2016	772.05	48.95	15.35
		11/29/2016	770.51	48.95	15.29
		2/28/2017	775.99	48.95	13.94
		6/6/2017	772.11	57.00	9.46
KIF-TWP-06	TWP-06	9/30/2010	775.23	65.72	13.75
KIF-TWP-26	TWP-26	10/4/2010	758.86	115.75	11.61

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-GW-02	GW-02	10/12/2010	751.05	23.03	18.73
		6/5/2017	756.30	49.00	13.81
KIF-22	22	1/8/2003	740.35	46.26	16.04
		6/16/2003	742.49	46.23	13.91
		9/2/2003	741.73	46.26	14.67
		12/29/2003	739.11	46.23	17.29
		6/7/2004	742.55	46.26	13.85
		9/13/2004	742.72	46.26	13.68
		12/6/2004	741.77	--	14.63
		6/1/2005	745.08	46.26	11.32
		12/13/2005	738.85	46.26	17.55
		6/6/2006	742.88	46.26	13.52
		12/15/2006	739.14	46.26	17.26
		6/5/2007	741.99	46.26	14.40
		12/3/2007	739.99	46.26	16.40
		6/2/2008	742.39	46.26	14.01
		12/2/2008	739.01	46.26	17.39
		6/10/2009	742.95	46.26	13.45
		9/14/2009	741.99	46.26	14.07
		12/16/2009	740.72	46.26	15.68
		3/11/2010	739.21	46.26	16.86
		4/19/2010	735.60	48.33	18.01
		6/16/2010	740.42	46.26	15.98
		8/25/2010	739.01	46.26	17.06
		9/29/2010	741.80	46.26	16.47
		12/15/2010	736.32	46.26	20.08
		6/29/2011	742.09	46.26	16.17
		8/3/2011	741.73	46.26	16.54
		12/5/2011	739.27	46.26	19.00
		6/18/2012	740.98	46.26	17.29
		12/10/2012	737.47	46.26	20.80
		6/24/2013	741.04	46.26	17.22
		8/15/2013	741.14	46.26	17.13
		12/4/2013	737.30	46.26	20.96
		6/11/2014	741.04	46.26	17.22
		12/10/2014	737.50	46.26	20.77
		6/22/2015	741.04	46.26	17.22
		9/28/2015	740.72	46.26	17.55
		12/7/2015	739.07	46.26	19.19
		3/28/2016	736.61	46.26	21.65
		6/22/2016	739.67	46.26	18.60

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Water Level Depth (ft)	Water Level Depth (ft)
KIF-22 (cont.)	22	9/27/2016	739.63	46.26	18.64
		12/5/2016	736.44	46.26	21.82
		3/6/2017	737.20	46.26	21.92
		6/12/2017	738.07	50.50	21.05

Note: Groundwater elevation data for WBF-100 will be included at a later date.

-- no data

cont. - continued

ft - feet

ft amsl - feet above mean sea level

GW - groundwater

Ref. - reference

Well ID - well identification

APPENDIX O
WELL 22 RECORDS

MONITORING WELL INSTALLATION RECORD

PROJECT: Kingston Fossil Plant

WELL NUMBER: KIF-22 | INSTALLATION DATE: July 10, 2002

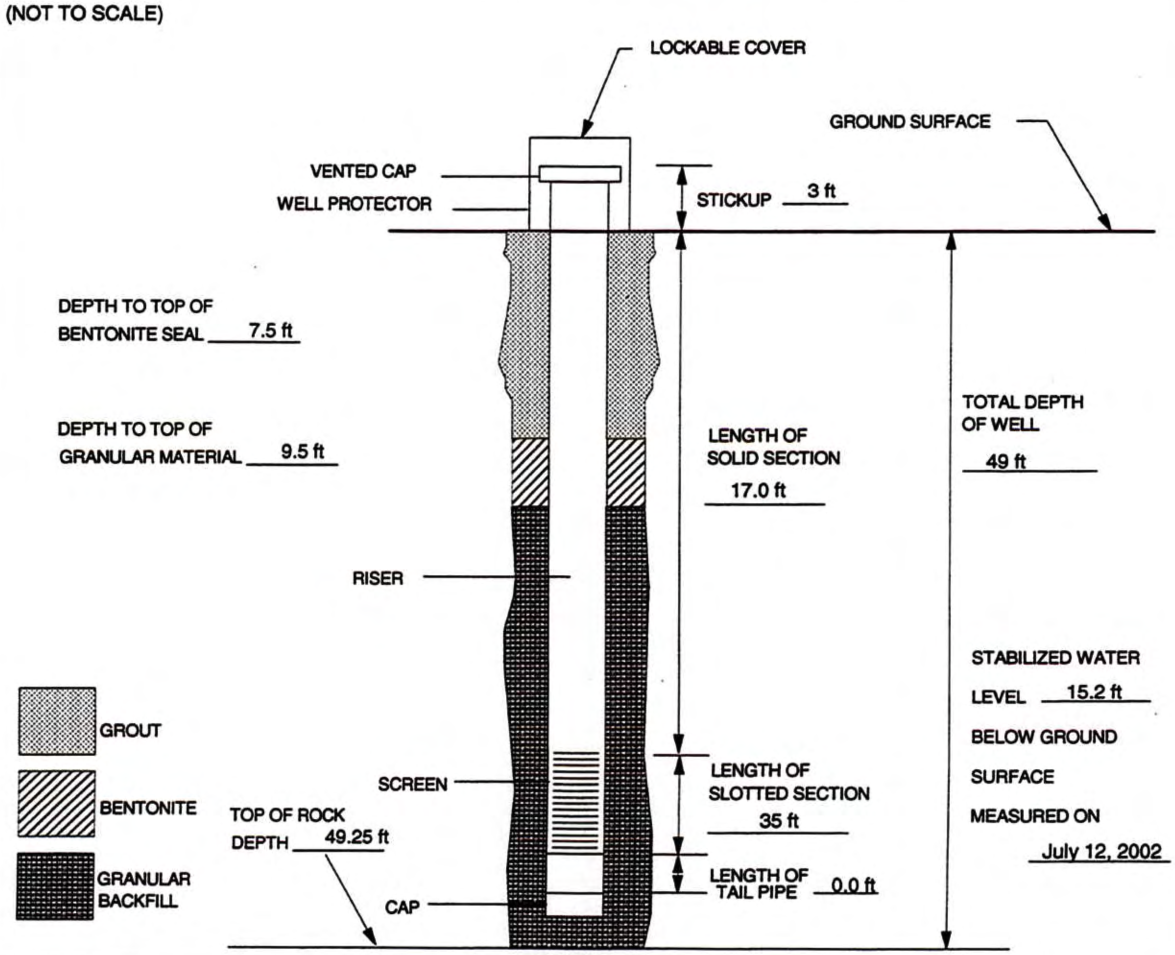
TOP OF INNER CASING: 756.2 ft-msl | CASING MATERIAL: PVC Sch 80

DRILLING TECHNIQUE: Hollow-Stem Auger | BOREHOLE DIAMETER: 8 1/4 in.

DRILLED BY: Lynn England | LOGGED BY: Jim Overton

COMMENTS: Filter sand was placed into the annulus from the bottom up with a sand injector.
Soil descriptions were taken from split spoon sampler.
Well completed with 4 inch by 4 inch by 5 foot lockable steel well protector and a 4 foot diameter concrete pad.
Four steel bollards were placed around the concrete pad.

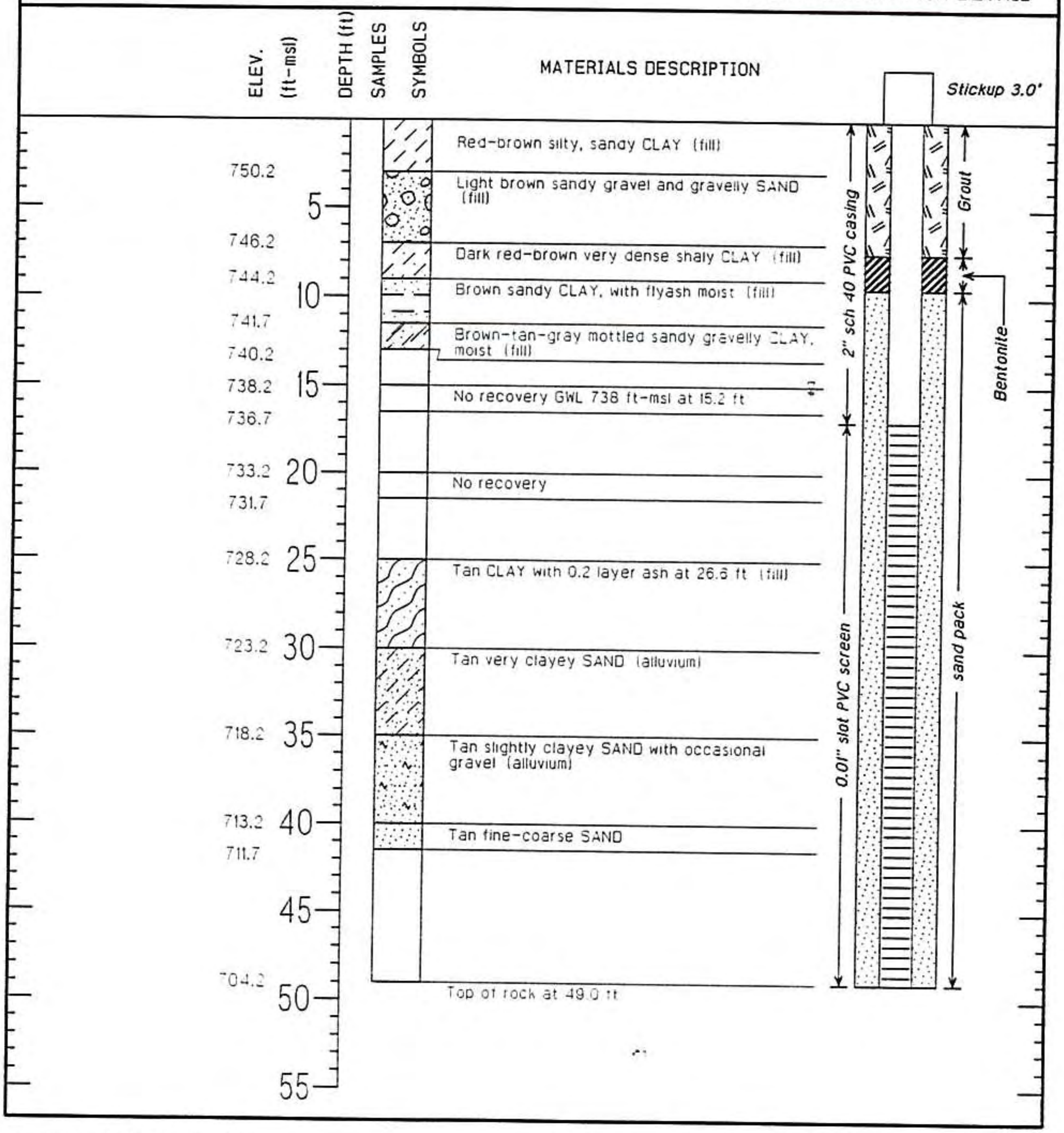
(NOT TO SCALE)



Tennessee Valley Authority

MONITORING WELL KIF-22

WELL CONSTRUCTION DETAIL



PROJECT Kingston Fossil Plant

DRILLING COMPANY TVA Field Engineering

LOCATION Kingston, TN

DATE DRILLED 07/10/02

DRILL RIG Hollow Stem Auger

SURFACE ELEVATION 753.2 ft-msl

LOGGER/ENGINEER Jim Overton

T.O.C. ELEVATION 756.2 ft-msl

WATER LEVEL (INITIAL) 15.2 ft

WATER LEVEL (24-HOUR) ft

EAST 2442754.9

NORTH 555694.2

APPENDIX P
STABILITY SAP

Stability
Sampling and Analysis Plan
Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
2	Addresses December 8, 2017 TDEC Review Comments and Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Issued for TDEC Approval	November 9, 2018

STABILITY
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Stability
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018 Revision 4

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	11/6/18 Date
McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.11.05 10:13:02 -05'00' TVA Investigation Field Lead	Date
Stanley Nixon Jr Health, Safety, and Environmental (HSE) Manager	11-7-18 Date
Investigation Project Manager	10/24/2018 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.11.05 20:33:05 -05'00' QA Oversight Manager	Date
Ryan Jones Laboratory Project Manager	10/24/2018 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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF 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 stability analyses at KIF (the Plant) has been identified. This Stability Sampling and Analysis Plan (SAP) has been prepared to outline the proposed analyses and the methods to be employed during the Investigation.

2.0 OBJECTIVES

The purpose of this Stability SAP is to outline the methods that will be used to execute the following activities:

- Develop slope stability models (including material parameters) and perform slope stability analyses for selected CCR units.
- Document the analyses in the EAR.

3.0 HEALTH AND SAFETY

Implementation of this SAP does not include field work. A Health and Safety Plan (HASP) is not required.

4.0 PLANT-SPECIFIC STABILITY ANALYSIS PLAN

The proposed stability analyses were selected to aid in addressing data gaps and supplementing existing data, as necessary to address information requests of the TDEC Multi-site Order for KIF. Rationale for individual analyses are discussed below.

Table 1 provides the stability analyses (i.e., load cases) proposed for each CCR unit. In cases where new analyses are not proposed, existing analyses adequately address the load case(s) for the unit. For more information on these existing analyses, refer to the Evaluation of Existing Geotechnical Data Appendix.

Table 1. Stability Analyses Proposed for each CCR Unit

CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Pseudostatic[1], Global	Pseudostatic[1], Veneer[2]	Post-EQ[3], Global
Interim Ash Staging Area (Closed Condition)					
Sluice Trench and Ballfield East of Sluice Trench (Closed Condition)	X	X	X	X	X
Stilling Pond (Closed Condition)					

[1] Pseudostatic, correlated to a tolerable displacement.
[2] Veneer stability is the slope stability of the final cover.
[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.

The rationale for the proposed analyses is as follows:

- Slope stability calculations are not required to demonstrate performance of the closed Interim Ash Staging Area due to the higher surrounding grade, flat closure grading, and containment towards the east by the Polishing Pond.
- In 2017, a graded filter was constructed along the outslope of the East Dike. The Sluice Trench and Ballfield East of Sluice Trench lacks documented static and seismic slope stability analyses for the current, closed geometry.
- The ongoing reassessment of the Stilling Pond closure design will include analyses sufficient to address the necessary load cases.
- Other load cases that are not proposed in Table 1 have existing analyses that are representative.

Loading conditions and results from the analyses will be documented within the EAR. For proposed stability analyses, recent water levels, including those measured per the EIP will be considered. When existing stability analyses are to be leveraged, recent water levels will be compared to the modeled levels to confirm that the analyses are still suitable.

Refer to Figure 1 in Attachment A for a layout of proposed analysis cross section locations. The selected locations represent critical cross sections based on reviews of previous stability analysis results, subsurface stratigraphy, material properties, and structure geometry. For selection of analysis section(s) for post-earthquake stability, the location of potentially liquefiable materials is also considered. Proposed section locations may be adjusted based on the methodology in Section 5.1.

5.0 TECHNICAL APPROACH

This section provides a framework for the procedures that will be used to perform the proposed slope stability analyses. Within this framework, industry standard engineering practices will be employed to execute the work. Individual engineering decisions cannot be prescribed, as they are dependent on the site conditions, available information, type of analysis, and other factors. Details of each analysis, including engineering judgments, will be documented in the EAR.

5.1 ANALYSIS FRAMEWORK

5.1.1 Load Cases

The load cases to be evaluated 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,
- Seismic, pseudostatic global stability,
- Seismic, pseudostatic veneer stability,
- Seismic, post-earthquake global stability (includes a preceding liquefaction triggering assessment).

5.1.2 Phased Assessment and Acceptance Criteria

The stability analyses will be performed using a phased assessment process. Initial phases employ available site information, simplified analysis methods, and more conservative acceptance criteria. If acceptable performance is demonstrated, the analyses for the particular load case(s) are complete. If not, the next phase may include collection of additional site information and/or more advanced analysis methods. Less conservative acceptance criteria may be utilized, commensurate with the improved site characterization. The process may continue through multiple phases, as outlined below. The use of a phased approach is consistent with industry standard engineering practices.

The load cases and acceptance criteria presented herein (Table 2) apply specifically for the TDEC Order. The same CCR units may also be subject to other requirements (which may be more or less stringent) for compliance with other regulations such as state permitting, CCR Rule, etc.

Phase 1 Assessment

- Use available geotechnical data (Standard Penetration Testing (SPT), Cone Penetration Testing (CPT), lab testing, etc.)
  - Where geotechnical data is insufficient, collect supplemental CPT data
- Compute static, long-term factor of safety (global, FS_{static} and veneer, $FS_{static\text{-}veneer}$ slope stability)
- For seismic load cases, use site-specific design earthquake loading
  - If not already available, TVA will perform site-specific seismic hazards assessment (Section 5.4.2)
- Complete liquefaction triggering assessment based on SPT and CPT data
- Compute pseudostatic factor of safety (global, FS_{pseudo} and veneer, $FS_{pseudo\text{-}veneer}$ slope stability)
  - Using Newmark displacement analyses, compute displacements for range of yield accelerations
  - Select pseudostatic coefficient equal to yield acceleration that gives displacement of 3 feet in the Newmark analysis
  - Assign strengths considering results of liquefaction assessment
  - Compute pseudostatic FS_{pseudo} and $FS_{pseudo\text{-}veneer}$
- Compute static, post-earthquake factor of safety (global slope stability)
  - Assign pseudostatic coefficient equal to zero (static case)
  - Assign strengths considering results of liquefaction assessment
  - Compute post-earthquake $FS_{post\text{-}EQ}$
- Performance is acceptable if the following criteria are met
  - $FS_{static} \geq 1.5$
  - $FS_{static\text{-}veneer} \geq 1.5$
  - $FS_{pseudo} \geq 1.0$
  - $FS_{pseudo\text{-}veneer} \geq 1.0$

- $FS_{post\text{-}EQ} \geq 1.1$

- If any load cases do not meet criteria, go to Phase 2

- During the Phase 1 stability assessment, TVA will work with TDEC to define criteria for acceptable performance that would be utilized during a potential Phase 4 (the final phase) of the proposed phased stability assessment. The factors that contribute to defining acceptable performance will be site-specific and related to the consequences of the predicted deformations. As more site-specific information becomes available after Phase 1, TVA and TDEC may need to revisit the acceptable performance criteria in light of the additional information.

Phase 2 Assessment

- Perform additional site explorations in targeted areas
    - Critical areas to be identified by parametric analyses
    - SPT using mud rotary drilling (or other suitable drilling method)
    - Seismic CPT soundings (companion to SPT locations)
    - Lab testing tailored to analysis needs (including triaxial and/or direct shear strength testing, as applicable)
- Compute static factor of safety
    - Update Phase 1 analyses with new site data
- Complete liquefaction triggering assessment
    - Update Phase 1 analyses with new site data
- Compute pseudostatic factor of safety
    - Update Phase 1 analyses with new site data
- Compute post-earthquake factor of safety
    - Update Phase 1 analyses with new site data
- Performance is acceptable if the following criteria are met
    - $FS_{static} \geq 1.5$
    - $FS_{static\text{-}veneer} \geq 1.5$

- $FS_{pseudo} \geq 1.0$
- $FS_{pseudo\text{-}veneer} \geq 1.0$
- $FS_{post\text{-}EQ} \geq 1.0$ (lower criteria based on improved site characterization)

- If any load cases do not meet criteria, go to Phase 3

Phase 3 Assessment

- Perform a nonlinear deformation analysis (FLAC, OpenSees, or other appropriate code) to estimate displacements
- Performance is acceptable if representative displacement ≤ 3 feet
- If representative displacement > 3 feet, go to Phase 4

Phase 4 Assessment

- Consider the consequences (impacts to human health and/or environment) of the predicted deformations
- As more site-specific information becomes available after Phase 1, TVA and TDEC may need to revisit the acceptable performance criteria in light of the additional information.

Note that the tolerable displacement is subject to adjustment based on site-specific features and consequences of specific failure modes.

Table 2. Summary of Load Cases and Acceptance Criteria

Load Case	Pool Levels	Incipient Motion	Analysis	Soil Strengths	Pore Pressures	Acceptance Criteria
Static, Long-Term, Global and Veneer	Impoundment (where applicable): Normal Operating Pool Adjacent Reservoir: Winter Pool	Inboard (Impoundments Only) and Outboard	Drained	Drained Static	Seepage for Modeled Pool Levels and/or Piezometer Data	FS ≥ 1.5
Pseudostatic, Global and Veneer	Impoundment (where applicable): Normal Operating Pool Adjacent Reservoir: Winter Pool	Inboard (Impoundments Only) and Outboard	Undrained Seismic	Undrained Seismic	Seepage for Modeled Pool Levels and/or Piezometer Data	FS ≥ 1.0 (Correlated to tolerable displacement of 3 feet[1])
Post-Earthquake, Global	Impoundment (where applicable): Normal Operating Pool Adjacent Reservoir: Winter Pool	Inboard (Impoundments Only) and Outboard	Undrained Static	Undrained Seismic; Residual Strengths in Liquefied Materials	Seepage for Modeled Pool Levels and/or Piezometer Data	FS ≥ 1.1 (Phase 1); FS ≥ 1.0 (Phase 2); Representative displacement ≤ 3 feet[1] (Phase 3)

[1] Tolerable displacement subject to adjustment based on site-specific features and consequences of specific failure modes.

5.1.3 Basis for Load Cases and Acceptance Criteria

There are no established closure design criteria for certain categories of CCR units that are not regulated under the CCR Rule. The US Environmental Protection Agency (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."

To establish the closure design criteria presented herein, relevant standards from the landfill and embankment dam industries were considered. The following industries or agencies were considered when selecting the appropriate load cases and acceptance criteria:

- State of Tennessee solid waste landfill design guidance (TDEC, date unknown),
- EPA municipal solid waste landfill (i.e., RCRA Subtitle D) design guidance (Richardson et al. 1995),
- EPA CCR Rule requirements,
- US Army Corps of Engineers (USACE) embankment dam design guidance (Hynes-Griffin and Franklin 1984),
- TVA embankment dam design guidance (TVA 2016). (Note that the analysis load cases and acceptance criteria are based upon and generally consistent with other industry standards, such as the dam safety criteria of the U.S. Army Corps of Engineers and the Federal Energy Regulatory Commission.)

5.1.3.1 Static Loading

For static loading, the landfill and embankment dam practices are generally in agreement that long-term (i.e., normal operating condition) loading should be analyzed for global slope stability. For landfills with a final cover that may consist of relatively thin layer(s) of materials, the long-term veneer stability should also be analyzed. The reviewed guidance documents generally agree that a static, long-term factor of safety of 1.5 for both global and veneer slope stability is appropriate, and this criterion is applied herein.

Other common static load cases, such as end-of-construction loading, flood loading and sudden drawdown loading are not applicable to existing landfills or surface impoundments that no longer impound water.

5.1.3.2 Seismic Loading

For seismic loading, the landfill and embankment dam practices are less consistent on the load cases to consider and the associated acceptance criteria. However, there is general consensus that because earthquake loading is less probable than static loading, that lower factors of safety and some permanent displacement can be accepted.

In the case of landfills, the tolerable displacement is typically related to the potential damage to components (liners, leachate collection pipes, covers, etc.) and the ability to make repairs after the earthquake. In the case of embankment dams, the tolerable displacement is typically related to preventing uncontrolled loss of pool, potential damage to internal components (sand filters, drainage pipes, etc.), and ability to make repairs after the earthquake.

Seismic loading is commonly evaluated by considering two scenarios:

- Stability during shaking, either using pseudostatic slope stability analyses or simplified displacement analyses,
- Stability immediately after shaking, using static, post-earthquake stability analyses that consider liquefaction potential and associated reductions in shear strength.

5.1.3.2.1 Pseudostatic Stability

There is general consensus that seismic-induced displacements are key to judging acceptable performance during and after the earthquake. However, the most common difference between various design guidance is whether to perform pseudostatic analyses (which can infer tolerable displacement) or to perform simplified displacement analyses (which estimate displacements directly). Depending on how the pseudostatic seismic coefficient is derived (i.e., the degree of conservatism), the slope stability analysis may or may not be a good index of displacement.

TDEC guidance for solid waste landfills judges acceptable performance based on results of simplified displacement analyses (Newmark sliding block or similar analysis). TDEC does not have acceptance criteria based on a pseudostatic slope stability factor of safety. Two acceptance criteria were established to "…insure that the landfill liner, leachate collection system and landfill appurtenances will remain functional when subjected to earthquake induced forces." The acceptance criteria are as follows:

- "Leachate collection systems and waste cells shall be designed to function without collection pipes for solid waste fill embankments that are predicted to undergo more than six inches of deformation."

- "No landfill shall be acceptable if the predicted seismic induced deformations within the waste fill exceed one-half the thickness of the clay liner component of the liner system."

In many cases, inactive CCR landfills and/or CCR surface impoundments that no longer impound water do not include leachate collection systems or engineered bottom liners, and can tolerate greater seismic displacements. As such, the above acceptance criteria are considered overly conservative and not applicable.

In contrast, CCR Rule has acceptance criteria based on a pseudostatic slope stability factor of safety of 1.0. The means to derive an appropriate pseudostatic seismic coefficient are not defined in the CCR Rule. In order to perform CCR Rule demonstrations, TVA has developed a method whereby the coefficient is correlated to a site-specific tolerable displacement. As a result, a factor of safety of 1.0 equates to the tolerable displacement. A factor of safety less than 1.0 would imply displacements that exceed the tolerable value.

EPA guidance for solid waste landfills and USACE and TVA guidance for embankment dams employ phased approaches. A pseudostatic slope stability analysis is performed, and if acceptance criteria ($FS_{pseudo} \geq 1.0$ for EPA and USACE; 1.1 or 1.0 for TVA depending on how well the site is characterized) are met it is implied that displacements are tolerable. The analysis methods recommended by EPA and USACE are correlated to tolerable displacements of 12 inches and 1 meter, respectively. If acceptance criteria are not met, a simplified displacement analysis is then performed. The estimated displacements are compared against tolerable displacement that is based on site-specific features and/or consequences.

In most cases, inactive CCR landfills and/or CCR surface impoundments that no longer impound water do not include leachate collection systems or engineered bottom liners, and can tolerate greater seismic displacements. Therefore, for pseudostatic slope stability (global), an acceptable factor of safety of 1.0 ($FS_{pseudo} \geq 1.0$) which is correlated to a tolerable displacement of 3 feet will be employed. Based on a series of seismic displacement analyses for a variety of earthquakes and site conditions, Hynes-Griffin and Franklin (1984) conclude that if FS_{pseudo} is greater than or equal to one, that the slope deformations should be tolerable for an embankment dam (they define tolerable as displacements less than 1 meter, or about 3 feet). The tolerable displacement is subject to adjustment based on site-specific features and consequences of specific failure modes.

With respect to veneer (i.e., final cover) slope stability during an earthquake, there is consensus that more permanent displacement is tolerable because of the low probability of the earthquake and the ability to repair the final cover. For solid waste landfills, EPA still suggests an acceptable factor of safety of 1.0, but states:

> "For cover systems, where permanent seismic deformations may be observed in post-earthquake inspections and damage to components can be repaired, larger permanent deformations may be considered acceptable. In fact, some regulatory agencies consider seismic deformations of the landfill cover system primarily a maintenance problem."

Indeed, the TDEC guidance for solid waste landfills requires a factor of safety of 1.0 but acknowledges design flexibility for final cover displacements that occur due to the earthquake:

> "Presently, it is the opinion of the Solid Waste Division that this type of failure mechanism will generally not result in a catastrophic type of failure. Therefore, some flexibility will be given for the design of the stability of landfill cover systems."

Therefore, for pseudostatic slope stability (veneer), an acceptable factor of safety of 1.0 ($FS_{pseudo\text{-}veneer} \geq 1.0$) which is correlated to a tolerable displacement of 1 meter (approximately 3 feet) will be employed. The tolerable displacement is subject to adjustment based on site-specific features and consequences of specific failure modes.

5.1.3.2.2 Post-Earthquake Stability

In addition to permanent displacements that occur during shaking, further movement can occur immediately after shaking if shear strengths are significantly reduced due to liquefaction triggering.

Assigning appropriate post-earthquake strengths first requires a liquefaction triggering assessment for each material in the slope stability model. The results of the liquefaction triggering assessment will inform the derivation of post-earthquake strengths. The post-earthquake slope stability analysis is a static load case; there is no earthquake load applied.

The TDEC guidance for solid waste landfills includes a liquefaction triggering assessment, but does not stipulate a post-earthquake slope stability analysis. Instead, an effort is made to estimate liquefaction-induced damage at the ground surface.

The EPA guidance for solid waste landfills and the TVA guidance for embankment dams include a liquefaction triggering assessment followed by a post-earthquake slope stability analysis. In the EPA and TVA guidance, performance is considered acceptable if the factor of safety ($FS_{post\text{-}EQ}$) is 1.1 or greater. However, TVA guidance also allows an acceptable $FS_{post\text{-}EQ}$ of 1.0 "for embankments with well-defined subsurface and site condition information."

The CCR Rule requires a liquefaction triggering assessment followed by a post-earthquake slope stability analysis. The acceptance criterion is $FS_{post\text{-}EQ}$ of 1.2. Commentary within the Rule notes that a minimum factor of safety higher than 1.0 was selected because "liquefaction potential analysis and post-liquefaction residual strength analysis involves a larger degree of uncertainties…in assumptions and analysis…".

Therefore, for post-earthquake slope stability (global), an acceptable factor of safety of 1.1 ($FS_{post\text{-}EQ} \geq 1.1$) will be employed. This applies when an ordinary amount/type of site information is available, and generally corresponds to a Phase 1 assessment as defined herein. If the site characterization is "well-defined" an acceptable factor of safety of 1.0 ($FS_{post\text{-}EQ} \geq 1.0$) will be employed. This generally corresponds to a Phase 2 assessment as defined herein.

If a Phase 3 assessment is necessary, including a nonlinear deformation analysis, the acceptance criteria is a representative displacement of 3 feet. The tolerable displacement is subject to adjustment based on site-specific features and consequences of specific failure modes.

5.2 CROSS SECTION DEVELOPMENT

Each analysis cross section will be selected to represent the critical cross section for slope stability failure. Cross sections previously evaluated will be reviewed and evaluated for use in the proposed analyses. If the previously used cross sections are not considered representative for the new analyses, new cross sections will be developed using available site-specific data (including data collected per the Exploratory Drilling SAP). The basis for analysis cross sections will be documented in the EAR.

5.3 MATERIAL PROPERTIES

Measurements of material properties are obtained from site-specific field and/or laboratory testing where available (including data collected per the Exploratory Drilling SAP). If parameters are not available, they will be derived for each material based on the available data, specific characteristics of the material, geologic setting, application of the parameter in the analysis, and professional judgment. If needed, standard engineering references such as Navy (NAVFAC), U. S. Army Corps of Engineers (USACE), and U. S. Bureau of Reclamation (USBR) publications will be used to develop material parameters. Material properties to be developed include but are not limited to the following parameters for use in the analyses:

- Unit Weights,
- Drained Shear Strengths,
- Undrained Shear Strengths,
- Seismic Shear Strengths,

- Post-Earthquake (Liquefied Strengths), and
- Hydraulic Conductivity.

Prior to the post-earthquake analysis, the materials will be evaluated for liquefaction potential using an industry standard, simplified stress-based approach (e.g., Boulanger and Idriss 2014). The liquefaction assessment may include site-specific ground response analyses. If a material is anticipated to liquefy, residual strengths will be estimated using available laboratory data, field data and/or published correlations.

Appropriate material properties will be applied, consistent with each load case (Table 2). A discussion of utilized parameters and their derivations will be included in the EAR.

5.4 LOADING

5.4.1 Pool Levels and Pore Water Pressures

For static, long-term and seismic load cases, the pool within an impoundment (where applicable) is the normal operating pool. The pool in the adjacent body of water (e.g., river or reservoir) is the normal operating pool (Summer or Winter Pool, whichever is more conservative) for the reservoir.

The slope stability analyses require pore water pressures for computing effective consolidation stresses, as defined for the load conditions. Pore water pressures can be estimated with finite element analyses (i.e., seepage models) or by assigning a piezometric line to the cross section. Either approach will be based, in part, on available site-specific piezometer data. The methodology utilized in the analyses will be documented in the EAR.

Consideration of both estimated pore water pressures and adjacent reservoir pool levels (where applicable) will generally encompass the phreatic conditions that will be experienced by the unit.

5.4.2 Seismic Loading

The design earthquake is an event with a 2 percent probability of exceedance in 50 years (i.e., return period of 2,475 years). This return period is similar to that of an event with a 10 percent probability of exceedance in 250 years (return period of 2,373 years). TVA seismic hazard models or appropriate U. S Geological Survey (USGS) seismic hazard mapping may be used to derive the appropriate seismic loading. Derivation of the seismic loads will be documented in the EAR.

5.5 SOFTWARE EMPLOYED IN ANALYSES

Slope stability will be evaluated using conventional, limit equilibrium methods as implemented in the GeoStudio SLOPE/W software or equivalent. With SLOPE/W, the distribution of pore water pressures within the earth mass may be mapped directly from the results of a SEEP/W analysis or piezometric line(s) can be input.

If ground response analyses become warranted, software such as Strata, QUAD4, or other appropriate code may be utilized.

If nonlinear deformation analyses become warranted, software such as FLAC, OpenSees, or other appropriate code may be utilized.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance Project Plan (QAPP) describes quality assurance (QA)/ quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to stability analyses.

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 Project Manager 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 stability analysis processes must be maintained throughout the Investigation.

Office personnel will be responsible for performing checks to confirm that the SAP has been followed. This consists of the completion of applicable forms and documentation of activities.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that data are appropriately maintained and accessible to data end users. The Investigation will be performed in accordance with the QAPP. Analyses will be subjected to data validation 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. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 3. Preliminary Schedule for Stability SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Stability SAP Submittal		Completed
Conduct Stability Analyses	180 Days	Following EIP Approval
Documentation	60 Days	Following Analyses

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- None.

9.0 REFERENCES

Boulanger, R.W. and Idriss, I.M. (2014). "CPT and SPT based liquefaction triggering procedures." Report No. UCD/CGM-14/01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA.

Hynes-Griffin, M. E., and Franklin, A. G. (1984). "Rationalizing the seismic coefficient method." Miscellaneous Paper GL-84-13, July. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi, 37 pages.

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Tennessee Division of Solid Waste Management (unknown date). "Earthquake Evaluation Guidance Document."

TVA (Tennessee Valley Authority). (2016). "Design and evaluation of new and existing river system dams." SRME-SPP-27.001, Rev. 0000, January 5 (effective date). Chattanooga, Tennessee.

United States Army Corps of Engineers (2003). "Slope stability." EM 1110-2-1902, October, Washington D.C.

United States Environmental Protection Agency (USEPA). (2015). "Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities." Federal Register, Vol. 80, No. 74, April 17.

ATTACHMENT A
FIGURE

CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Pseudostatic[1], Global	Pseudostatic[1], Veneer[2]	Post-EQ[3], Global
Interim Ash Staging Area (Closed Condition)	NR[4]	NR	NR	NR	NR
Sluice Trench (& Ballfield East of Sluice Trench) (Closed Condition)	A – A, Polishing Pond	Typ.[5]	A – A, Polishing Pond	Typ.	A – A, Polishing Pond
Stilling Pond (Closed Condition)	STA. 119+69, STA. 132+37	Typ.	STA. 132+37	Typ.	STA. 119+69, STA. 132+37

[1] Pseudostatic, but related to a site-specific tolerable displacement.

[2] Veneer stability is the slope stability of the final cover.

[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.

[4] NR = Not Required; Slope stability calculations not required to demonstrate performance of the closed Interim Ash Staging Area due to the higher surrounding grade, flat closure grading, and containment towards the east by the Polishing Pond

[5] Typical design section was analyzed.

Blue cells are completed analyses. Yellow cells are proposed analyses.

Figure No.
1

Title
Completed and Proposed Stability Analyses

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by DMB on 2018-06-11
Technical Review by RAA on 2018-06-11

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Stability Cross Section
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec
TVA

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APPENDIX Q
HISTORIC SEEP SUMMARY

Seepage History Summary

TVA has conducted annual dike inspections at KIF since 1967. These inspections focused on stability issues pertaining to seeps. NPDES Permit No. TN0005452 was issued by TDEC to the TVA Kingston Plant. 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 Knoxville Environmental Field Office documenting the findings of the inspections and remedial activities implemented.

Remedial activities include the construction of redwater engineered wetlands in 1986 as shown in TVA Drawing Series 10W440. The purpose of this system was to treat then pump redwater seepage into the main ash pond which then discharges at NPDES outfall 001. In 2005, the Dredge Cell Restoration Project was initiated to lower the phreatic water surface in the dredge cells in response to a dike leak in 2003. This restoration included the construction of tiered drains in Dike C which collected seepage and pumped it into the main ash pond. This drainage system was improved in 2008 with the installation of dewatering wells.

TVA maintains a Seepage Action Plan (Stantec 2010) which identifies areas of concern (AOC) by a unique number and documents the date of discovery, description, size, mitigation status, and current status. A map depicting historic seepage areas is shown on Figure 1. A summary of the seep history for KIF is provided in Table 1. It should be noted that the majority of seeps listed in Table 1 were located in areas which are now within the footprint of the Kingston Recovery Project (KRP). Other than AOC 2 seeps have not been observed at the KRP since its construction in 2015, as documented in subsequent annual inspection reports.

Table 1. Seepage History Summary			
Map ID	Seepage Action Plan AOC No.	CCR Unit	Description
A	N/A	Ash Disposal Area/ KRP	The 1970 annual inspection report documented water leaking around the Ash Disposal Area spillway pipe. Fill was placed around the northern spillway and the pipe was excavated and replaced which fixed this seep. This seep was located within the footprint of the KRP. This seep has not been observed since the construction of the KRP as documented in the annual inspection reports.
B	N/A	Ash Disposal Area/KRP	Per the 1979 annual inspection report the exterior dike slopes of Dike C revealed seepage occurring along the length of the east dike of the Ash Pond. This seep was located in an area which is now within the footprint of the KRP. This seep has not been observed since the construction of the KRP as documented in the annual inspection reports.
C	N/A	Stilling Pond	The 1978 annual inspection report noted seepage through weep holes in the concrete end wall of the spillway outlet pipes; however, the dike slope behind the end wall appeared to be dry and well compacted. This seep was repaired as part of the buttress installation in Dike C. No Seepage has been observed since this repair. The Stilling Pond was dewatered in 2017 as part of the Stilling Pond Closure.
D	N/A	Stilling Pond	Seepage was observed at the toe of the exterior slope of the south end of Dike C as reported in the 1979 annual inspection report. This seep was repaired as part of the buttress installation in Dike C. No Seepage has been observed since this repair. The Stilling Pond was dewatered in 2017 as part of the Stilling Pond Closure.
E	N/A	Engineered Wetlands	Per the 1983 annual inspection report, seepage was observed along the east dike adjacent to the condenser intake channel. In 1984 a temporary channel was constructed to collect and pump this red water to the Main Ash Pond as detailed in drawing series 10W430. In 1986, the redwater seepage was intercepted and drained into an engineered wetland for treatment before being pumped to the Main Ash Pond. This engineered wetland is shown detailed in drawing series 10W440 and 10N420. This is no longer an active seep.

F	N/A	KRP	The 1988 inspection documented seepage on the north side of Dike C and located within the footprint of the KRP. This seep has not been observed since the construction of the KRP as documented in the annual inspection reports.
G	N/A	Dredge Cell 2 /KRP	The 1988 inspection documented seepage on the north side of Dike C and located within the footprint of the KRP. Later inspections reported that this location was dry and since 2000 inspection reports do not mention this seep. This seep has not been observed since the construction of the KRP as documented in the annual inspection reports.
H	N/A	Dredge Cell 3 /KRP	The 2004 dike inspection reported a leak at the toe of the dike for Dredge Cell 3 that occurred on November 6, 2003. This seep was located within the current footprint of the KRP. This seep has not been observed since the construction of the KRP as documented in the annual inspection reports.
I	N/A	Dredge Cell 2 /KRP	This seep was first reported in the January 2008 annual inspection report and located within the footprint of the KRP. This seep has not been observed since the construction of the KRP as documented in the annual inspection reports.
J	N/A	Dredge Cell 2 /KRP	This seep was first reported after the October 2008 annual inspection report and located within the footprint of the KRP. This 4f. x 4ft. wet spot is called out in drawing API 2009-1. This seep has not been observed since the construction of the KRP as documented in the annual inspection reports.
K	N/A	Stilling Pond	The 2010 annual inspection noted possible seepage on the exterior side of Dike C toward the intake channel. Dike C was repaired in 2011 with a rock buttress and no further activity has been reported. The Stilling Pond was dewatered in 2017 as part of the Stilling Pond Closure. No seeps have been observed since the closure.
L	2	Engineered Wetlands	The 2010 annual inspection noted seepage at multiple locations near the waterline of the wetland on the East Dike. Six piezometers were installed in April 2010 along two cross-sections of the east dike to monitor seepage conditions. These seeps are being monitored and ongoing analysis is being conducted.
M	3	Stilling Pond	Multiple seeps near the toe of the exterior northeast slope of the Stilling Pond were initially observed by Stantec on 3/20/2010. Dike C was repaired in 2011 with a rock buttress and no further activity has been reported. This AOC is classified as Action Level 1 (Non-Flowing) and inactive.

N	4	Stilling Pond	A 2010 inspection of dike stability revealed multiple seeps into the Stilling Pond through the divider dike. Seeps have not been observed since the construction of the KRP as documented in the annual inspection reports. The stilling pond was closed in 2017. This AOC is classified as Action Level 1 (Non-Flowing) and inactive.
O	5	Stilling Pond	A 2010 inspection of dike stability revealed multiple seeps into the Stilling Pond through the divider dike This seep has not been observed since the construction of the KRP as documented in the annual inspection reports. The stilling pond was closed in 2017. This AOC is classified as Action Level 1 (Non-Flowing) and inactive.
P	6	Stilling Pond	A 2010 inspection of dike stability revealed multiple seeps into the Stilling Pond through the divider dike. This seep has not been observed since the construction of the KRP as documented in the annual inspection reports. The stilling pond was closed in 2017. This AOC is classified as Action Level 1 (Non-Flowing) and inactive.
Q	N/A	KRP	This seepage area was noted in the 2012 Annual Redwater Seepage Inspection Report. This seep was located within the footprint of the KRP and has not been observed since the construction of the KRP.
R	N/A	Stilling Pond	The 2014 Formal inspection of CCP Facilities and Ponds report noted a seep through the headwall at penetration number 9 diffuser. The 2016 Quarterly Dike Inspection reports that there are no seeps at the concrete wall that supports pond discharge piping and is no longer an active seep.

Note: AOC 1 is located south of the KRP on the Peninsula Disposal Area and is not mapped as a part of this summary.

References

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Tennessee Valley Authority (TVA). 2012. "Annual Redwater Seepage Inspection Report." January 7.

Tennessee Valley Authority (TVA). 2017. "Kingston Fossil Plant Quarterly Dike Inspection – Annual Report 2016." January 13.

Figure No.
1

Title
Kingston Fossil Plant Historic Seep Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LT on 2018-06-07
Technical Review by RAA on 2018-06-07

0 250 500 750 1,000 Feet
1:3,000 (At original document size of 22x34)

Legend

- Area of Concern (AOC) (Map ID/AOC #)
- Historic Seep (Map ID)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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TVA

APPENDIX R
SEEP SAP

Seep
Sampling and Analysis Plan
Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
2	Issued for TDEC Review	March 2, 2018
3	Addresses May 2, 2018 TDEC Review Comments and Issued for TDEC Review	June 15, 2018
4	Addresses Applicable Programmatic Revisions and Issued for TDEC Approval	November 9, 2018

SEEP
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Seep
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018

Revision 4

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	11/6/18 Date
McClung, Nicholas Anthony — Digitally signed by McClung, Nicholas Anthony Date: 2018.11.05 10:14:33 -05'00'	
TVA Investigation Field Lead	Date
Health, Safety, and Environmental (HSE) Manager	11-7-18 Date
Investigation Project Manager	10/24/2018 Date
Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.11.05 20:34:20 -05'00'	
QA Oversight Manager	Date
Laboratory Project Manager	11/2/18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

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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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On September 16, 2016, TVA submitted the KIF 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 surface streams on or adjacent to the KIF Plant (Plant). This Seep SAP presents a phased approach and plan to sample soil and water from seeps along surface impoundments and landfills at the 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 Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and 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 in the Study Area, with locations verified in the field using 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 Table 1, Proposed Seep Sampling Locations, and the completed table 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 ENV-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 planned in accordance with TVA TI ENV-TI-05.80.01 *Planning Sampling Events* and 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: additional work order will be required to remove 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-05.80.01, *Planning Sampling 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-05.80.40, *Surface Water Sampling*
- ENV-TI-05.80.46, *Field Measurement Using a Multiparameter Sonde*
- ENV-TI-05.80.50, *Soil and Sediment Sampling*

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 Field Team Leader, 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 Project Manager 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 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
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	Liquid & Solid - SW-846 6020A	HNO3 to pH < 2 & Cool to <6°C; 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	Liquid - SW-846 7470A; Solid - SW-846 7471B	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days
Radium 226	Liquid - SW-846 903.0; Solid - SW-846 901.1	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	1 L glass or Plastic; 8-oz glass (soil)	180 days
Radium 228	Liquid - SW-846 904.0; Solid - SW-846 901.1	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	2 L glass or plastic; 8-oz glass (soil)	180 days
Chloride	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days
Fluoride	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days
Sulfate	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	125-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
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	Liquid - SW-846 9040C (field measurement); Solid - SW-846 9045D	NA	NA (liquids); 4-oz glass (soil)	NA*

*The pH of water 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 Project Manager 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). (2013). "Surface Water Sampling." Technical Instruction ENV-TI-05.80.40, Revision 0000. January 1.

Tennessee Valley Authority (TVA). (2017a). "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0000 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.

Tennessee Valley Authority (TVA). (2017h). "Soil and Sediment Sampling." Technical Instruction ENV-TI-05.80.50, Revision 0000. September 29.

ATTACHMENT A
FIGURE

Figure No.
1

Title
Kingston Fossil Plant Historic Seep Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LT on 2018-06-07
Technical Review by RAA on 2018-06-07

0 250 500 750 1,000 Feet
1:3,000 (At original document size of 22x34)

Legend

- Area of Concern (AOC) (Map ID/AOC #)
- Historic Seep (Map ID)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

Stantec TVA

U:\TVA-EIP\175618610\gis\mxds\KIF_Historic_Seep_Locations.mxd Revised: 2018-06-07 By: tfink

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 S
CCR MATERIAL CHARACTERISTICS SAP

CCR Material Characteristics Sampling and Analysis Plan Kingston Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Kingston Fossil Plant
Harriman, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

November 9, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	June 15, 2018
1	Addresses Applicable Programmatic Revisions and Issued for TDEC Approval	November 9, 2018

CCR MATERIAL CHARACTERISTICS
SAMPLING AND ANALYSIS PLAN
KINGSTON FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: CCR Material Characteristics
Sampling and Analysis Plan
Kingston Fossil Plant
Tennessee Valley Authority
Kingston, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: November 9, 2018 Revision 1

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 — Date: 11/6/18

McClung, Nicholas Anthony
Digitally signed by McClung, Nicholas Anthony
Date: 2018.11.05 10:13:33 -05'00'
TVA Investigation Field Lead — Date

Health, Safety, and Environmental (HSE) Manager — Date: 11-7-18

Investigation Project Manager — Date: 10/24/2018

Rock J. Vitale
Digitally signed by Rock J. Vitale
DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US
Date: 2018.11.05 20:33:30 -05'00'
QA Oversight Manager — Date

Laboratory Project Manager — Date: 11/2/18

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 Kingston Fossil Plant (KIF) on April 28, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at KIF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted 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 September 16, 2016, TVA submitted KIF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

TDEC's comments on Revision 2 included a request for a leachability characterization study that would include 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 from each investigation area at KIF.

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.

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 Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and 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 Material Characteristics SAP consists of the Sluice Trench and Ballfield Area East of the Sluice Trench, and the Interim Ash Staging Area (IASA); the Stilling Pond has been exempted due to recent leachability studies. 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). Five sample locations were selected based on TDEC's request to characterize the leachability of constituents from the material in the Study Area. 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.

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 former ponds once they have been dewatered and stabilized. After the temporary wells have been installed, pore water samples will be taken at the base of the units in the ash.

A map showing all proposed 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 KIF Exploratory Drilling SAP. The proposed temporary well locations are subject to change based on ongoing site operations and conditions. TDEC will be notified of any changes in well locations.

Table 1. Proposed Sample Locations

Sample Location ID	Description
TW01	IASA (sluiced ash) – northern-most TW*
TW02	IASA (sluiced ash) – south of TW01
TW03	IASA (sluiced ash) – eastern-most TW* in IASA
TW04	Sluice Trench and Ballfield East of the Sluice Trench (sluiced ash) – eastern-most TW*
TW05	Sluice Trench and Ballfield East of the Sluice Trench (sluiced ash) – southern-most TW*

*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 planned in accordance with TVA TI ENV-TI-05.80.01 *Planning Sampling* Events, conducted according to TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling* and 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-05.80.01 *Planning Sampling 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-05.80.42 *Groundwater Sampling*
- ENV-TI-05.80.44 *Groundwater Level and Well Depth Measurement*
- ENV-TI-05.80.46 *Field Measurement Using a Multiparameter Sonde*
- ENV-TI-05.80.50, *Soil and Sediment Sampling*

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 both for totals, and leachability, 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.

Pore water 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% microsiemens per centimeter (µS/cm);
- Dissolved oxygen (DO) - ±10% for > 0.5 mg/L or <0.5 mg/L; and
- Turbidity - below 10 Nephelometric Turbidity Unit (NTU) 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 Field Team Leader, 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 TVA 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 Project Manager 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 the 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 nitrile (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. Sample collection will be conducted in accordance with TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling*. 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*.

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. 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 (or equivalent) 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

Prior to placing each CCR material sample into the laboratory supplied containers, an aliquot of the homogenized sample will be tested using a field pH test kit with the results recorded in the daily field notes. 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 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 analyzed for total CCR Parameters, as well as leachability, after being subjected to the most applicable leaching method based on emerging science in the industry, which could include the 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. 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
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	Liquid & Solid - SW-846 6020A	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (CCR)	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 & Cool to <6°C	250-mL HDPE	28 days
Mercury, total	Liquid - SW-846 7470A; Solid - SW-846 7471B	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (CCR)	28 days
Radium 226	Liquid - SW-846 903.0; Solid - SW-846 901.1	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	1 L glass or Plastic; 8-oz glass (CCR)	180 days
Radium 228	Liquid - SW-846 904.0; Solid - SW-846 901.1	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	2 L glass or plastic; 8-oz glass (CCR)	180 days
Chloride	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (CCR)	28 days
Fluoride	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (CCR)	28 days
Sulfate	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	125-mL HDPE; 4-oz glass (CCR)	28 days
pH	Liquid - SW-846 9040C (field measurement);	NA	NA (liquids); 4-oz glass (CCR)	NA*

Table 6. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
	Solid - SW-846 9045D			
Total Dissolved Solids (TDS)	SM2540C	Cool to <6°C	250-mL HDPE	7 days
Total Organic Carbon (TOC)	Liquid - SM5310C; Solid - SW-846 9060A	H_2SO_4 to pH<2 & Cool to <6°C; Cool to <6°C	250-mL amber glass; 4-oz glass (CCR)	28 days

*The pH of pore water samples will be measured in the field. Holding time for CCR material pH samples is 15 minutes following creation of sample paste. CCR material 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 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 ® or other appropriate non-phosphatic detergent in 5-gallon buckets. Following decontamination, fluids will be disposed of in accordance with 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:

- CCR material cuttings
- Purge Water
- Personnel Protection 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 Project Manager 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 every 20 samples or once per 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
Prepare for Field Activities	25 Days	Following EIP Approval
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. "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0000 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. "Groundwater Sampling." Technical Instruction ENV-TI-05.80.42, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017h. "Groundwater Level and Well Depth Measurement." Technical Instruction ENV-TI-05.80.44, Revision 0000. March 31

Tennessee Valley Authority (TVA). 2017i. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017j. "Soil and Sediment Sampling." Technical Instruction ENV-TI-05.80.50, Revision 0000 September 29.

ATTACHMENT A
FIGURE

Figure No.
1

Title
Proposed Temporary Well Locations

Client/Project
Tennessee Valley Authority
Kingston Fossil Plant

Project Location
Roane County, Tennessee

175618610
Prepared by LMB on 2018-10-31
Technical Review by EM on 2018-10-31

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe (Screened Interval)
- Existing Piezometer Vibrating Wire (Tip Interval)
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- TVA Property Boundary (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA and flown by Tuck Mapping on March 16, 2017.
3. This imagery does not show the current condition of the Stilling Pond. The Stilling Pond has been closed since the imagery was collected.

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 T
PUBLIC COMMENTS

Table 1
TVA Kingston EIP Rev 4
Summary of Public Comments & TVA Responses
October 29, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (October 29, 2018)
1	General	All	NA	NA	NA	Excerpt from letter dated 9/12/2018 Why don't you use natural resources like wind mills? Have you done lung studies on children, and matched with studies you did before you shortened the stacks, my grandchildren were born healthy, but all have respiratory problems? Have you done epidemiology studies? Cancer rate? And when you send out public notices, be more specific, list the hazards involved…	9/12/2018	Kimberly Howe	These comments are noted. The purpose of the Tennessee Department of Environment and Conservation (TDEC) Order is (1) to establish transparent and comprehensive process for the investigation, assessment, and remediation of unacceptable risks, resulting from the management and disposal of coal combustion residuals (CCR), and (2) coordinate the implementation of the federal CCR rule to insure compliance with Tennessee laws and regulations that govern the management and disposal of CCR. As part of the TDEC Order process, Tennessee Valley Authority (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 CCR at the Kingston Fossil Plant. The results of the EI will be summarized in the Environmental Assessment Report (EAR). These comments do not provide specific suggestions pertaining to the technical approach of the current version of the EIP, which sets forth technical investigations necessary to properly evaluate CCR impacts to human health and the environment.
2	General	All	NA	NA	NA	Public Comment on the TVA-KIF Environmental Investigation Plan (excerpt from document provided below) It is time to reframe this inquiry to provide interagency cooperation in a site-specific, wholistic approach to public health and environmental assessment. In the future, agencies/institutions responsible for human health assessment need to include all known potential, site-specific contaminants of concern. Please include the Tennessee Department of Health-Environmental Epidemiology Program in a review of this document and future plans for monitoring this TVA-KIF site with respect to human health and safety. This TVA-EIP needs a corresponding long-term monitoring plan that synthesizes sampling and analysis in assessment required in TDEC CCR and effluent permits in addition to the Commissioner's Order. It may also be necessary to establish a formal cooperative agreement among agencies that share responsibility for environmental contamination (i.e., TVA and DOE) to assure that future monitoring is integrated in a wholistic way to gauge the efficacy of mitigation and report progress to local government officials and the public.	8/31/2018	Lynne Roberson	These comments are noted. As part of the TDEC Order process, TVA will be conducting an EI as outlined in the EIP and assessing potential risks that may result from the management and disposal of CCR at the Kingston Fossil Plant. The results of the EI will be summarized in the EAR. These comments do not provide specific suggestions pertaining to the technical approach of the current version of the EIP, which sets forth technical investigations necessary to properly evaluate CCR impacts to human health and the environment. The EIP was prepared by credentialed professionals (engineers and geologists) licensed in the State of Tennessee. TDEC staff are also Tennessee-licensed professionals that will review the EAR independently. Data collected during the EI will be verified and validated by a third-party consultant under contract to TVA. As agreed by TDEC and the United States Environmental Protection Agency (EPA) following the cleanup from the Kingston spill, TVA will continue to monitor the effectiveness of the selected Kingston remedial action through annual monitoring for up to 30 years of fish and invertebrate populations and community structure in the Emory and Clinch Rivers, bioaccumulation in fish and mayflies, and ash and CCR-related contaminants in river sediments. In addition, TVA will conduct sediment toxicity tests at 5-year intervals. This long-term monitoring is administered under a federal CERCLA program with EPA oversight separate from the TDEC Order.

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October 29, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (October 29, 2018)
3	General	All	NA	NA	NA	Excerpt from *TVA Environmental Investigation Plan – Kingston Fossil Plant Public Comments*: The monitoring frequencies, reporting requirements, containment dike design requirements, and hazard controls proposed in the current version of the KIF EIP are all based upon this incorrect hazard determination for coal ash. As such, The local residents, public (especially those using the nearby Watts Bar recreational facilities), and TVA KIF personnel will not be properly protected from the actual hazards presented by the coal ash at the KIF. Based upon these facts, TVA needs to reevaluate and update appropriately all responses to TDEC information requests for the KIF to appropriately protect the local residents, public, and its own KIF staff from the real hazards of coal ash. This is also true of all the other TVA coal fired fossil plants in the TVA organization. Therefore, a total rework of the current version of the EIP being presented for public comment is required. Only once this document has been reworked and corrected as indicated above will it be ready for proper review and consideration.	9/18/2018	Roane County Environmental Review Board (Mary Anne Koltowich)	These comments are noted. The EPA has classified coal ash and CCR as non-hazardous solid waste. Commissioner's Order OGC15-0177 was established under the regulatory authority of Tennessee's Waste Management and Remediation laws. That regulatory guidance provides the framework for this evaluation. As part of the TDEC Order process, TVA will be conducting an EI as outlined in the EIP and assessing potential risks that may result from the management and disposal of CCR at the Kingston Fossil Plant. The results of the EI will be summarized in the EAR. These comments do not provide specific suggestions pertaining to the technical approach of the current version of the EIP, which sets forth technical investigations necessary to properly evaluate CCR impacts to human health and the environment.
4	General	All	NA	NA	NA	The fossil fuel material in question, coal was removed from the earth, oxidized/(burnt) to create clean safe energy for all, and the resultant ash residue was subsequently returned to the earth. This 'fly ash' is no more hazardous than the ash in your fire pit in the back yard. Five year monitoring is absolutely adequate. Do not squander Tax Payer monies to appease fear mongers.	8/11/2018	Chris Mckinney	These comments are noted. As part of the TDEC Order process, TVA will be conducting an EI as outlined in the EIP and assessing potential risks that may result from the management and disposal of CCR at the Kingston Fossil Plant. The results of the EI will be summarized in the EAR. These comments do not provide specific suggestions pertaining to the technical approach of the current version of the EIP, which sets forth technical investigations necessary to properly evaluate CCR impacts to human health and the environment.
5	3.1.1	TDEC Site Specific Information Request No. 1	13	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Section 3.1.1, p13 discusses the modeling planned to estimate the volume of coal waste (a.k.a., coal combustion residue, or CCR) below the groundwater table and saturated. Groundwater in Tennessee is defined as part of "waters of the state" and must be protected. Any waste found to be saturated by or in groundwater should be targeted for removal.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	These comments are noted. The EI will provide information about the volume and location of CCR in relation to saturated conditions. In addition, evaluating the effect of CCR materials on groundwater quality is part of the EI. The need to conduct corrective actions to remediate groundwater will be based on the results of the EI and included in the corrective action risk assessment (CARA) plan.

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October 29, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (October 29, 2018)
6	3.1.2	TDEC Site Specific Information Request No. 2	14	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Section 3.1.2, p14 discusses the upper most aquifer. Care must be taken to identify this groundwater without resorting to claims of "perched water" and not groundwater, as has happened many times in Tennessee. All groundwater should be addressed and protected.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	These comments are noted. An objective of the EI is to supplement the existing monitoring well network for the KIF Study Area by installing additional monitoring wells to further characterize the hydrogeology of the Study Area and evaluate groundwater quality. The need to conduct corrective actions to remediate groundwater will be based on the results of the EI and included in the CARA plan.
7	3.1.4	TDEC Site Specific Information Request No. 4	18	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Section 3.1.4, p18 discusses investigation of "red-water seeps." This seems to suggest that such leaks are ongoing and not just historic. It should be remembered that these seeps were the prelude to the massive Kingston spill of December 2008. Any ongoing seeps are discharges and must be covered and monitored by the NPDES permit until eliminated. They should not be obscured by rock, making them difficult to observe and monitor, and the plan should address this.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	Seepage from existing 'red-water seeps' along the East Dike has been identified and addressed by collecting and routing these flows through the National Pollutant Discharge Elimination System (NPDES) wastewater treatment system for treatment and discharge via Outfall 001. Quarterly inspections are conducted in accordance with the Seepage Action Plan as required by NPDES Permit No. TN0005452. Identified seeps are addressed in accordance with Part III.D. and Part III. E. of the NPDES Permit. As part of the TDEC Order process, TVA will be conducting an EI as outlined in the EIP. The EIP includes a seep investigation to be implemented at the KIF Study Area. The results of the EI will be summarized in the EAR. Seeps identified during the EI will be addressed in accordance with the Seepage Action Plan.
8	3.1.4	TDEC Site Specific Information Request No. 4	19	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Section 3.1.4, p19 mentions the East Dike Seepage Mitigation Project was done with a state ARAP and Corps 404 Nationwide permit # 3. How is it possible that anything to do with such a significant site with related historic impacts could be covered by anything other than individual permits? How were the NEPA aspects of this addressed? Anything to do with Kingston coal ash for the foreseeable future should be considered significant under NEPA for multiple reasons as laid out in that law and regulations. No future general state or nationwide federal permits should be allowed.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	The East Dike Seepage Mitigation Project was authorized by TDEC under individual ARAP/401 Water Quality Certification NRS16.142 and by the USACE under File No. 2016-00521 Nationwide Permit #3 verification. Further, TVA conducts an appropriate level of review under NEPA in relation to each particular project under consideration. As part of the TDEC Order process, TVA will be conducting an EI as outlined in the EIP. The EIP includes a seep investigation to be implemented at the KIF Study Area. The results of the EI will be summarized in the EAR.

Table 1
TVA Kingston EIP Rev 4
Summary of Public Comments & TVA Responses
October 29, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (October 29, 2018)
9	3.4.1	TDEC Ground Water Monitoring Information Request No. 1	25	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Section 3.4.1, p25 addresses a survey of wells and springs in the area and confirmatory sampling if any CCR constituents exceed MCLs. Levels above MCLs should not be the trigger for further evaluation; it should be ambient conditions as established by background or area reference levels. Allowing contaminant levels to be as high as just under MCLs should not be allowed – especially if that is the result of leaking waste. A well owner depending on groundwater does not want to drink CCR contaminants that are present, but not quite over an MCL. They have the legal right to uncontaminated groundwater, which is part of "waters of the state." Such evaluations should also be based on unfiltered water, as that is how many – if not all – well users consume their water. For springs, MCLs make even less sense, as springs are the surface expression of flowing underground waters that form streams – which are surface waters covered by different criteria than MCLs, and which are more stringent for some parameters. Further, antidegradation provisions of state water quality standards likely control the quality of such spring-formed stream, and the background or reference levels should determine need for further evaluation, not MCLs.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	These comments are noted. Maximum Contaminant Levels (MCLs) are United States Environmental Protection Agency drinking water standards for public water systems. They are often used as a reference for private drinking water supplies. CCR constituents are naturally occurring. The purpose of the EI is to evaluate effects, if present, from TVA's CCR units; however, TVA will notify TDEC if CCR constituents are detected at concentrations greater than a MCL regardless of its source. The objective of the Water Use Survey is to evaluate the quality of sources of water, including springs, used for domestic or business purposes. Other parts of the EI will evaluate surface water quality. Unfiltered samples will be collected for analysis.
10	3.5.1	TDEC Ground Water – Chemical and Physical Properties Information Request No. 1	27	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Section 3.5.1, p27 addresses arsenic found in Monitoring Well KIF-22 that was being attributed to high solids and replaced with a new well. Maybe the high reading is because there is contamination with arsenic and it should not be dismissed as a suspended solids problem. EPA protocols (as mentioned in our recent comments on the John Sevier EIP) state that unfiltered groundwater should be used so as to not remove the contaminants that are being sought.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	These comments are noted. Arsenic concentrations at well 22, which was screened in fill material consisting of ash, sand, gravel, and clay, are planned to be addressed under the current Ash Disposal Area monitoring program by replacing well 22 with a new well 22C not screened in fill material. The replacement well will allow data representative of groundwater conditions downgradient of the Ash Disposal Area to be obtained. The results for the new well will be evaluated in the EAR. Groundwater will be sampled in accordance with the Groundwater Sampling and Analysis Plan, which is based on approved EPA sampling methodology, included in the EIP. The sampling method for groundwater is based on collecting unfiltered samples. In some cases, both unfiltered and filtered samples may be collected. The results of both unfiltered and filtered samples will be evaluated and summarized in the EAR.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (October 29, 2018)
11	4.1.3	A.3 TDEC Site Information Request No. 3	38	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Section 4.1.3, p38 discusses how historic maps will be used to determine pre-TVA site conditions for historic stream flows and other conditions. This seemingly minor point can have major ramifications. Knowing where natural waters once flowed – and maybe still do, even if below view – is often key in determining where to look for problems today.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	These comments are noted. Historic surface water features, as indicated in the EIP, will be summarized in the EAR following the evaluation of the data. Surface water will be investigated as part of the EI and the results will be summarized in the EAR.
12	4.2	B. Water Use Survey	40	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Section 4.2, p40 states that there will be a survey of domestic water use within ½ mile of the site. This seems much too conservative, and a wider area such as 5 miles should be considered.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	This comment is noted. The survey radius was provided by the General Guidelines for environmental investigation of TVA coal fired power plants found in Appendix B of the EIP. If sampling reveals CCR constituents present above MCLs within the ½ mile initial survey boundary, then TVA will report the information to TDEC. The need for a greater survey radius will be evaluated based on the results from the ½ mile water use survey radius.
13	4.5	Surface Water Impacts	58	All	All	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 Evaluation of surface waters begins on page 60 and describes various means of investigations, including use of existing data from recent studies related to the big spill of 2008. In looking at surface water impacts and conditions, near-shore locations should not be overlooked. It is our understanding that pervious work mainly (or only) focused on mid-channel and/or mid-depth samples, and it ignored coves and shorelines where ash was visibly accumulating when the lake was declared clean. These shallow areas are where many people recreate – especially the young – and should not be overlooked by only mid-channel sampling or averaging. All areas of public waters are protected for the public. Previous sampling of the adjacent waters was done by representatives of impacted parties in the months following the big spill – and provided to the state and federal authorities, including TVA – but such data were ignored in evaluations of declarations of "clean", and not even cited in this EIP as a source of information.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	These comments are noted. The existing data available from TVA and other governmental agencies from the Kingston Recovery Project and the associated long-term monitoring efforts will be reviewed and evaluated for the EAR. The need for additional data will be evaluated during this process.

Table 1
TVA Kingston EIP Rev 4
Summary of Public Comments & TVA Responses
October 29, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (October 29, 2018)
14	4.5.5	E.5 TDEC Surface Water Impacts Request No. 5	63	NA	NA	Excerpt from Tennessee Clean Water Network letter dated 9/28/2018 Re: Kingston Fossil Plant Environmental Investigation Plant (EIP), Revision 3 (excerpt) It is noted that conductivity is to be used as a parameter to evaluate water quality in the area. We support this tool and encourage its considered use to identify leaks and sample locations that might otherwise be missed due to subsurface flows or coverage by rip-rap over leaking areas. Specific protocols should be presented as to how conductivity readings will be used to determine potential leaks and locations to sample at the water's edge before dilution.	9/28/2018	Tennessee Clean Water Network (Kathy Hawes)	These comments are noted. Specific protocols for the seep investigation, including field testing at the water's edge for specified parameters, including conductivity, are outlined in the Seep Sampling and Analysis Plan (SAP) [Appendix R of the EIP]. If seeps are identified, seep samples will be collected from seepage flows. Seep samples will not be collected from adjacent waterbodies
15	4.2	B. Water Use Survey	40	All	All	Comment on Kingston EIP postcard received by TVA: The half-mile well testing zone is far too small. Those with wells farther than 0.5 miles may be impacted and if there are no wells between them and the ash, we won't know. Also, well depth can be variable and deeper wells may be affected when closer shallow wells wouldn't.	8/30/2018	Adam Hughes, Knoxville, TN	This comment is noted. The survey radius was provided by the General Guidelines for environmental investigation of TVA coal fired power plants found in Appendix B of the EIP. There is no constraint on the depth of the wells to be surveyed. If sampling reveals CCR constituents present above MCLs within the ½ mile initial survey boundary, then TVA will report the information to TDEC. The need to sample additional water supply wells beyond the ½ mile radius will be evaluated using the results of the water use survey and the overall EI. Additionally, an objective of the EI is to characterize the hydrogeology of the Study Area and evaluate groundwater quality at various depths using an existing monitoring well network supplemented with additional wells installed as part of the EI. The results will be summarized in the EAR.
16	4.2	B. Water Use Survey	40	All	All	Comment on Kingston EIP postcard Card received by TVA: The ½ mile radius water testing as drawn is too small. The perimeter needs to expand to include land across the water channel.	8/30/2018	Jean Cheely	This comment is noted. The survey radius was provided by the General Guidelines for environmental investigation of TVA coal fired power plants found in Appendix B of the EIP. If sampling reveals CCR constituents present above MCLs within the ½ mile initial survey boundary, then TVA will report the information to TDEC. The need to sample additional water supply wells beyond the ½ mile radius will be evaluated using the results of the water use survey and the overall EI.