Environmental Assessment Report

Kingston Fossil Plant

Harriman, Tennessee

Tennessee Valley Authority

Title and Approval Page

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Kingston Fossil Plant
Tennessee Valley Authority
Harriman, Tennessee

Prepared By: Tennessee Valley Authority

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TDEC CCR Technical Manager	Date

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Executive Summary

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to Tennessee Valley Authority (TVA) to establish a process for investigating, assessing, and remediating unacceptable risks from management of coal combustion residuals (CCR) at TVA coal-fired plants in the state of Tennessee. TVA constructed the Kingston Fossil Plant (KIF Plant) between 1951 and 1954 on approximately 100 acres and began generating power in 1954. There are three CCR management units[1] at the KIF Plant included in the TDEC Order: the Interim Ash Staging Area, Sluice Trench and Area East of Sluice Trench, and the Stilling Pond. Each of the TDEC Order CCR management units was previously closed in accordance with applicable regulations in effect at the time of closure.

In accordance with the TDEC Order, TVA and Stantec Consulting Services Inc. (Stantec), on behalf of TVA, prepared an Environmental Investigation Plan (EIP) for the KIF Plant to obtain and provide information requested by TDEC. As specified in the TDEC Order, the primary objective of the EIP was to "identify the extent of soil, surface water, and groundwater contamination by CCR" from onsite management of CCR material in impoundments and landfills. In addition, per TDEC's information requests, the EIP included assessment of CCR management unit structural stability and integrity.

Between 2018 and 2021, TVA and Stantec conducted the TDEC Order environmental investigations (EI) for the KIF Plant TDEC Order CCR management units. The EI included characterization of the site hydrogeology and investigations of CCR material, groundwater, background soils, seeps, as well as a Water Use Survey. Investigations associated with surface streams, sediments, and ecology have been addressed as part of the Kingston Recovery Project (KRP), and the findings from those investigations and monitoring programs are incorporated herein. EI activities were implemented in accordance with the approved Sampling and Analysis Plans and Quality Assurance Project Plans, including TVA- and TDEC-approved programmatic and project-specific changes made following approval of the EIP. Based on a comprehensive quality assurance review, the EI data are usable and meet the objectives of the TDEC Order.

The EI data were evaluated along with information collected as part of previous investigations and other ongoing regulatory monitoring programs conducted between the 1970s and 2022, including the KRP. The objectives of the TDEC Order are similar to these other programs, including TDEC landfill permit requirements (Chapter 0400-11-01) and the United States Environmental Protection Agency rule (Title 40, Code of Federal Regulations Part 257, Subpart D) (CCR Rule), that cover certain CCR management units. Collectively, these data provide a broad-based characterization of the CCR management units to meet the objectives of the EIP. Geotechnical data were used for TDEC Order CCR management unit stability and integrity evaluations. EI environmental sample data were used to characterize the extent of potential impacts and were compared to constituent-specific TDEC-approved levels to identify CCR constituents that require further evaluation in the next phase of the TDEC Order, the Corrective Action/Risk Assessment (CARA) Plan.

This Environmental Assessment Report (EAR) describes the extent of surface stream water, sediment, and groundwater contamination from the KIF Plant TDEC Order CCR management units, and provides the information, data, and evaluations used to make those assessments. As described herein, more than 96% of the groundwater sample results from over 300 samples were below the approved levels. The KRP data included for evaluation of surface stream water, sediment and ecology were collected under a similar quality assurance program as the EI data and are considered to be

[1] The term "CCR management unit" is used in this document generally and is not intended to be a designation under federal or state regulations.

of comparable data quality for use in this EAR. The EI data indicate impacts to limited onsite groundwater areas. The extensive investigations conducted for the KRP and subsequent long-term monitoring program data indicate that there are no adverse impacts to ecological communities in the Emory, Clinch, and Tennessee Rivers from the KIF Plant or the residual ash in those rivers. The data from the EI and KRP will be used to evaluate the basis and methods for CCR management unit closure in the CARA Plan, including an evaluation of the performance of existing closure methods; modifications to the closure methodology will be identified, as needed, in the CARA Plan.

The following are the overall assessment findings based on data as presented in this EAR and the previous studies:

- Evaluation of the previous and ongoing extensive investigations conducted for the KRP indicate that surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health in the Clinch, Emory, and Tennessee Rivers, or to aerial-feeding insectivorous birds. TVA is continuing long-term monitoring activities to fully document these findings, as required by the United States Environmental Protection Agency and TDEC under the terms of the Comprehensive Environmental Response, Compensation, and Liability Act remedy.

- The TDEC Order CCR management units have adequate structural stability and slopes are stable under current static and seismic loading conditions, except for the seismic global slope stability at the Sluice Trench and Area East of Sluice Trench. TVA is currently evaluating mitigation alternatives, and it is anticipated that the mitigation design process will commence in parallel with the CARA phase of the TDEC Order program.

- No seeps were identified during the EI.

- All but one TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below the TDEC-approved groundwater screening levels (GSLs), and groundwater impacts are limited to onsite areas downgradient along the perimeter of the TDEC Order CCR management units. However, additional assessments will be included in the CARA Plan to evaluate the need for corrective action for targeted onsite groundwater remediation at locations where statistically significant concentrations of cobalt above the GSL exist.

- Drainage improvements or potential corrective actions are expected to reduce concentrations of CCR constituents to below GSLs in groundwater at downgradient monitoring locations.

- The groundwater flow direction within the uppermost aquifer beneath the TDEC Order CCR management units is generally to the east-southeast towards Emory River and the Plant Intake Channel. Groundwater flow in the vicinity of the TDEC Order CCR management units is bounded to the east and southeast by the Emory River and the Plant Intake Channel. Pine Ridge to the west and upgradient of the plant serves as a topographic divide to groundwater flow.

- Based on the overall results of the water use survey, current and historical CCR management associated with the KIF Plant have not affected water supply wells or springs located in the vicinity of the KIF Plant.

Exhibit ES-1 shows overall findings of the investigation and the locations where the environmental assessments concluded that no further evaluation is needed. It also shows where further evaluation is needed in the CARA Plan for onsite groundwater. Onsite groundwater impacts will require further evaluation regardless of the CCR management unit closure method, and groundwater remediation can be accomplished along with closure in place or closure by removal.

TVA continues to evaluate means to beneficially use CCR material in a manner consistent with regulatory requirements while maximizing value to the Tennessee Valley.

Upon TDEC approval of the EAR, and in accordance with the TDEC Order, TVA will further evaluate these findings and prepare a CARA Plan for submittal to TDEC. The CARA Plan, which will be subject to a public review and comment process, will evaluate whether unacceptable risks related to management of CCR material exist at the KIF Plant. The CARA Plan will also specify the actions TVA plans to take at the TDEC Order CCR management units and the basis of those actions. It will also incorporate other operational changes planned or in progress by TVA, including details for CCR beneficial use operations, modification of the TDEC Order CCR management units as needed to meet regulatory standards, and long-term closure and monitoring.

Exhibit No.
ES-1

Title
Summary of Environmental Assessment Report Findings
Kingston Fossil Plant

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location: Roane, Tennessee
175668043
Prepared by KB on 2023-05-17

Key Findings

Nearly all of the environmental sample results were **below the approved levels**.

This means that TVA is managing its CCR units in a way that protects the ecological integrity of the Emory, Tennessee, and Clinch Rivers, and their aquatic communities.

Assessment and Monitoring Findings

These symbols summarize the findings of the investigation and monitoring:

- No action is needed.
- Corrective action is being evaluated in this area.

Next Steps

With TDEC acceptance of the environmental assessment, TVA will further evaluate certain areas for potential corrective action and will conduct a water use survey to better understand groundwater conditions around the Kingston Fossil Plant.

TVA will use these findings to prepare and submit a corrective action plan to TDEC. This plan, which will be released for public review and comment, will specify measures TVA plans to take to address unacceptable risks.

TVA's efforts will continue until regulators are satisfied, and monitoring of groundwater will continue for many years.

* TVA is continuing long-term ecological monitoring in the Emory, Tennessee, and Clinch Rivers to confirm Kingston Recovery Project remedial objectives are met and that there are no adverse impacts to ecological communities.

* Slopes are stable under current static conditions. Additional mitigation measures are being designed for seismic conditions.

NOTE: The KRP Ash Landfill is not part of this assessment and is regulated by the TDEC Division of Solid Waste Management.

Stantec TVA

Acronyms and Abbreviations

amsl	Above Mean Sea Level
AOC	Area of Concern
AOI	Area of Interest
BERA	Baseline Ecological Risk Assessment
bgs	Below Ground Surface
BTV	Background Threshold Value
CARA	Corrective Action/Risk Assessment
CCR	Coal Combustion Residuals
CCR Parameters	CCR Constituents listed in 40 CFR 257, Appendices III and IV, and the five inorganic constituents listed in Appendix I of Tennessee Rule 0400-11-01-.04
CCR Rule	USEPA Final Rule on Disposal of Coal Combustion Residuals from Electric Utilities
CERCLA	Comprehensive Environment Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Constituents of Concern
CRM	Clinch River Mile
CSM	Conceptual Site Model
DMP	Data Management Plan
DQO	Data Quality Objective
DSWM	TDEC Division of Solid Waste Management
EAR	Environmental Assessment Report
EE/CA	Engineering Evaluation/Cost Analysis
EI	Environmental Investigation
EIP	Environmental Investigation Plan
EnvStds	Environmental Standards, Inc.
ERDC	United States Army Corps of Engineers Engineer Research and Development Center
ERM	Emory River Mile
EXD	Exploratory Drilling
°F	Degrees Fahrenheit
GEL	GEL Laboratories, LLC
GSL	Groundwater Screening Level
GWPS	Groundwater Protection Standard(s)
KIF Plant	Kingston Fossil Plant
KRP	Kingston Recovery Project
LTM SAP	Long-Term Monitoring Sampling and Analysis Plan
MNR	Monitored Natural Recovery
MQA	Material Quantity Assessment
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
%	Percent

Acronyms and Abbreviations

PCS	Perimeter Containment System
PLM	Polarized Light Microscopy
PWS	Perimeter Wall Stabilization
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAO	Remedial Action Objectives
RG	Remedial Goal
RJ Lee	RJ Lee Group
SAP	Sampling and Analysis Plan
SAR	Sampling and Analysis Report
SPLP	Synthetic Precipitation Leaching Procedure
SSLs	Statistically Significant Levels
Stantec	Stantec Consulting Services Inc.
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TDEC Order	Commissioner's Order OGC15-0177
Terramodel	Terramodel 3D™
TestAmerica	Eurofins Environment Testing America
TME	Tissue Monitoring Endpoint
TN	Tennessee
TOC	Total Organic Carbon
TriAD	TriAD Environmental Consultants, Inc.
TVA	Tennessee Valley Authority
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTLs	Upper Tolerance Limits

Chapter 1 Introduction

The Tennessee Valley Authority (TVA) and Stantec Consulting Services Inc. (Stantec), on behalf of TVA, prepared this Environmental Assessment Report (EAR) to provide an evaluation of the environmental conditions at the Kingston Fossil Plant (KIF Plant) in Harriman, Tennessee, that may have been related to management of coal combustion residuals (CCR) in onsite impoundments and landfills. The KIF Plant is an operational TVA coal-fired power plant in Roane County, located in the east portion of Tennessee (see below and Exhibit 1-1).

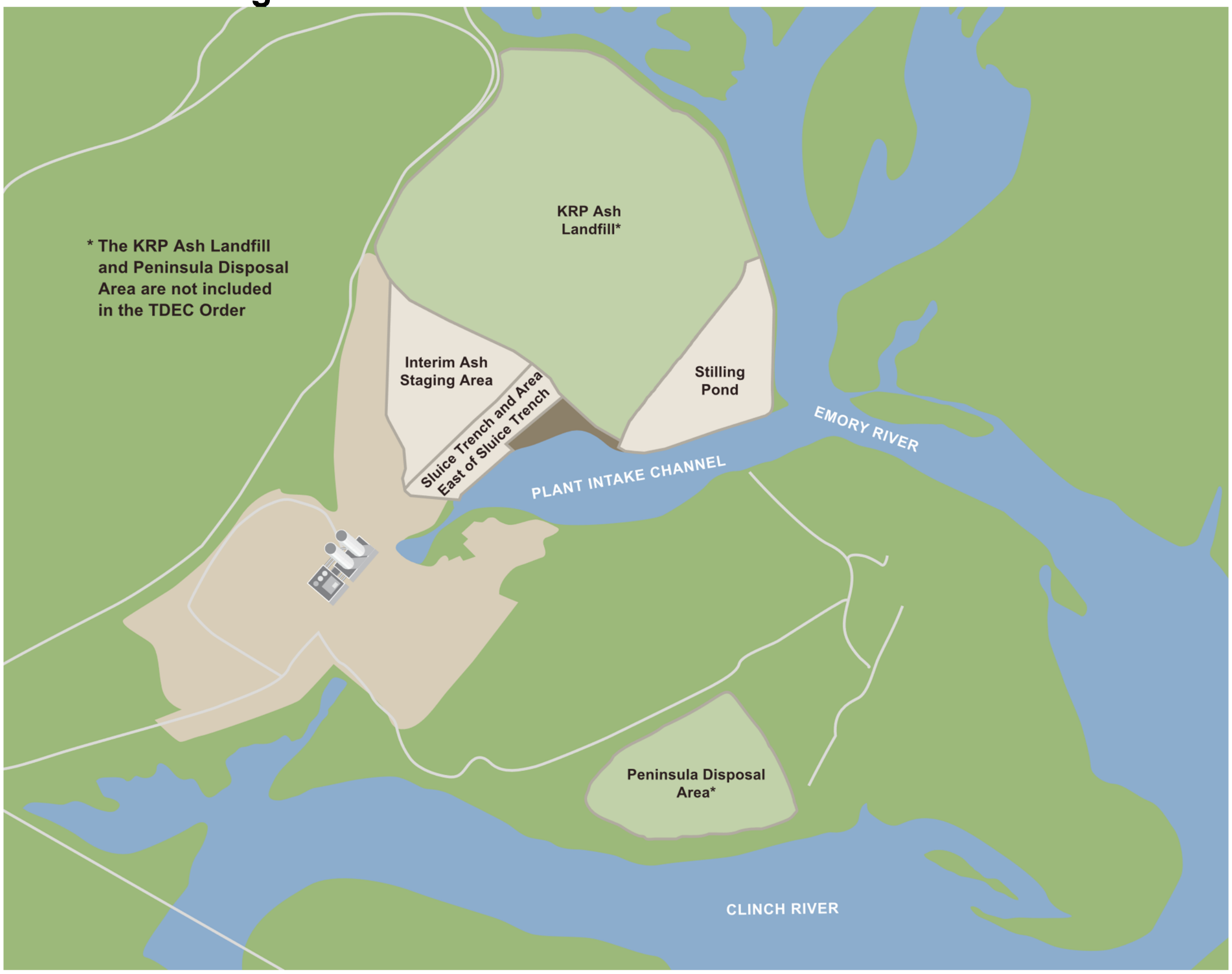
KIF Plant Location

1.1 Background, Scope, and Objectives

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to TVA (TDEC 2015, in Appendix A.1). Per the June 14, 2016, letter from TDEC to TVA, the three CCR management units[2] at the KIF Plant included in the TDEC Order are: Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench, which are surface impoundments (see below) and referenced collectively herein as "TDEC Order CCR management units." Per the June 14, 2016, Environmental Investigation Plan request letter from TDEC (Appendix A.2), the Kingston Recovery Project (KRP) Ash Landfill and Peninsula Disposal Area CCR management units (see below) were not included in the TDEC Order due to prior considerations and work at those areas.

[2] The term "CCR management unit" is used in this document generally and is not intended to be a designation under federal or state regulations.

KIF CCR Management Units



In accordance with the TDEC Order, TVA prepared an Environmental Investigation Plan (EIP) for the KIF Plant (TVA 2018) to obtain and provide information requested by TDEC. Following public review and comment on the draft, the EIP was approved by TDEC on November 16, 2018, and TVA implemented the activities between 2018 and 2021 in accordance with the approved EIP. As specified in the TDEC Order, the objective of the EIP was to "identify the extent of soil, surface water, and ground water contamination by CCR" from onsite management of CCR material in impoundments and landfills. In addition, per TDEC's information requests, the EIP included assessment of CCR management unit structural stability and integrity.

The EIP included characterization of the site hydrogeology and investigations of CCR material, groundwater, background soils, and seeps at and near the KIF Plant TDEC Order CCR management units to supplement historical data. As described further in Chapter 1.3, and detailed in Chapter 7, surface stream, sediment and ecological characterization activities were not included in the EIP because of the extensive investigations performed for the KRP. This EAR presents the results of the EIP and KRP investigations and an evaluation of recent and historical data to provide conceptual site models (CSMs) for the TDEC Order CCR management units and overall findings for environmental media at the KIF

Plant. CSMs describe sources of CCR constituents, pathways by which they can move, and environment media potentially impacted if they are released. As required by the TDEC Order, this EAR will be revised to address TDEC comments until TDEC determines that the extent of CCR contamination has been defined.

1.2 Regulatory Framework

The onsite management of CCR at the KIF Plant is subject to the following regulatory programs relevant to this investigation. Data from these programs was considered in the development of the EAR.

1.2.1 TDEC Order

The TDEC Order was issued to establish a process for investigating, assessing, and remediating unacceptable risks from management of CCR material at TVA coal-fired plants in the state of Tennessee. The TDEC Order also established a process whereby TDEC would oversee TVA's implementation of the United States Environmental Protection Agency (USEPA) CCR Rule for coordination and compliance with Tennessee's solid waste management program. Information about the USEPA CCR Rule is provided in Chapter 1.2.2.

Upon TDEC approval of the EAR, TVA will prepare and submit a Corrective Action/Risk Assessment (CARA) Plan to TDEC. The CARA Plan, which will be subject to a public review and comment process, will specify the actions that TVA plans to take to mitigate unacceptable risks at the KIF Plant TDEC Order CCR management units, including the basis of those actions. The information provided in this EAR will support TVA's preparation of the CARA Plan and TDEC's decision-making process regarding the actions to be taken at the KIF Plant TDEC Order CCR management units pursuant to the TDEC Order.

1.2.2 CCR Rule

The USEPA CCR Rule sets forth national criteria for the management of CCR material, was published on April 17, 2015, and can be found in Title 40, Code of Federal Regulations (40 CFR) Part 257, Subpart D (CCR Rule). The rule includes criteria for monitoring groundwater and assessing corrective measures if constituents listed in Appendix IV of the CCR Rule are detected in samples collected from downgradient groundwater monitoring wells at statistically significant levels (SSLs) greater than established groundwater protection standards (GWPS). Groundwater monitoring results and assessment of corrective measures are reported as required by the CCR Rule. TVA's CCR Rule Compliance Data and Information website is available for the public to view CCR Rule-required documents, including groundwater monitoring reports for the KIF Plant CCR management units at the following location: Kingston Coal Combustion Residuals (tva.com).

Additional CCR Rule criteria include closure and post-closure plans, design (including structural stability), location demonstrations, and operating criteria demonstrations which are certified by a qualified professional engineer.

Two of three CCR management units at the KIF Plant that are included in the TDEC Order are also subject to the CCR Rule: (1) the Stilling Pond and (2) the Sluice Trench and Area East of Sluice Trench.

1.2.3 State Programs

In addition to the TDEC Order and CCR Rule, TDEC has issued permits to TVA for ongoing CCR management and wastewater discharges from the KIF Plant CCR management units. Current permits include:

- TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM) - Class II Landfill Permit No. IDL 73-000-0094 for the Ash Disposal Facility Landfill (herein after referenced as the KRP Ash Landfill)
- TDEC Rule 0400-11-01-.04 DSWM - Class II Landfill Permit No. IDL 73-000-0211 for the Peninsula Disposal Area
- National Pollutant Discharge Elimination System (NPDES) Permit No. TN0005452. Permitted wastewater discharges are to the Clinch River Mile (CRM) 2.9 via Outfalls 001 (which includes CCR management unit discharges) and 002.

Under DSWM landfill permits IDL 73-000-0094 and IDL 73-000-0211, records are maintained for groundwater monitoring well sample results and groundwater elevations throughout the life of the unit, including the post-closure care period. Groundwater monitoring results are reported to TDEC at the intervals specified in the permit. As part of that program, monitoring well KIF-22C was installed in November 2017 as a replacement well for well 22A because CCR material was observed in the well 22A screen interval. Analytical results from replacement well KIF-22C from March 2018 through 2021 have not shown a detection above the TDEC-approved groundwater screening levels (GSLs) for TDEC Appendix I or CCR Rule Appendix IV constituents (Appendix A.2).

Under the NPDES permit, outfall monitoring results are recorded and submitted monthly to TDEC's Division of Water Resources. Raw water intake samples are taken annually and submitted in the Discharge Monitoring Report following the sampling event. Whole effluent toxicity testing is conducted annually. Perimeter dike inspections are conducted in accordance with the requirements of a Seepage Action Plan. A report of seep inspection results, a listing of seep conditions, and corrective actions completed and in progress are submitted annually. An alternative thermal limit was approved for the permit as a result of biological monitoring data showing that a thermal variance is justified in the near-field area of the plant's final discharge to the Clinch River via Outfall 002.

1.2.4 Kingston Recovery Project

On December 22, 2008, approximately 5.4 million cubic yards of CCR material were displaced to the adjacent Swan Pond Embayment with transport into the Emory, Clinch, and Tennessee River systems as a result of a structural failure initiated in the northwestern corner of Ash Disposal Area Dredge Cell No. 2 (refer to Exhibit 1-2). TVA undertook immediate response actions beginning on the day of the failure in close coordination with the USEPA, TDEC, and other agencies. TVA and the USEPA signed an Administrative Order and Agreement on Consent 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 requiring the comprehensive assessment, cleanup and restoration of areas impacted by the release. The recovery and restoration actions discussed herein are collectively referenced as the KRP. TVA's compliance with the Administrative Order and Agreement on Consent is documented in the *Kingston Ash Recovery Project Completion Report* (TVA 2015).

Time-critical actions began immediately following issuance of the Administrative Order and Agreement on Consent. These actions included the dredging and excavation of CCR material from the Emory River and Swan Pond Embayment, dewatering and processing of the recovered CCR material (including water management), loading of the dewatered CCR material into railcars, and transport of the CCR material to the Arrowhead Landfill in Perry County, Alabama per the Action Memorandum approved by USEPA (TVA 2009). Dredging of the Emory River during the time-critical removal action removed approximately 3,511,000 cubic yards of released CCR material and sediment, but not all CCR material was removed. Time-critical dredging was not conducted below Emory River Mile (ERM) 1.8 due to the presence of non -KIF

Plant related legacy constituents (Cesium-137) in the sediment. Completion of the time-critical removal actions were documented in TVA (2011a).

Subsequent non-time-critical actions approved by USEPA (TVA 2012b) included the removal of additional CCR material from the Swan Pond Embayment. CCR material removed as part of the non-time-critical actions was dewatered and placed in the KRP Ash Landfill. The KRP Ash Landfill was constructed with a perimeter containment system to withstand design earthquake loads and closed with the construction of a flexible membrane liner system and soil cap. The perimeter containment system (PCS) was designed to prevent offsite release of CCR material from the closed ash landfill, for both long-term static conditions and during seismic loading. The PCS was not designed to contain pore water or groundwater. The PCS included a Perimeter Wall Stabilization (PWS) component consisting of a grid of buried cement-bentonite walls constructed within a designated footprint around the landfill perimeter (Exhibit 1-2). For purposes of the PWS design and construction, the perimeter was divided into eight segments. For each segment, one of three approved PWS configurations was constructed, depending upon the design requirements. These configurations include: two perimeter walls (inboard and outboard) that are connected by shear walls across the stabilized footprint; an inboard perimeter wall with shear walls extending the full width of the stabilized footprint; and shear walls (without perimeter walls) extending the full width of the stabilized footprint. The design requirements for each segment determined the width of the stabilized footprint, spacing between inboard and outboard walls (where applicable), spacing between shear walls, and depth of bedrock embedment.

Upon completion of the removal actions, an estimated 532,000 cubic yards of CCR material remained in the river system (TVA 2015). The *Action Memorandum for the River System* (TVA 2012b) provided the justification for leaving that material in place to avoid impairing the ecological habitat or increasing short-term risks to human health or the environment. Monitored natural recovery (MNR) was the recommended action approved by the USEPA to address the residual CCR material in the river system. Long-term monitoring programs were developed to assess the effectiveness of MNR and confirm that risks associated with the CCR material release remain low. Long-term monitoring results are reported to TDEC and USEPA every two years. Every five years, the long-term monitoring activities are reviewed and adjusted as appropriate. This monitoring will continue for up to 30 years. More information regarding long-term monitoring of the river system is provided in Chapter 7.

1.3 Environmental Investigation Overview

The following provides an overview of the environmental investigation (EI) activities conducted in accordance with the EIP that are reported in this EAR. The evaluation of existing data from previous studies conducted at the KIF Plant served as the foundation to support the TDEC Order EI. Based on the previous and ongoing extensive surface stream, sediment and ecological investigations conducted for the KRP, discussed further in Chapters 2 and 7, the EI did not include additional surface stream, sediment or ecological sampling activities, but rather required an assessment of this KRP data in this EAR.

1.3.1 Investigation Activities

In November 2018, Revision 4 of the EIP was approved by TDEC (Appendix A.2), which details the proposed EI to be conducted by TVA to provide additional information requested by TDEC. The EIP is comprised of desktop studies, Sampling and Analysis Plans (SAPs), a Quality Assurance Project Plan (QAPP), a Data Management Plan (DMP), a proposed schedule of investigative activities, and responses to TDEC information requests and public comments.

Environmental media samples collected as part of the EI, or for other ongoing environmental programs being conducted at the plant, were analyzed for CCR parameters listed in the CCR Rule, Appendices III and IV. Five additional inorganic parameters listed in Appendix I of Tennessee (TN) Rule 0400-11-01-.04 that are not included in the CCR Rule Appendices III and IV were analyzed to maintain continuity with TDEC environmental programs.

CCR Parameters
CCR Rule Appendix III Parameters
Boron
Calcium
Chloride
Fluoride[1] (also Appendix IV)
pH
Sulfate
Total Dissolved Solids
CCR Rule Appendix IV Parameters
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Lead
Lithium
Mercury
Molybdenum
Radium-226+228
Selenium
Thallium
Additional TDEC Appendix I Parameters
Copper
Nickel
Silver
Vanadium
Zinc

Notes: [1]Fluoride is both a CCR Rule Appendix III and CCR Rule Appendix IV CCR parameter. In this table, and in the results figures and tables for this report, fluoride has been grouped with the Appendix III CCR parameters only to avoid duplication. Only TDEC Appendix I and CCR Rule Appendix IV constituents are subject to potential corrective measures.

The combined CCR Rule Appendices III and IV parameters and TDEC Appendix I inorganic parameters are referenced collectively herein as “CCR Parameters.” As specified in the SAPs, additional parameter analyses were also performed based on the specific needs of the investigation. Where applicable, additional analyses are described in Chapters 3 through 6 below. Additionally, CCR constituents were analyzed as part of the KRP as discussed in Chapter 7.

As documented in this EAR, the EI was implemented in accordance with the SAPs, which were updated with TVA- and TDEC-approved programmatic and project-specific changes made after approval of the EIP. EI results are summarized in this report, with details of each investigation provided in technical evaluation summaries and associated sampling and analysis reports (SARs) included as appendices. The purpose of the SARs was to document the work completed during the investigations and present the information and data collected to meet the objectives of the SAPs. The SARs were prepared and submitted to TDEC for review following completion of the SAP scopes of work. If TDEC provided comments after their initial reviews of the SARs, the comments were addressed, and the SARs were updated and re-submitted to TDEC for final acceptance. After each of the SARs was accepted by TDEC, those EI results, along with historical data collected under other State and/or CCR programs, were evaluated and are presented in this EAR.

The investigations and subsequent assessments completed pursuant to the EIP and EIP SAPs at the KIF Plant TDEC Order CCR management units are listed below:

- Background Soil Investigation
- Exploratory Drilling
- CCR Material Characteristics Investigation
- Material Quantity Assessment
- Hydrogeological Investigation
- Groundwater Investigation
- Seep Investigation
- Assessment of KRP environmental media investigations

1.3.1.1 Screening Levels

Sampling results obtained during these investigations are evaluated in this EAR by comparing concentrations of CCR Parameters to TDEC-approved screening levels (Table 1-1 and Appendix A.2). GSLs are based on published human health risk-based values considering these media as potential potable water sources. The purpose of this comparison is to identify CCR Parameters in environmental media that require further assessment in the CARA Plan. The screening levels are generic (not specific to an individual person or ecological receptor) and are protective of human and ecological health. Most screening levels are not regulatory standards and are conservatively based on published health studies. Concentrations above the screening level do not necessarily mean that an adverse health effect is occurring, but rather, that further evaluation is required in the CARA Plan to determine if an unacceptable risk exists, and if corrective action is required.

The statistical evaluation conducted for groundwater analytical results in this EAR was for investigatory purposes to characterize the extent of CCR impacts as required by the TDEC Order. It was not conducted for compliance with the CCR Rule or TDEC permitted landfill monitoring programs. Reports for compliance with the CCR Rule can be found on TVA's CCR Rule Compliance Data and Information website. Groundwater monitoring reports for the TDEC permitted landfill monitoring program are submitted to TDEC within 60 days of sampling events.

1.3.1.2 Hydrogeological Terms

For purposes of this EAR, the following hydrogeological terms as they are defined below are used throughout this document.

- Pore water – subsurface water that occurs in pore spaces in CCR material.
- Groundwater – subsurface water that occurs in pore spaces in unconsolidated or geologic materials (e.g., soil, bedrock).
- Aquifer – a geologic formation capable of yielding usable quantities of groundwater.
- Unconfined aquifer – an aquifer in which the water table forms the upper boundary.
- Saturated – Unconsolidated or geologic materials (e.g., soil, bedrock) or CCR material where all of the pore space is filled with water. The use of the term "saturated" in reference to the moisture content of CCR material does not imply that the pore water is readily separable from the CCR material.

- Moisture content – the measure of the amount of water contained within unconsolidated or geologic materials (e.g., soil, bedrock) or CCR material. Moisture content of saturated material can be variable because the characteristics of the material determine the amount of pore space available for water to fill.

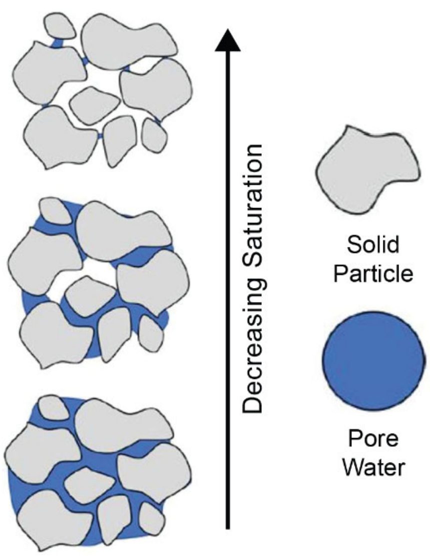
- Phreatic surface – the surface of pore water at which pressure is atmospheric and below which CCR material may be saturated with pore water. Pore water levels are measured at locations where temporary wells or piezometers were installed within CCR material. The measured pore water levels are used to infer pore water levels between the wells and piezometers to develop the phreatic surface.

- Uppermost aquifer - the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within a facility's property boundary.

- Water table – the surface of groundwater at which pressure is atmospheric and below which geologic materials (e.g., soil or bedrock) may be saturated with groundwater. The measured groundwater levels are used to infer groundwater levels between the wells and piezometers to develop the water table surface. Groundwater levels are measured at locations where wells or piezometers were installed at depths near the depth of the water table surface.

Groundwater level measurements from wells or piezometers installed around the CCR management units and at multiple depths below the water table provide information about the direction of groundwater movement.

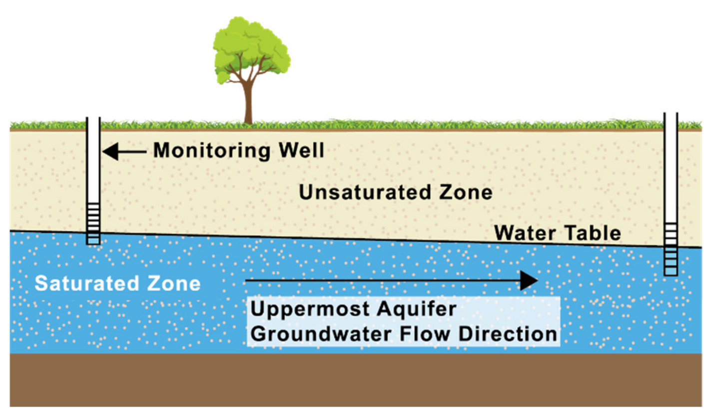
Pore Water



Benson, C., *Water Flow in Coal Combustion Products and Drainage of Free Water*, Report No. 3002021963, Electric Power Research Institute, Palo Alto, CA.

This figure depicts how subsurface water occurs in the pore spaces in CCR material (referred to as "pore water" in this EAR), and how saturation varies within the CCR material. The phreatic surface is the surface of pore water at which pressure is atmospheric and below which CCR material may be saturated with pore water.

Unconfined Aquifer



Groundwater is subsurface water that occurs in pore spaces in soil or bedrock. Groundwater level measurements taken in a well screened near the water table in an unconfined aquifer represent the water level in the aquifer. Groundwater level measurements are used to estimate directions of groundwater movement. Groundwater generally flows much more slowly than water in a surface stream or river.

1.3.2 Data Management and Quality Assessment

For the EI, laboratory analytical testing was conducted by the following laboratories:

- GEL Laboratories, LLC (GEL) in Charleston, South Carolina
- Eurofins Environment Testing America Inc. (formerly known as TestAmerica and referenced herein as TestAmerica), in Nashville, Tennessee; Pittsburgh, Pennsylvania; and St. Louis, Missouri
- RJ Lee Group, Inc. (RJ Lee) in Monroeville, Pennsylvania.

Geotechnical laboratory testing and data review was performed by Stantec in Lexington and Louisville, Kentucky.

Data management was performed by Environmental Standards, Inc. (EnvStds). Field data and laboratory analytical data collected under the EI were managed in a database in accordance with the DMP for the TDEC Order (EnvStds 2018a). The DMP was developed for data collected under the TDEC Order. Consolidated management of data related to the TDEC Order allowed for environmental data associated with the investigation to be appropriately maintained and accessible to data end users. The DMP provided a basis for supporting technical data management with an emphasis on completeness, data usability, and defensibility of the data.

To support the EI, a Quality Assurance (QA) program was implemented to verify that environmental data used for decision-making were reliable. The overall QA objective for field activities, laboratory analyses, and data assessment was to produce data of sufficient and known quality to support program-specific objectives and produce high-quality, legally-defensible data. This objective was met by following the QAPP (EnvStds 2018b), included as Appendix C of the EIP.

The QAPP was followed for investigation data quality assessment, where data quality refers to the level of reliability associated with a dataset or data point. The QAPP describes QA procedures and Quality Control (QC) measures applied to EI activities, describes the generation and use of environmental data associated with the investigation, is applicable to sampling and monitoring programs associated with EI activities, and provides quantitative objectives for analytical data generated under the investigation activities.

Data collected during the EI were evaluated for usability by conducting a QA review, per the QAPP. As part of TVA's commitment to generate representative and reliable data, EnvStds performed oversight of field activities, field documentation review, centralized data management, and data validation or verification of laboratory analytical data. In addition, TDEC and TDEC's contractor Civil & Environmental Consultants, Inc., were periodically onsite to observe field activities and collect confirmation samples during the investigations. Based on the QA review performed by EnvStds, the EI data collected are considered usable for reporting and evaluation in this EAR and meet the objectives of the TDEC Order. Further documentation of the QA program implemented during the EI is provided in the *Data Quality Summary Report for the Tennessee Valley Authority Kingston Fossil Plant Environmental Investigation* prepared by EnvStds following completion of the EI (EnvStds 2023).

As noted above, surface stream, sediment, and ecological investigations were not included in the EIP; rather, the environmental assessment relies on data generated under the KRP. Environmental investigations and monitoring conducted as part of the KRP were governed by a comprehensive QA program, which ultimately served as the basis for the QA Program developed for the KIF Plant EI. Similar to the KIF EI QA Program, the KRP QA program included third-party field audits, field documentation review, laboratory audits, laboratory analytical data validation, and a comprehensive integrated data management process. Accordingly, the analytical data generated under the KRP are considered to be of comparable quality to the data generated under the KIF EI. Additional information regarding the QA program for data utilized in the KIF EAR is provided in the *TVA KIF Ash Recovery Project Quality Assurance Project Plan* (EnvStds 2009, 2010, and 2013) and the *Long-Term Monitoring Sampling and Analysis Plan* (LTM SAP) (TVA 2013). Additional information regarding the quality of the KRP data utilized in the KIF EAR is provided in the *Baseline Ecological Risk Assessment* (BERA) (Arcadis 2012) and the *River System Engineering Evaluation/Cost Analysis* (TVA 2012a).

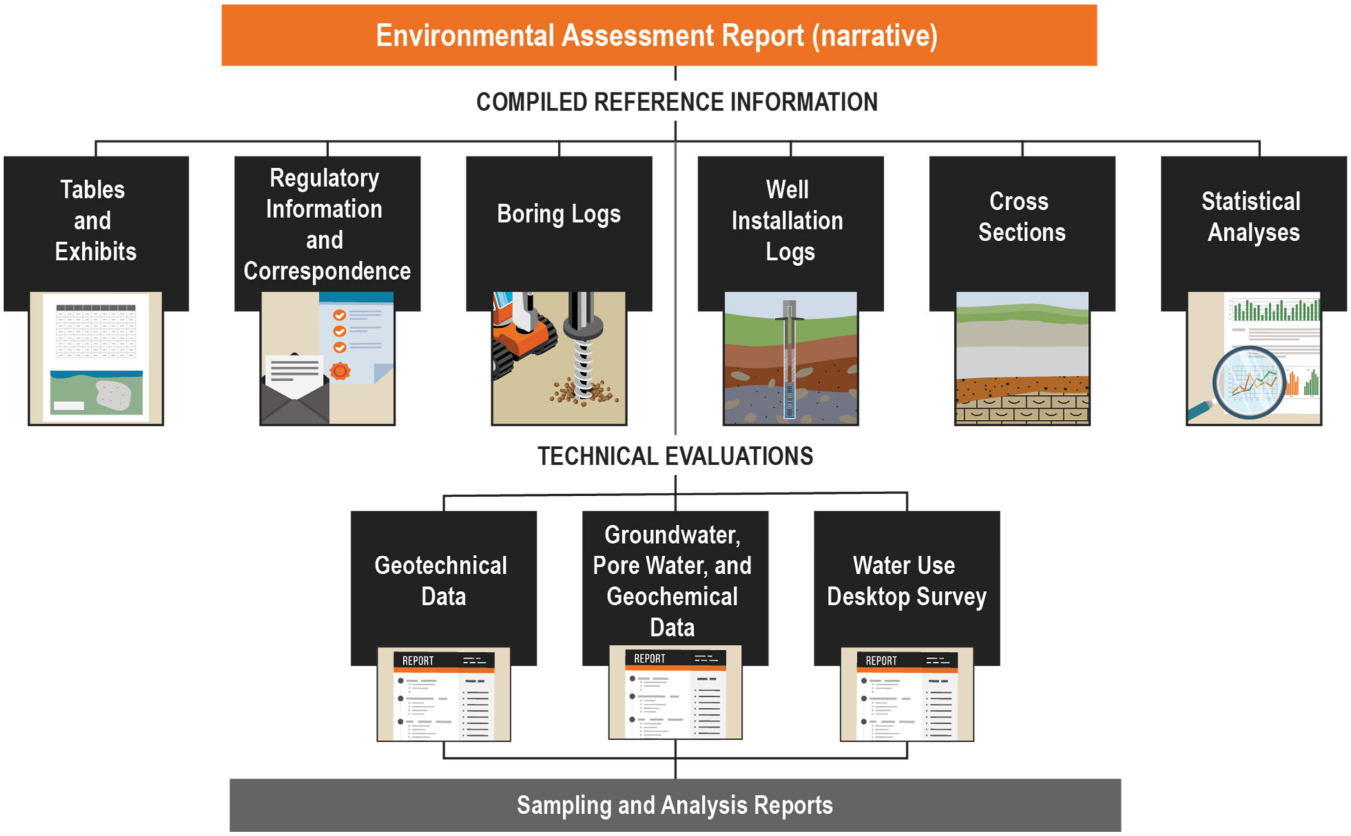
1.4 Key Milestones

A chronology of key milestones and events related to the TDEC Order and implementation of the EIP that occurred following approval of the EIP is provided below.

Date	Event
October 1, 2018	Phase 1 EI field activities commence to support CCR Rule
November 16, 2018	TDEC approval of KIF Plant EIP Revision 4
December 17, 2018	Kickoff meeting held with TVA and TDEC to discuss implementation of EIP
December 6, 2019	Phase 1 EI field activities substantially complete (excluding Phase 2 Sampling and Water Use Survey)
June 17, 2020	Initial SAR submitted to TDEC
January 25, 2021	Phase 2 field activities commence
February 26, 2021	Phase 2 field activities complete
March 28, 2023	Last SAR accepted by TDEC
May 30, 2023	Submittal of KIF Plant EAR Revision 0 to TDEC
January 12, 2024	Initiation of Water Use Survey

1.5 Report Organization

This EAR is based on EI data and results from other ongoing environmental programs obtained for the KIF Plant TDEC Order CCR management units through 2022. To facilitate discussion of the interrelationships of the data collected during the EI and other ongoing environmental programs, the EAR presents an evaluation of findings organized in the following principal investigation components: background soils, CCR material, hydrogeology, seeps, and ecology. Chapters 3 through 8 herein provide a summary of each investigation's scope and presents the evaluation of those data, along with relevant historical or other environmental program data. The summary of findings presented in Chapters 3 through 6 and 8 are supported by detailed technical information and analyses presented in appendices as diagrammed below. Details of technical evaluations and information supporting those evaluations are included in appendices organized by subject matter. Field investigation activities sampling results are provided in SARs associated with each subject matter. The structure of the overall document is provided in the diagram below.


Environmental Assessment Report (narrative)
COMPILED REFERENCE INFORMATION
Tables and Exhibits
Regulatory Information and Correspondence
Boring Logs
Well Installation Logs
Cross Sections
Statistical Analyses
TECHNICAL EVALUATIONS
Geotechnical Data
Groundwater, Pore Water, and Geochemical Data
Water Use Desktop Survey
REPORT
REPORT
REPORT
Sampling and Analysis Reports

This EAR is organized as follows:

- **Executive Summary**: Describes the principal elements and findings of the environmental investigations presented in the EAR
- **Chapter 1 – Introduction:** Describes the background and purpose of the investigation, regulatory framework, an overview of the EI, public and agency involvement, and EAR organization
- **Chapter 2 – Site History and Physical Characteristics:** Presents the operational history, land use, and physical characteristics of the KIF Plant
- **Chapter 3 – Background Soil Investigation:** Summarizes the results of background soil investigations conducted for the KIF Plant
- **Chapter 4 – CCR Material Investigations:** Summarizes the TDEC Order CCR management unit geotechnical investigation results, including exploratory drilling, slope stability, structural integrity, and structural stability (bedrock) evaluations, findings from evaluations of pore water and CCR material characteristics investigation results, and provides information regarding CCR material characteristics and quantities
- **Chapter 5 – Hydrogeological Investigations:** Describes hydrogeologic conditions based on data from historical groundwater sampling and EI activities, and findings from geochemical evaluations of groundwater and pore water. Additionally, the findings of the water use survey are presented.
- **Chapter 6 – Seep Investigation:** Summarizes the results of the seep investigation
- **Chapter 7 – Surface Streams, Sediment, and Ecological Investigations:** Describes the historical activities and findings from the environmental sampling, biological studies, and human health and ecological risk assessments conducted as part of the KRP.
- **Chapter 8 – TDEC Order Investigation Summary and Conceptual Site Models:** Presents the KIF Plant CSMs describing the characterization of CCR material contained in the TDEC Order CCR management units, and a summary of the nature and extent of associated impacts (if any) to groundwater, soil, seeps, surface stream water, and ecology
- **Chapter 9 – Conclusions and Next Steps:** Presents a summary of, and conclusions based on, the EI conducted at the KIF Plant TDEC Order CCR management units and next steps for activities related to the TDEC Order
- **Chapter 10 – References:** List of documents referenced in the EAR
- **Tables and Exhibits:** Presented following the main text of this report, and are numbered according to the chapter that they are first presented in
- **Appendices:** Includes regulatory information, technical data (i.e., boring logs, well installation logs, cross sections), data and statistical analyses, technical evaluations, and SARs for each investigation. Technical evaluations and supporting information have been grouped into the investigation components described in the main report (e.g., background soils, CCR material, hydrogeology, seeps, surface stream water, sediment, and ecology).

Chapter 2 Site History and Physical Characteristics

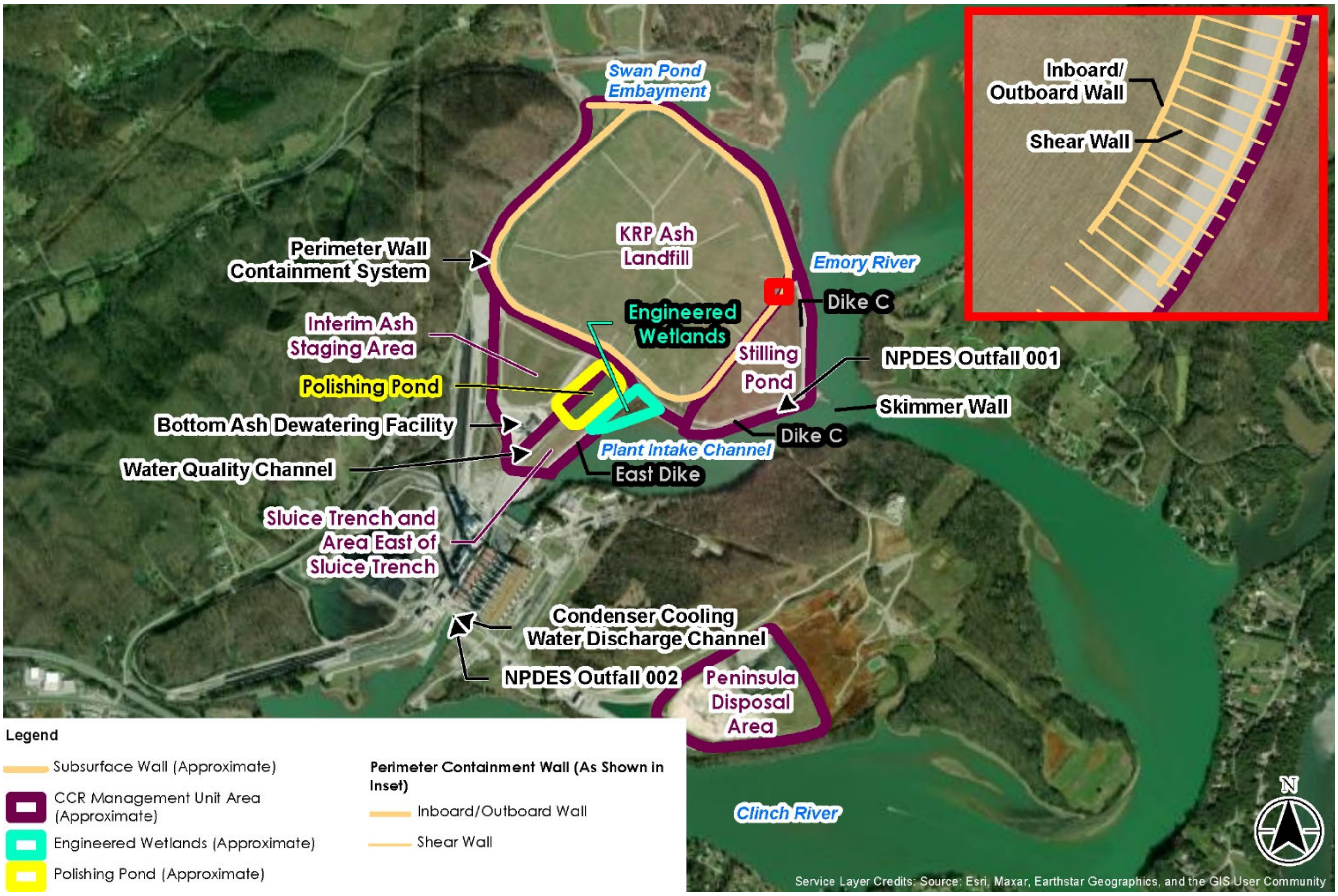
2.1 Site Operations

TVA constructed the KIF Plant between 1951 and 1954 to provide additional electricity generating capacity for the atomic energy installation at Oak Ridge (TVA 1965). TVA commenced power generation at the KIF Plant in 1954. TVA operates the nine-unit KIF Plant that annually generates approximately 10 billion kilowatt-hours of electricity (i.e., enough to supply 700,000 homes) (TVA 2022a). To meet the demand, Kingston burns approximately 14,000 tons of coal per day and annually produces approximately 122,000 tons of CCR material in the forms of fly ash, bottom ash, and gypsum (TVA 2022a). Both fly ash and gypsum generated from the KIF Plant operations are beneficially reused as raw manufacturing materials. Of the 122,000 tons of CCR material produced each year, approximately 101,000 tons are beneficially used. On average, approximately 91 percent (%) of the fly ash generated at the KIF Plant is sold for reuse in the concrete industry each year where it is used in dams, roads, bridges, buildings, precast concrete products, airport runways, and driveways. KIF Plant fly ash was used in the concrete for the Riverwalk parking garage in Knoxville and the University of Tennessee Student Union building. Concrete with fly ash is stronger, more durable, lower cost, and environmentally friendly because every ton of fly ash that replaces Portland cement reduces carbon emissions by one ton (TVA 2022b). More than 75 concrete plants in Tennessee, Kentucky, Virginia, Georgia, and North Carolina use fly ash from the KIF Plant. Additionally, approximately 84% of the gypsum generated annually at the KIF Plant is sold to Georgia Pacific for use in the wallboard industry and CEMEX Knoxville to manufacture ready mix concrete. This type of gypsum is considered synthetic, and it conserves natural resources by replacing mined natural gypsum.

The KIF Plant has a total of five CCR management units, as shown on Exhibit 2-1: the Stilling Pond, Interim Ash Staging Area, Sluice Trench and Area East of Sluice Trench, Peninsula Disposal Area, and KRP Ash Landfill. Three of these CCR management units (the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench) are TDEC Order CCR management units. With the exception of the currently active Peninsula Disposal Area, each of the CCR management units was closed in accordance with applicable regulations in effect at the time of closure. The total area of the CCR management units at the KIF Plant is approximately 395 acres. The total area of the TDEC Order CCR management units at the KIF Plant is approximately 100 acres.

TVA currently manages CCR material generated by the KIF Plant in the Peninsula Disposal Area. Fly ash that is not beneficially used is transported by truck to the Peninsula Disposal Area for disposal. Dewatered gypsum is temporarily stockpiled in the Peninsula Disposal Area for later beneficial use. Reject gypsum (gypsum fines) are disposed within the Peninsula Disposal Area. Bottom ash is sluiced to the Bottom Ash Dewatering Facility where it is dewatered and then transported by truck to the Peninsula Disposal Area for disposal. A water quality channel conveys process water to the Polishing Pond. Conveyance piping carries treated process water from the Polishing Pond outlet to NPDES-permitted Outfall 001 where it is discharged to the Plant Intake Channel.

KIF Plant Features



2.2 CCR Management Unit History and Land Use

KIF Plant discharges were initially discharged to the Initial Ash Disposal Area which was a slack water area created by the impoundment of Watts Bar Reservoir. The Initial Ash Disposal Area discharged to Watts Bar Reservoir until construction of the perimeter dike system that formed the Ash Pond was completed in 1958. The Initial Ash Disposal Area reached CCR material placement capacity in 1965, and CCR material was subsequently directed to the Ash Disposal Area where it was deposited and progressively filled from south to north. From 1958 to 1977, water in the Ash Disposal Area discharged via a dual riser pipe system through Dike C to Watts Bar Reservoir. Between 1976 and 1978, TVA raised Dike C from elevation 748 feet to 765 feet and constructed a divider dike to form the Stilling Pond to allow fine particles to settle out before discharging to the Plant Intake Channel (Exhibit 2-2). The Metal Cleaning Ponds were also constructed in the footprint of the closed Initial Ash Disposal Area during this time period.

In 1983, TVA constructed Dike D, an interior dike, in a southwest-to-northeast direction. The construction of Dike D roughly reduced the size of the Ash Disposal Area by half as part of a transition to dredge cell operations. In 1984, TVA began sluicing fly ash, bottom ash, and other plant process waters into a sluice trench that discharged to the Ash Disposal Area. Fly ash and bottom ash were then excavated from the sluice trench, dredged from the Ash Collection Pond, and transported to Dredge Cell Nos. 1, 2, and 3 for stacking (Exhibit 2-2). The dredge cells were permitted by TDEC as a Class II Solid Waste Landfill.

Shortly after the sluice trench was placed into service, red water seeps were noted in the area between the sluice trench and East Dike. Engineered Wetlands were constructed in 1987 to provide passive treatment to this acidic seepage. Currently, water from the Engineered Wetlands is pumped to the Water Quality Channel prior to discharging to the Polishing Pond for treatment and NPDES Outfall 001 (Exhibit 2-1).

Seeps were noted on the west slope of Dredge Cell Nos. 1, 2, and 3 from 2003 through 2008. Per the KIF Plant's *Routine Handling Operations and Maintenance Support Document* (TVA 2011b), quarterly seep inspections were conducted and documented and actions to address identified seeps were determined, prioritized, and executed. Further information regarding the history of the seep inspections is provided in Chapter 6.1. Instability was noted along the western limits of Dredge Cell Nos. 1, 2, and 3, which resulted in repairs. An Emergency Dredge Cell was constructed to stage CCR material while the repairs were being made.

In December 2007, the Peninsula Disposal Area was permitted by TDEC for the management of wet gypsum. A permit modification was later approved, allowing for the management of bottom ash and fly ash in the Peninsula Disposal Area along with gypsum.

In December of 2008, failure initiated in the northwestern corner of Ash Disposal Area Dredge Cell No. 2 (Exhibit 2-2), resulting in significant displacement of CCR material to the Emory and Clinch Rivers. This resulted in TVA and the USEPA signing an Administrative Order and Agreement on Consent that provided the regulatory framework for response and recovery actions under CERCLA. TDEC also issued a Commissioner's Order to TVA requiring the comprehensive assessment, cleanup and restoration of areas impacted by the release. In accordance with these USEPA and TDEC Orders, TVA submitted plans and reports associated with the response and recovery projects to USEPA for review and approval, and USEPA consulted TDEC during the review process.

TVA initiated emergency response actions and recovery operations the day of the failure on December 22, 2008 and continuing through 2015. These included river dredging, environmental sampling, ecological investigations, embayment restoration, groundwater flow modeling, and construction of the KRP Ash Landfill.

As a part of removal actions and per approvals from TDEC, the Metal Cleaning Ponds were closed so that the area could serve as a temporary staging area for CCR material during river dredging operations and subsequent construction of the KRP Ash Landfill (Exhibit 2-2). A delineation layer of stone and geotextile fabric was placed over the subgrade prior to staging CCR material. This staging area corresponds to the Interim Ash Staging Area.

Staged CCR material above the delineation layer was eventually removed from the Interim Ash Staging Area and placed in the Peninsula Disposal Area (AECOM 2016a). TVA completed capping and closure of the KRP Ash Landfill in 2015 and the Interim Ash Staging Area in 2016.

TVA's compliance with the Administrative Order and Agreement on Consent is documented in the *Kingston Ash Recovery Project Completion Report* (TVA 2015). In recognition of TVA's cleanup, ecological restoration, and community revitalization efforts as part of the KRP, USEPA Region 4 awarded TVA its Excellence in Site Reuse award in June 2015. Chapter 7 provides further information regarding environmental sampling, analysis, and monitoring activities completed during the KRP, and subsequent long-term monitoring to assess effectiveness of the remedy.

In 2015, TVA initiated the transition from wet to dry CCR material handling which included the following activities:

- Construction of temporary free-standing containers and the Bottom Ash Dewatering Facility to dewater bottom ash (Exhibit 2-1)
- Capping and closure of the sluice trench area of the Sluice Trench and Area East of Sluice Trench as documented in AECOM (2018 and 2019)
- Construction of a geomembrane-lined water quality channel and Polishing Pond to convey and treat process water prior to discharging to NPDES Outfall 001
- Construction of conveyance piping from the Polishing Pond outlet to NPDES Outfall 001
- Capping and closure of the Stilling Pond.

Capping and closure of the Stilling Pond involved the removal of free water, partial excavation of Dike C for borrow material, and the construction of a cap with a geomembrane liner and vegetative soil layer as documented in Stantec (2017 and 2018a). TVA completed the construction of a seepage collection system and reverse graded filter at the East Dike in 2017. The seepage collection system discharges seep water to the Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001. The closure of Sluice Trench and Area East of Sluice Trench CCR management unit was completed in 2018 with the construction of a cap with a geomembrane and vegetative soil layer along the East Dike in 2018 (AECOM 2018).

2.3 Ownership and Surrounding Land Use

The KIF Plant is owned and operated by TVA, a corporate agency of the United States, and is located at the confluence of the Clinch River and the west bank of the Emory River, as shown on Exhibit 2-1.

Land use surrounding the KIF Plant is primarily developed, and includes residential, commercial, with some forest areas with the nearest residence located approximately 0.4 miles south of the KIF Plant in Harriman. Additionally, four municipal water departments withdraw water from the Emory River, Little Emory River, and Watts Bar Lake for municipal purposes in the vicinity of the KIF Plant, as follows (TVA 2022c).

- The Roane Central Water District supplies public water to areas west and southwest of the KIF Plant with water sourced from the Rockwood Water Utility approximately five miles southwest and downstream of the plant. The Rockwood Water Utility obtains water from Watts Bar Reservoir near the Postoak Creek inlet.
- The Harriman Utility Board supplies public water to areas north and northwest of the KIF Plant with water sourced from the Emory River approximately 2.5 miles northwest and upstream of the plant.
- The Kingston Water Department supplies public water to areas south and southeast, including the KIF Plant, with water sourced from Watts Bar Reservoir approximately two miles south and downstream of the plant, but slightly upstream of the confluence of the Emory and Clinch Rivers.
- The Cumberland Water Utility supplies public water to areas east and northeast of the KIF Plant with water sourced from the Little Emory River approximately four miles northeast and upstream of KIF.

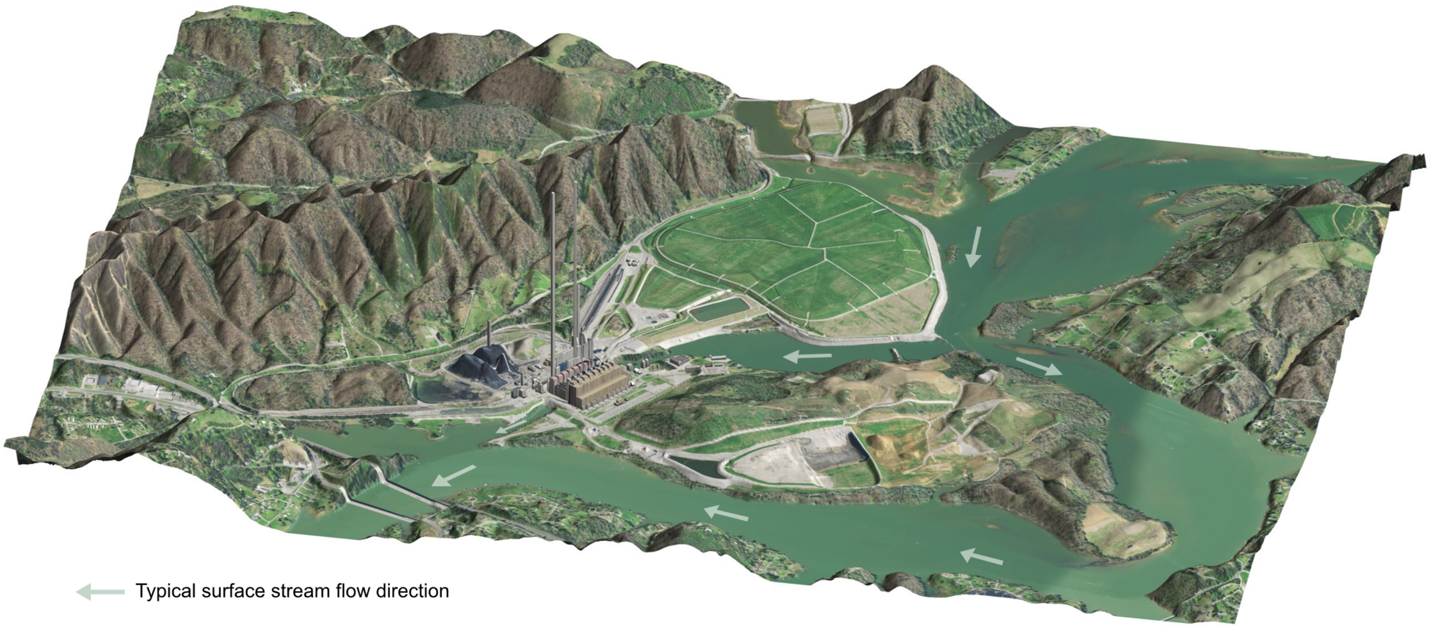
2.4 Physical Characteristics

2.4.1 Regional and Site Physiography

The KIF Plant is located within the Valley and Ridge physiographic province of the Appalachian Highlands physiographic division (Fenneman 1938). The Valley and Ridge Physiographic Province consists of a belt of northeast / southwest trending ridges and valleys formed by the differential erosion of a thick sequence of folded and faulted Paleozoic sedimentary rocks (USGS 1995). The elevations within the province range from about 380 feet above sea level to 4,604 feet above sea level (USGS 1995). Exhibit 2-3 presents the 1941 regional United States Geological Survey (USGS) topographic map of a portion of the Valley and Ridge province in the vicinity of the KIF Plant prior to construction.

The figure below provides a current aerial photograph overlain on the topography of and near the KIF Plant. The plant is located in a topographically low area with a higher elevation ridge to the northwest and the Emory River on the east. The KIF Plant pre-construction elevation ranged from approximately 740 to 750 feet above mean sea level (amsl).

KIF Physiographic Features



2.4.2 Regional Geology, Hydrogeology and Surface Water Hydrology

Regionally, the Valley and Ridge province consists of a belt of northeast-southwest trending ridges and valleys formed by differential erosion of a thick sequence of folded and faulted Paleozoic rocks (USGS 1995). Much of the valleys are made up of limestones and shales which are more susceptible to erosion, while the more resistant sandstones and conglomerates form the ridges (USGS 1978). The folded strata are the result of the thrust faulting and the various deformation events that produced the Appalachian Mountains (USGS 1979). The folding is less intense in the Tennessee portion of the province, but major faults are common and vertical to overturned beds appear in many places, particularly on the northwestern sides of anticlines (USGS 1997).

2.4.2.1 Geology

Locally, structural geology at the KIF Plant is typical of the Valley and Ridge province and consists of northeast striking and southeast-dipping strata (TVA 1991). Bedding planes dip to the southeast and have been primarily controlled by the Chattanooga Thrust Fault and the Kingston Thrust Fault, which trend in a northeasterly direction and can be traced from northwest Georgia to Central Virginia (TVA 2018). Local geologic mapping indicates the plant is underlain by Cambrian and Ordovician age bedrock of the Rome Formation, Conasauga Group, and the Knox Group, as shown on Exhibit 2-4. The bedrock primarily consists of shale with interbedded siltstone, limestone, and conglomerate, and are locally of low groundwater-producing capacity. Cores collected from the KRP Landfill had bedding contact angles of 10 to 30 degrees from horizontal (AECOM 2009). Borehole geophysics conducted at boring AD-2-D (located east of the Sluice Trench) indicated a statistical mean bedding plane dip of 41 degrees toward the southeast in the Conasauga Formation (Appendix H.1, Attachment H.1-B). The band of Rome Formation on the northwest side of the KIF Plant, along with the overlying Conasauga and Knox Formations, represent a thrust fault block which has been forced over the Knox Group outcrop to the northwest. The two major faults associated with this thrust block constitute the two closest faults to the KIF Plant (TVA 2004). Unconsolidated deposits overlay the bedrock and can be divided into two categories: (1) alluvial clays, silts, sands, and gravels deposited by the Clinch River and its tributaries, and (2) residuum derived from the decomposition of the parent bedrocks (TVA 2004). The site-specific geology of the KIF Plant is discussed in Chapter 5.

2.4.2.2 Surface Water Hydrology

The KIF Plant is located at the confluence of the Emory River and Clinch River (Exhibit 2-1). The Emory River flows in a northwest to southeast direction and the Clinch River flows in a northeast to southwest direction. Both the Emory River and Clinch River are impounded by Watts Bar Dam. In accordance with the TVA *Watts Bar Operating Guide* (TVA 2022d), normal summer pool for Watts Bar Reservoir is maintained between 740 and 741 feet above mean sea level (amsl); normal winter pool is maintained between 735 and 737 feet amsl. Prior to the construction of Watts Bar Dam, Swan Pond Creek followed a meandering course through the KIF Plant footprint and discharged to the Emory River (Exhibit 2-5); however, the construction of Watts Bar Dam circa 1942 created a backwater area that impounded Swan Pond Creek along with the Emory and Clinch Rivers. Springs were not identified in the Water Use Survey Area (refer to Chapter 5.4 for more details).

The complex surface water hydrology at the KIF Plant is influenced by structures constructed to divert cold water to the Plant Intake Channel as well as conditions in Watts Bar Reservoir. These structures include an underwater dam located on the Clinch River that diverts cold water upstream along the bottom of the Emory River to the Plant Intake Channel and a skimmer wall that restricts warmer water from flowing into the Plant Intake Channel (Exhibit 2-1). Wave action in Watts Bar Reservoir temporarily induces reverse flows in the vicinity of the KIF Plant. Cold water discharges from Melton Hill Dam, located approximately 19 miles upstream of the KIF Plant on the Clinch River, also influence thermal stratification near the KIF Plant.

2.4.2.3 Regional Hydrogeology

The Valley and Ridge province is underlain by carbonate bedrock aquifers of Cambrian, Ordovician, and Mississippian age (USGS 1995). On a regional level, these aquifers underlie more than one-half of the province and are typically present in valleys and rarely present on the broad, dissected ridges.

Groundwater in the Valley and Ridge aquifers primarily is stored in and moves through fractures, bedding planes, and solution openings in the rocks. Groundwater movement in the province in eastern Tennessee is localized in part by the repeating lithology created by thrust faulting and in part by streams. Major streams are parallel to the northeast-trending valleys and ridges, and tributary streams are perpendicular to the valleys and ridges. Older rocks have been displaced over younger rocks along thrust fault forming a repeating sequence of permeable and less permeable hydrogeologic units. The repeating sequence, coupled with the stream network, divides the area into a series of adjacent, isolated, shallow groundwater flow systems. Within these local flow systems, most of the groundwater movement takes place within 300 feet of land surface. The water moves from the ridges toward the adjacent streams that flow parallel to the long axes of the valleys. The majority of the groundwater is discharged directly to local springs or streams, but some of it flows along permeable fractures, bedding planes, and solution zones to finally discharge at more distant springs or streams. A summary of the hydrogeological characterization of the KIF Plant TDEC Order CCR management units is presented in Chapter 5.

2.4.3 Local Climate

Locally near the KIF Plant, the average monthly high temperature at weather station USC00404871, Kingston, Tennessee (National Oceanic & Atmospheric Administration 2020) located approximately three miles south of the KIF Plant, ranges between 38 degrees Fahrenheit (°F) in January to 78°F in July, and the average monthly low ranges between 28°F in January to 69°F in July. Average annual precipitation at this location is 55.2 inches, with December being the wettest month, averaging 5.7 inches, and October being the driest month, averaging 3.3 inches.

2.4.4 Cultural and Historical Resources

Historically, the banks of the Clinch River were used as hunting grounds and settlements for the Woodland, Mississippian, and Cherokee Indian Tribes (United States Department of Agriculture [USDA] 2009). In the late 1700s, a battle for the land between the Native Americans and white settlers spanning over 28 years, resulted in the settlement of the Clinch River region by the pioneers (USDA 2009).

Roane County became a hub for the transport of iron, coal, and agricultural products by barge, flatboat, or steamboat and later by rail after the Civil War. Industries including agriculture, iron, and timber were prevalent in the early 1900s (USDA 2009). President Roosevelt signed the Tennessee Valley Authority Act on May 18, 1933, creating the TVA as a federal corporation (TVA 2023a). TVA completed the construction of Watts Bar Dam in January 1942, three weeks after Pearl Harbor, which provided electricity for the war effort – including the Manhattan Project at nearby Oak Ridge National Laboratories. The Watts Bar Reservoir extends from the dam to 72.4 miles northeast to Fort Loudon Dam, including Roane County (TVA 2023b). Today, tourism is a major industry in the area, as over 700 miles of shoreline along Watts Bar Reservoir is located within Roane County (Roane Alliance 2023).

TVA conducted environmental reviews during the planning phase of the EI to comply with the National Environmental Policy Act (NEPA). These reviews included an assessment through the NEPA categorical exclusion process of whether proposed activities, such as drilling soil borings and installing monitoring wells, would impact cultural and historical resources, natural resources, parks, recreation or refuge lands, wilderness areas, natural landmarks, wetlands and floodplains, and other ecologically significant or critical areas. No issues were identified during this process. Therefore, additional measures to minimize or avoid adverse environmental impacts were not needed.

Chapter 3 Background Soil Investigation

Constituents in CCR material are also present in naturally occurring soil. To evaluate potential contributions of CCR Parameters in naturally occurring soil to other environmental media, such as surface water or groundwater, TVA reviewed information from historical studies and completed a background soil investigation as part of the EI. EI field activities were performed in general accordance with the following documents: *Background Soil SAP* (Stantec 2018b) and the *QAPP* (EnvStds 2018b) including TVA- and TDEC-approved programmatic and project-specific changes made after approval of the EIP.

The following sections summarize EI activities and present overall investigation and statistical evaluation findings for background soils based on data obtained during the EI. Additional information regarding the background soil statistical analyses and the EI are provided in Appendices E.1 and F.1, respectively.

3.1 TDEC Order Investigation Activities

The objective of the TDEC Order background soil investigation was to characterize background soils on TVA property near the KIF Plant TDEC Order CCR management units by sampling locations where naturally occurring, undisturbed, native soils are present and unaffected by CCR material. A total of 81 samples were collected from 12 background soil borings. For the background soil borings, the sampling team typically collected approximately two-foot grab samples from the mid-point of each five-foot soil run based on recovery. These sampling locations are depicted on Exhibit 3-1.

Background soil borings were advanced and sampled using a direct push technology rig. The average depth of the borings was approximately 25 feet below ground surface (bgs). Samples were analyzed for CCR Parameters. Surficial soil samples were collected from each background soil boring location and analyzed for the presence of ash (% ash) to evaluate the presence or absence of CCR material. Soil samples were also tested for pH in the field.

3.2 Lithology

Boring logs for the background soil borings are provided in Appendix B.1. Review of the background soil boring logs, the Geologic Map and Mineral Resources Summary of the Harriman Quadrangle, (Tennessee Division of Geology, Geologic Quadrangle Map, 123 NE, 1993) and the Geologic Map of the Elverton Quadrangle (Tennessee Geological Survey, Geologic Quadrangle Map, 130-NW, 2015), indicated that the borings were installed in two different geologic units. These units and the associated borings are summarized in Table 3-1.

3.3 Background Soil Investigation Results Summary

Field and lithologic data were reviewed for each EI boring location to evaluate whether collected samples accurately represent unsaturated background conditions. Twenty-one (21) samples were excluded from the statistical analysis datasets for being collected in the saturated zone or consisting of non-native soils based on the presence of non-native materials.

The EI background soils data collected from unsaturated intervals in native soils were statistically evaluated for potential outliers and anomalous data, dataset comparison parameters, and overall data variability. Multiple potential outliers were identified and flagged in the dataset. However, given the heterogeneity of naturally occurring inorganic compounds in soils, statistical outliers were not removed prior to statistical analysis.

Background threshold values (BTVs) are estimates of constituent concentrations in samples collected from unimpacted naturally occurring soils. Specifically, 95% one-sided Upper Tolerance Limits (UTLs) with 95% coverage (95% UTLs) were used to calculate BTVs, representing that there is a 95% confidence on average that 95% of the data are below the UTL. UTLs were calculated at three depth intervals: 0 to 0.5 feet bgs, 0.5 to less than or equal to 10 feet bgs and greater than 10 feet bgs. In addition, a UTL was calculated for each CCR Parameter using results collected from the three depth intervals combined. The results of these calculations are summarized in the *Statistical Analysis of Background Soil Data* in Appendix E.1, with BTVs provided in Attachment E.1-A.

3.4 Rock Outcrop Survey

As a subtask of the Background Soil investigation, a Rock Outcrop Survey was conducted to evaluate the rock types within the vicinity of the KIF Plant as potential sources of CCR constituents that may be present in the soil sampled during the background soil investigation. Six different areas were chosen based on their locations in relation to the KIF Plant; Areas 01, 02, and 05 were located on the west side of the KRP Ash Landfill; Area 03 was located south of the KIF Plant on the north bank of the Clinch River; Area 04 was located west of the Coal Yard; and Area 06 was located on KIF Plant property along the south bank of the Emory River Inlet south of the Stilling Pond. Rock samples were collected on August 28, 2019, from Areas 03 and 06; and on August 29, 2019, from Areas 01, 02, 04, and 05. The locations of the rock outcrop survey areas are depicted in Exhibit 3-2. Details of the rock outcrop survey are presented in the *Background Soil Investigation Sampling and Analysis Report* in Appendix F.1.

Sandstones and shales of the Conasauga Group were observed in Areas 01 (Sandstone and shale) and 02 (predominantly shale and sandstone). The strike of the outcrops for these areas ranged from N35°E to N70°E. The dip ranged from 32°SE to 43°SE. Finely crystalline limestones of the Maynardville Limestone were observed in Areas 03 and 06. The strike of the outcrops observed in Area 03 ranged from N75°E to N85°E. The dips ranged from 25°SE to 29°SE. At Area 06 the strike was N50°E with a dip of 27°SE. Rock types observed at Area 05 samples 01, 02, 04, and 05 appear to be consistent with the alternating layers of siltstones, shales, limestones, and thinly bedded sandstones of the Conasauga Shale. The strike of the outcrop ranged from N55°E and N64°E. The dips ranged from 34°SE to 43°SE. Sample locations 03C and 04C appear to be located adjacent to the contact between Conasauga Shale and the underlying rocks of the Rome Formation. Area 05 sample G01 is located in the Rome Formation. Due to the eroded nature of the outcrop at sample location G01, no strike or dip measurements were taken.

A large fold was observed in the beds in outcrop in Area 01 near sample areas 01 and 02 and 03 with more minor folding observed in Area 05, but maps scale structures, including fracture sets, were not observed. Map scale features, including fracture sets, were not observed at the other outcrops. The observed rock types, formations, and orientation of beds were consistent with published information including the Geologic Map of the Harriman Quadrangle, Tennessee (Moore, Finlayson, and Milici 1993).

TVA conducted an additional Rock Outcrop Sampling Investigation as outlined in the *Background Soil Sampling and Analysis Plan, Kingston Fossil Plant – Addendum I Rock Outcrop survey Sampling* (Stantec 2021). Additional rock samples were collected on June 21, 22, and 23, 2021 and submitted for laboratory analysis to further assess the geochemical characteristics of the parent rock in select outcrops in the vicinity of the KIF Plant. The laboratory analyses targeted evaluation of metal hydroxides that could influence the availability of naturally occurring metals for leaching from exposed bedrock outcrops. Additionally, the bedrock outcrops also provided a proxy for the geochemistry of residuum that evolves from natural weathering of bedrock. The analyses conducted on the rock outcrop samples are provided in the *Background Soil SAP, Kingston Fossil Plant – Addendum I Rock Outcrop Survey Sampling* (Stantec 2021). The locations of the rock outcrop samples are provided on Exhibit 3-3, and results of the analyses are provided in Table 3-2.

A preliminary assessment of the analytical results indicated that certain naturally occurring metals, which are also CCR constituents, were present in sufficient amounts to potentially leach from bedrock under certain pH and oxidation-reduction conditions at concentrations similar to concentrations observed in groundwater samples collected downgradient of the TDEC Order CCR management units. The analytical results will be used to support a geochemical modeling evaluation to be conducted as part of the CARA Plan.

Chapter 4 CCR Material Investigations

To evaluate the extent, structural stability, characteristics, and quantities of CCR material in the management units, TVA reviewed information from historical studies, and performed investigations as part of the EI. EI field activities were performed in general accordance with the following documents: *Exploratory Drilling SAP* and *Addendum to Exploratory Drilling SAP* (Stantec 2018c, Stantec 2020*), CCR Material Characteristics SAP* (Stantec 2018d), *Material Quantity SAP* (Stantec 2018e), and the *QAPP* (EnvStds 2018b), including TVA- and TDEC-approved programmatic and project-specific changes that were made after approval of the EIP. Field work included drilling 26 borings, installing three piezometers and five temporary wells, and collecting 54 CCR material samples and five pore water samples.

The following sections summarize the geotechnical stability evaluation findings, CCR material characteristic results, and CCR material quantity estimates based on the data obtained during previous investigations and the EI at the TDEC Order CCR management units at the KIF Plant. Additional details regarding these investigations are provided in Appendix G.

4.1 Geotechnical Investigation

The purpose of the geotechnical investigation component of the EI was to further characterize and evaluate subsurface conditions for the three TDEC Order CCR management units at the KIF Plant, including the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench. For this investigation, TVA reviewed information from previous representative studies and assessments, completed an exploratory drilling field program, and conducted evaluations for slope stability, structural integrity, and structural stability (bedrock).

The following sections summarize the previous studies and present overall geotechnical investigation and evaluation findings based on data obtained during previous studies and the EI for the KIF Plant TDEC Order CCR management units.

4.1.1 Exploratory Drilling

4.1.1.1 Previous Representative Studies and Assessments

Through the various information requests, as well as TDEC comments on the EIP, a need was identified for an evaluation of existing geotechnical data (borings, piezometric data, laboratory data, material parameters, analyses, etc.). The *Evaluation of Existing Geotechnical Data* (Appendix L of the EIP) was prepared to review the existing data and evaluate its adequacy with respect to responding to the various TDEC information requests. Evaluating the adequacy of existing data, in accordance with the *QAPP*, depends on both the type of data and its intended use. Where applicable, existing geotechnical data were used to support the subjects addressed throughout the EAR.

4.1.1.2 TDEC Order Investigation Activities

Exploratory drilling (EXD) field work was conducted in two phases (Phase 1 and Phase 2) and consisted of three primary activities: drilling and sampling, installing temporary wells, and installing piezometers. The primary objective of the Phase 1 EXD was to perform borings and install temporary wells to further characterize subsurface conditions at the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench. The primary objective of the Phase 2 EXD was to perform borings and install vibrating wire piezometers to further characterize subsurface conditions at the Sluice Trench and Area East of Sluice Trench.

Boring layouts are shown on Exhibits 4-1 and 4-2. For additional details on the EXD activities, refer to Appendices G.1 and G.2 (*Technical Evaluation of Geotechnical Data* and the *KIF Exploratory Drilling SAR*, respectively).

4.1.1.3 Results and Discussion

At each boring location, the uppermost foundation soil was predominantly lean clay or silt, with two occurrences of silty sand. This is generally consistent with historical borings across the KIF Plant TDEC Order CCR management units, including the Stilling Pond (where no EXD activities were necessary).

4.1.2 Slope Stability

The load cases evaluated in the stability analyses are based on conventional practice and appropriate industry standards for landfills and surface water impoundments, as applicable, and are noted below:

- 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).

As described in the KIF Plant EIP, including the *Evaluation of Existing Geotechnical Data* (EIP Appendix L), the existing data are sufficient to establish appropriate shear strengths and stability results for certain static and seismic load cases. The summaries of existing geotechnical data demonstrate that existing data are representative and suitable to support the stability analyses. Supplemental geotechnical data were collected, per the *EXD SAP*, to support the new or updated stability analyses described in the EIP and the *Stability SAP*.

For the KIF Plant, historical stability analyses were adequate to address:

1) the Stilling Pond static global, static veneer, seismic global, and seismic veneer slope stability analyses for the current geometry.

For the KIF Plant, the *Stability SAP* was necessary to address:

1) the Sluice Trench and Area East of Sluice Trench static global, static veneer, seismic global, and seismic veneer slope stability analyses for the current, closed geometry.

The closure design of the Interim Ash Staging Area (AECOM 2016b and 2016c) generally leveled the unit footprint 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. This rationale was presented in the EIP and *Stability SAP* and was accepted by TDEC.

4.1.2.1 Results and Discussion

The static and seismic stability results for the KIF Plant TDEC Order CCR management units are summarized and compared to criteria in Appendix G.1. For additional details on the analyses required under the *Stability SAP*, refer to the *Static Stability SAR* and *Seismic Stability SAR* provided as Appendix G.3 and Appendix G.4, respectively. The global stability and the veneer stability for each analyzed section meet the established factor of safety criteria for the static load cases. The pseudostatic veneer stability for the typical sections meet the established factor of safety criteria for the seismic load cases. The pseudostatic and post-earthquake, global stability for the cross section at the Stilling Pond meet the established factor of safety criteria for the seismic load cases.

The pseudostatic and post-earthquake, global stability for the cross sections at the Sluice Trench and Area East of Sluice Trench (both cross sections for pseudostatic, one cross section for post-earthquake) do not meet the established factor of safety criteria for the seismic load cases. TVA is currently evaluating mitigation alternatives for the Sluice Trench and Area East of Sluice Trench that would be designed to meet the seismic stability acceptance criteria as defined in the *Stability SAP*. It is anticipated that the mitigation design process will commence in parallel with the CARA phase of the TDEC Order program.

4.1.3 Structural Integrity

"Structural integrity" considers structural potential failure modes that could lead to a release of CCR material, other than slope stability and structural stability of bedrock.

For the KIF Plant TDEC Order CCR management units, the EIP summarized historical reports that would be leveraged to address structural integrity; those are referenced in Appendix G.1. There was no SAP specifically required under the TDEC Order program to address this subject.

4.1.3.1 Results and Discussion

Based on the historical report information, no significant deficiencies were identified with respect to structural integrity of the TDEC Order CCR management units. In addition, TVA further promotes structural integrity of the TDEC Order CCR management units by performing routine inspections and other compliance activities, in accordance with TVA policies, state regulations, and federal regulations.

4.1.4 Structural Stability (Bedrock)

"Structural stability (bedrock)" considers stability of bedrock below fill areas—that is, evaluating the bedrock with respect to voids/cavities and faults/joints of significant lateral or vertical extent that could be large enough to lead to loss of structural support and potential release of the overlying CCR material.

For the KIF Plant TDEC Order CCR management units, the EIP, including the *Evaluation of Existing Geotechnical Data* (EIP Appendix L), summarized historical reports that would be leveraged to address structural stability of the bedrock.

4.1.4.1 Results and Discussion

The Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench at the KIF Plant are underlain by the Conasauga Shale formation. Locally, the Conasauga formation shows little variation in composition and condition and is primarily shale interbedded with limestone and siltstone. Based upon the site-specific geologic mapping, rock core borings, and TDEC Order CCR management unit operational performance, there is no evidence of voids/cavities that could lead to loss of structural support and potential release of the overlying CCR material.

4.2 CCR Material Characteristics

TVA reviewed information from historical studies and completed a CCR material characteristics investigation as part of the EI to characterize leachability of CCR constituents within the three TDEC Order CCR management units at the KIF Plant: Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench. EI field activities were performed in general accordance with the following documents: *CCR Material Characteristics SAP* (Stantec 2018d), *EXD SAP* (Stantec 2018c), and the *QAPP* (EnvStds 2018b), including TVA- and TDEC-approved programmatic and project-specific changes made after approval of the EIP.

The following sections summarize historical studies and EI CCR material characterization activities, and present overall investigation and statistical evaluation findings. Additional information regarding the CCR material and pore water statistical analyses and the investigation are provided in Appendix E.2 and G.5, respectively. Further evaluation of the CCR material and pore water results is provided in Appendix G.1. Additional evaluation in context of the hydrogeologic conditions at the KIF Plant is provided in Chapter 5.1 and Appendix H.1.

4.2.1 Previous Studies and Assessments

In 2008 and 2009, TVA, TDEC, and USEPA conducted chemical characterization of CCR material as part of the KRP (TVA 2011a). CCR material samples were collected and analyzed for total metals and Toxicity Characteristic Leaching Procedure (TCLP) metals. TVA collected additional samples in April 2009 for TCLP analyses for waste characterization purposes as part of the KRP. Based on the waste characterization results, recovered CCR material was regulated as non-hazardous solid waste under Resource Conservation and Recovery Act Subtitle D and transported to the Arrowhead Landfill in Uniontown, Alabama.

In 2012, 2013, and 2016, TVA conducted additional chemical characterization studies of the CCR material produced by operations at the KIF Plant (AECOM 2016d). CCR material samples were collected and tested for physical and chemical characteristics, including leachability and total metals. The collected samples included dry fly ash, bottom ash, gypsum, and gypsum fines.

Pore water and CCR material were collected from the Stilling Pond in November 2017 (Stantec 2018f). The pore water and CCR material samples were subjected to CCR Parameter and Synthetic Precipitation Leaching Procedure (SPLP) analyses, similar to the samples collected under the EI as described below.

The historical studies did not include collecting CCR management unit pore water from the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench. Therefore, a more comprehensive investigation was conducted as part of the EI which included collection and analyses of pore water, as summarized in Chapter 4.2.2.

4.2.2 TDEC Order Investigation Activities

The objective of the TDEC Order CCR material characteristics investigation was to characterize the leachability of CCR Parameters by collecting pore water and CCR material samples (saturated and unsaturated) from within the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench. A total of 54 CCR material samples, were collected from five temporary well borings and seven retained geotechnical borings (Exhibit 4-3). These were analyzed for CCR Parameters (defined in Chapter 1.3) and additional parameters of interest for the CCR material characteristics investigation. The additional parameters of interest and analyses included total organic carbon (TOC), iron, and manganese. TVA also performed SPLP analyses for metals and radiological parameters. During sampling, CCR material present at each boring was visually characterized using the Unified Soil Classification System, which classifies material by grain size distribution followed by the material's textural properties.

Following temporary well installation and development, pore water levels were measured prior to sampling, hydraulic conductivity testing was performed, and pore water samples were collected from each well. The temporary well locations are depicted on Exhibit 4-3.

4.2.3 CCR Material Characteristics Evaluation

This section presents a summary of the evaluation of the CCR material and pore water analytical results to assess the presence of constituents in and their susceptibility to leach from CCR material. In addition, SPLP analysis of CCR material was conducted to assess whether SPLP can be used to predict pore water concentrations.

4.2.3.1 Total Metals and SPLP Evaluation Results

Statistical evaluations were conducted to evaluate whether the total concentrations of metals in CCR material could be used as a reliable predictor of leachable concentrations as represented by SPLP concentrations. The evaluations included comparison of total metals concentrations in CCR material to SPLP concentrations. The results indicated that the total concentrations of metals in CCR material are not reliable predictors of the magnitudes of the potentially leached concentrations using SPLP. Additional discussion of the evaluations is provided in Appendices E.2 and G.1.

TVA also compared pore water results to SPLP results for the CCR material to evaluate whether SPLP could be used as a predictor of pore water concentrations. CCR constituent concentrations were generally higher in pore water samples than in SPLP results. These findings indicate that SPLP analysis of CCR material is not a good predictor of pore water concentrations. The results indicate that direct measurement of pore water concentrations is the most accurate method of characterizing potential leachability of CCR constituents from CCR material, but geochemical modeling is needed to predict the concentrations of constituents in groundwater. Additional discussion of the evaluations is provided in Appendices E.2 and G.1.

4.2.3.2 Pore Water Phreatic Surface

TVA measured pore water levels within the temporary wells on a monthly frequency for six months. In addition, the wells were gauged during bi-monthly EI groundwater sampling events. This information was combined with available information from other instruments to develop phreatic surface maps for the Sluice Trench and Area East of Sluice Trench and the Interim Ash Staging Area at the time of gauging. The phreatic surface is the surface of pore water at which pressure is atmospheric and below which CCR material may be saturated with pore water. The use of the term "saturated" or references to the moisture content of CCR material does not imply that the pore water is readily separable from the

CCR material. Saturated CCR material can have a range of moisture contents based on the characteristics of the material. Pore water levels were not available for the temporary wells installed in the Stilling Pond due to the wells being abandoned for cap placement. Pore water levels were available from piezometers installed in the Stilling Pond; however, the dataset was not of sufficient density for pore water elevation contours to be drawn for this TDEC Order CCR management unit. Exhibit 4-4 provides a representative phreatic surface elevation contour map for Event #3 conducted in August 2019 for the Sluice Trench and Area East of Sluice Trench and the Interim Ash Staging Area. Table 4-1 provides a summary of the pore water gauging data from the six consecutive pore water gauging events, including EI Groundwater Sampling Event #3. Additional data for other gauging events can be found in Appendices H.6, H.7, and H.8.

Each of the TDEC Order CCR management units was previously closed in accordance with applicable regulations in effect at the time of closure. The pore water levels reported herein may not represent steady-state conditions.

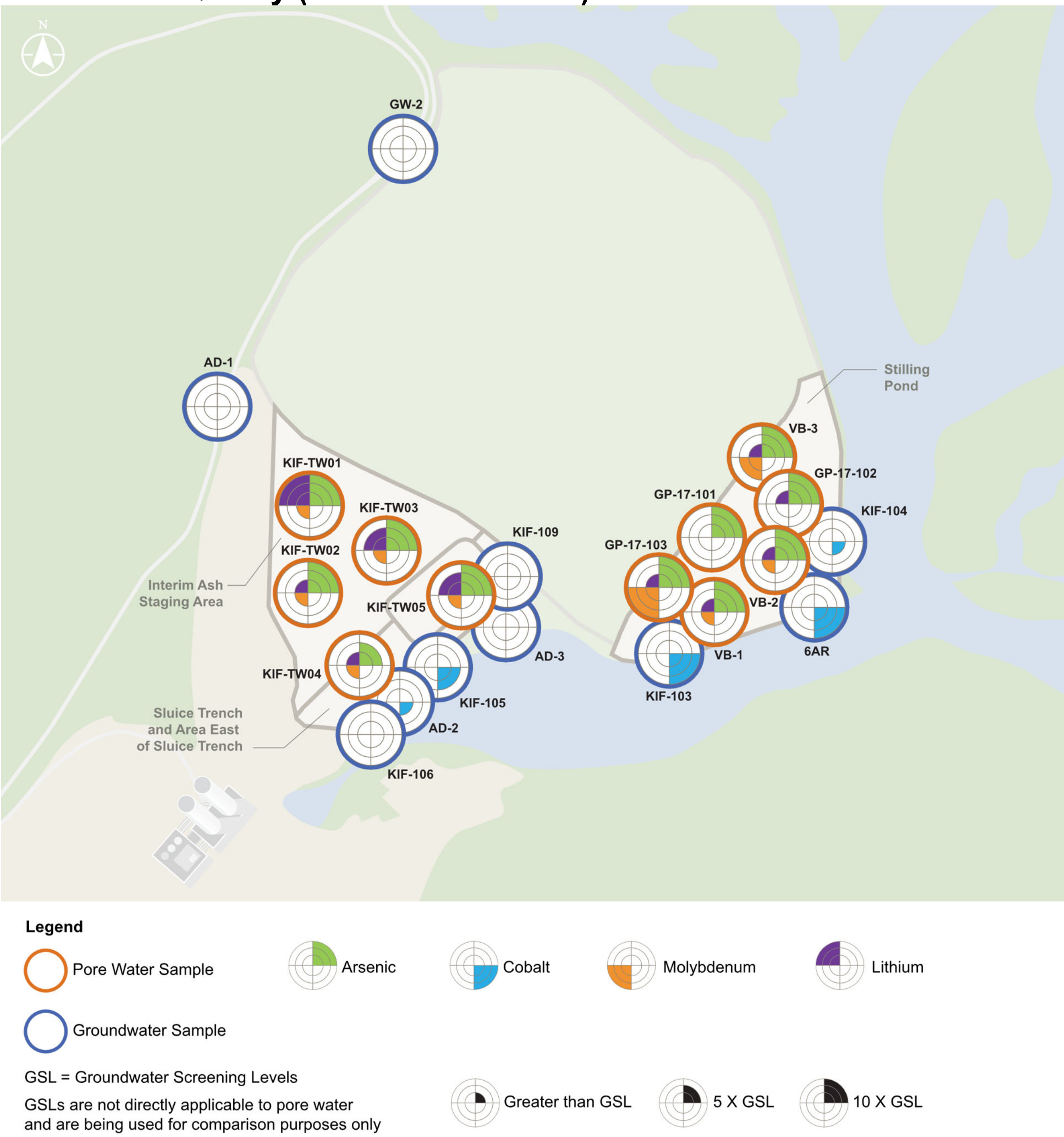
4.2.3.3 Pore Water Quality Evaluation

This section provides a summary of the analytical results for pore water samples collected from temporary wells installed as part of the EI and for other investigations. Pore water samples were collected during four sampling events. The first and second sampling events were conducted as part of the EI in November 2017 and April 2019. The third and fourth sampling events were conducted as part of other investigative activities in March and April 2021.

The pore water characterization evaluation was based on a comparison of pore water concentrations to groundwater concentrations and GSLs across the KIF Plant. GSLs are not directly applicable to pore water. Comparing pore water concentrations to GSLs is used to identify CCR constituents that have some potential to impact groundwater downgradient of CCR management units. Pore water concentrations were compared to GSLs for constituents listed in Appendix I of TDEC Rule 0400-11-01-.04 (TDEC Appendix I) and in Appendix IV of the CCR Rule because these constituents are subject to potential corrective measures.

Three TDEC Appendix I or CCR Rule Appendix IV constituents (arsenic, lithium, and molybdenum) had reported concentrations in one or more pore water samples above a GSL. None of these constituents had statistically significant concentrations in groundwater above a GSL. Cobalt is the only constituent with a statistically significant concentration in groundwater above a GSL. The figure below summarizes reported pore water and groundwater analytical results and their comparisons to GSLs. The locations of temporary pore water wells are shown as symbols with an orange outer ring; groundwater well symbols have a blue outer ring. The colored slices in each symbol indicate CCR constituents detected above a GSL in each temporary pore water and groundwater well. The number of colored sections within each slice represents the magnitude of the reported concentrations relative to the GSL. The legend provides further explanation of the colors and rings.

Pore Water Quality (with Groundwater)



There is a distinct difference between pore water and groundwater quality. As this figure illustrates, many constituents detected above a GSL in pore water samples were below the applicable GSLs in groundwater samples from the same areas.

4.2.4 CCR Material Characteristics Summary

The CCR material and pore water data collected during the EI were evaluated, along with historical data and data collected from other programs.

The following are the key findings of the KIF Plant CCR material characteristics investigation:

- The total concentrations of metals in CCR material are not a reliable predictor of the magnitude of the potentially leached concentrations represented by SPLP results, and SPLP analysis was not a good predictor of pore water concentrations. The results indicate that direct measurement of pore water concentrations is the most accurate way of characterizing potential leachability of CCR constituents from CCR material, but geochemical modeling is needed to predict the concentrations of constituents in groundwater.
- Each of the TDEC Order CCR management units was previously closed in accordance with applicable regulations in effect at the time of closure. The pore water levels reported herein may not represent steady-state conditions.
- Generally, there is a distinct difference between pore water and groundwater quality.

4.3 CCR Material Quantity Assessment

TVA completed a Material Quantity Assessment (MQA) to estimate CCR material quantities and other properties in support of fulfilling the requirements for the TDEC Order. MQA activities were performed in general accordance with the *Material Quantity SAP* (Stantec 2018e). The following sections summarize historical studies and EI activities, and present overall evaluation findings for material quantity based on data obtained during previous studies and the EI for the KIF TDEC Order CCR management units.

4.3.1 Previous Studies and Assessments

Previous material quantity assessments were completed by TriAD Environmental Consultants, Inc. (TriAD) of Nashville, Tennessee as part of their *Historical Ash Volume Calculations* (TriAD 2017). The calculations were performed for the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench. The TriAD historical ash volume results are provided in Appendix G.6.

4.3.2 TDEC Order Investigation Activities

The objectives of the MQA conducted pursuant to the *Material Quantity SAP* were to describe CCR management unit geometry, CCR material quantity, phreatic surface elevations, and subsurface conditions for the three TDEC Order CCR management units at the KIF Plant: Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench (MQA Study Area).

Three-dimensional models of the MQA Study Area were developed using data from existing borings installed under different environmental or geotechnical programs, as well as pre-construction topographic information, historical drawings, and survey information for the MQA Study Area. The existing information was supplemented with data from borings drilled per the *EXD SAP*. For additional details regarding the development of the models, refer to the *MQA SAR* (Appendix G.7).

The three-dimensional models were analyzed using AutoDesk® AutoCAD® Civil 3D surface volumes to estimate CCR material volumes. Pore water level and pore water pressure measurements recorded in the temporary wells and piezometers per the *Material Quantity, CCR Material Characteristics and Groundwater Investigation SAPs* and summarized in Table 4-1, were compared to the three-dimensional models to estimate the quantity of CCR material below the phreatic surface in the TDEC Order CCR management units. Specifically, pore water level and pore water pressure measurements from Groundwater Investigation Event #3 shown on Exhibit 4-4 were used to estimate the quantity of CCR material below the phreatic surface in the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench.

4.3.3 Material Quantity Assessment Results

4.3.3.1 Cross Sections

Cross sections developed using the three-dimensional models are provided in Appendix D. As shown on Exhibit D-1, Section A-A' is a cross section of the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench and Section B-B' is a cross section of the Stilling Pond. The cross sections profile the TDEC Order CCR management units from the groundline based on 2017 aerial and 2018 as-built construction surveys to below the top of rock surface.

4.3.3.2 CCR Material Limits and Depth

Exhibit 4-5 shows estimated limits and depth ranges of CCR material within the MQA Study Area. The CCR limits shown on Exhibit 4-5 and Section A-A' correspond to the railroad embankment, perimeter wall containment system, and inside crest of the East Dike in the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench. The CCR material limits shown on Exhibit 4-5 and Section B-B' correspond to the perimeter wall containment system and the inside crest of the starter dike in the Stilling Pond. Estimated CCR material depth ranges from 0 to 56 feet. Table 4-2 provides the range of estimated CCR material depths and aerial extent for each CCR management unit.

4.3.3.3 CCR Material Volumes

CCR material volumes summarized in Table 4-2 were estimated using the three-dimensional models and AutoDesk® AutoCAD® Civil 3D volume surfaces. The volumes were also compared to the pore water elevation contours shown on Exhibit 4-4 to estimate the volume of CCR material below the phreatic surface. As explained in Chapter 1.3.1, the phreatic surface is the surface of pore water at which pressure is atmospheric and below which CCR material may be saturated with pore water. The use of the term "saturated" and/or references to the moisture content of CCR material does not imply that the pore water is readily separable from the CCR material. Saturated CCR material can have a range of moisture contents based on the characteristics of the material.

The total acreage of the CCR material limits for the TDEC Order CCR management units is approximately 100 acres. The estimated total volume of CCR material is approximately 4.7 million cubic yards. Approximately 68% of the estimated total volume of CCR material is below the estimated phreatic surface.

Each of the TDEC Order CCR management units was previously closed in accordance with applicable regulations in effect at the time of closure. The pore water levels reported herein may not represent steady-state conditions.

4.3.3.4 Comparison to Previous MQA

TriAD previously computed material quantity volumes for the MQA Study Area (TriAD 2017), as discussed in Chapter 4.3.1. TriAD's estimated total aerial extent and volume of CCR material were approximately 90 acres and 4.1 million cubic yards, respectively. A comparison of the two volumetric models indicates that the EI CCR material volume estimates are approximately 10% to 15% higher for the Stilling Pond and combined Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench CCR management units, respectively.

For the Stilling Pond, these differences are likely due to the following conditions:

- Bottom of CCR material contours for the TriAD and EI volumetric models were both sourced from TVA Drawing 10N400; however, the drawings in Appendix G.6 indicated the 730-, 740-, and 750-feet elevation contours were used for the TriAD volumetric models whereas the EI volumetric model used additional contours, the lowest of which was the 726-feet elevation contour.

- The area of the EI volumetric model is larger than the TriAD volumetric model area since the EI limits between the KRP Ash Landfill and Stilling Pond correspond to the perimeter wall containment system, which includes an area not included in the TriAD volumetric model limits.

For the combined Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench CCR management units, these differences are likely due to the following conditions:

- Bottom of CCR material contours for the EI volumetric model were sourced from TVA Drawing 10N400 and supplemented with bottom of CCR material elevation data collected during the EXD activities, whereas the TriAD model bottom of CCR material contours were sourced from TVA Drawing 10N200. TVA Drawing 10N200 shows one 740-feet elevation contour within the footprint of the Interim Ash Staging Area, whereas TVA Drawing 10N400 shows multiple contours, the lowest of which is the 724-feet elevation contour.

- The CCR contours shown for the TriAD model do not extend to the railroad embankment.

4.3.3.5 Secondary Volume Estimates and Verification Method

The CCR material quantity analyses completed in AutoDesk® AutoCAD® Civil 3D were verified with the Trimble Terramodel 3D™ software package (Terramodel). The top and bottom of the CCR material surfaces were imported into Terramodel to perform secondary CCR material volume estimates. The Terramodel analyses confirmed the Civil 3D volumes with a deviation of less than 1%. Terramodel CCR material volume estimate summaries are provided in Appendix G.6.

4.4 CCR Material Investigation Summary

CCR material investigations provided geotechnical and analytical data to evaluate the extent, structural stability, characteristics, and material quantities in the TDEC Order CCR management units. CCR material characteristics data were also further evaluated in the hydrogeological evaluations. Primary investigation findings are:

- For the Interim Ash Staging Area and the Stilling Pond, the slope stability evaluation indicates that global and veneer slope stabilities meet the established factor of safety criteria for the static and seismic load cases.

- For the Sluice Trench and Area East of Sluice Trench, the slope stability evaluation indicates that global and veneer slope stabilities meet the established factor of safety criteria for the static load cases. For the seismic load cases, the evaluation indicates that veneer slope stability meets the established factor of safety criteria, but that the pseudostatic global and post-earthquake global load cases do not meet the criteria. TVA is currently evaluating mitigation alternatives and it is anticipated that the mitigation design process will commence in parallel with the CARA phase of the TDEC Order program.

- The three TDEC Order CCR management units have adequate structural integrity, and there is no evidence of voids/cavities in bedrock that could lead to loss of structural support and potential release of overlying CCR material.
- CCR material and pore water have been characterized as specified in the EIP, and CCR material and phreatic surfaces have been estimated for each of the three TDEC Order CCR management units. CCR material and estimated depth ranges are depicted in plan view on Exhibit 4-5 and on cross-sections in Appendix D.
- Estimated CCR material volumes and areas for the three TDEC Order CCR management units are provided in Table 4-2. The total area of the CCR material within the TDEC Order CCR management units is approximately 100 acres, and the estimated total volume is approximately 4.7 million cubic yards. Approximately 68% of the estimated total volume of CCR material within the TDEC Order CCR management units is below the estimated phreatic surface. The pore water levels reported herein may not represent steady-state conditions. In addition, the phreatic surface in the Interim Ash Staging Area would be expected to decrease in elevation if modifications to stormwater drainage or to the existing soil cap system were to be implemented.
- Direct measurement of pore water concentrations is the most accurate way of characterizing potential leachability of CCR constituents from CCR material.
- There is a distinct difference between pore water and groundwater quality.

Chapter 5 Hydrogeological Investigations

To evaluate hydrogeological conditions and to characterize groundwater quality, TVA reviewed information from previous studies, integrated data and findings from previous and other ongoing environmental programs and conducted hydrogeological and groundwater investigations as part of the EI (see Appendix H.1 for information included in the evaluation). EI field activities were conducted in general accordance with the following documents: *Hydrogeological Investigation SAP* (Stantec 2018g), *Groundwater Investigation SAP* (Stantec 2018h), and the *QAPP* (EnvStds 2018b), including TVA- and TDEC-approved programmatic and project-specific changes that were made after approval of the EIP. Field work included installing permanent wells and borings to collect samples of groundwater for analysis of CCR Parameters and geochemistry evaluation parameters. Additionally, as part of the EI, a water use survey was performed in general accordance with the *Water Use Survey SAP* (Stantec 2018i).

The following sections summarize findings based on evaluation of the information collected from implementation of the EI and data collected under other TDEC permitted landfill and CCR Rule programs at and near the KIF Plant TDEC Order CCR management units. Additional details regarding these investigations and evaluations are provided in Appendices E.3 and H.1 through H.9.

5.1 Groundwater and Hydrogeological Investigations

The purpose of the groundwater and hydrogeological investigations was to further characterize and evaluate subsurface conditions in proximity to three TDEC Order CCR management units at the KIF Plant, including the Sluice Trench and Area East of Sluice Trench, Interim Ash Staging Area, and Stilling Pond. For this investigation, TVA reviewed information from previous representative studies and assessments, completed field sampling programs, and conducted evaluations related to geology, hydrogeology, and groundwater quality as part of the EI.

5.1.1 Previous Studies and Assessments

Exploratory drilling at the KIF Plant began in 1951 to evaluate the suitability for the foundation for a proposed power plant. Since that time, several exploratory drilling and hydrogeological investigations have been conducted. Groundwater monitoring has been underway at the KIF Plant since approximately 1976. Monitoring well networks were previously installed to evaluate groundwater conditions as part of the TDEC permitted landfill and CCR Rule groundwater monitoring programs. Appendix H.1 provides summaries of informative studies related to the hydrogeology of the KIF Plant.

Groundwater data from the TDEC permitted landfill and CCR Rule programs follow quality assurance programs similar to that developed for the TDEC Order. Data from these historical and ongoing groundwater monitoring programs applicable to the TDEC Order CCR management units are included in the evaluation summarized below.

5.1.2 TDEC Order Investigation Activities

The objectives of the TDEC Order groundwater and hydrogeological investigations were to characterize groundwater quality and evaluate groundwater flow conditions in the vicinity of the KIF Plant TDEC Order CCR management units. Well installation and sample location selection, sample collection methodology, sample analyses, and quality assurance/quality control (QA/QC) completed for the investigations are provided in the *Hydrogeological Investigation SAR*

(Appendix H.2) and the *Groundwater Investigation SARs* for the six sampling events (Appendices H.3 through H.8). Exhibit 5-1 shows the locations of wells installed as part of the EI.

The proposed background permanent well (KIF-102) was planned at a location west of the TDEC Order CCR management units to provide groundwater samples that have not been affected by the CCR management units and to be representative of background conditions; however, none of the 11 borings advanced in the vicinity of this location was completed as a well because saturated unconsolidated materials were not encountered above bedrock. Soil samples were not collected at the location of proposed background monitoring well KIF-102 because the proposed well was not completed. Wells AD-1 and GW-2, which were previously installed for other programs are being utilized as background wells used for the EI.

The remaining downgradient permanent wells (KIF-103, KIF-104, KIF-105, and KIF-106) were installed in unconsolidated materials downgradient of the CCR management units to provide additional locations to evaluate groundwater levels and quality.

5.1.3 Hydrogeological Investigation Results

Several soil boring and well installation projects at and in the vicinity of the KIF Plant TDEC Order CCR management units yielded information about the geology, groundwater elevations, groundwater flow direction, and groundwater quality. This section provides an evaluation of the hydrogeological setting of KIF Plant TDEC Order CCR management units. Details of the evaluations are provided in Appendix H.1.

5.1.3.1 Well Construction and Presence of CCR Material

Based on the reported analytical results for water samples collected from well KIF-107, TVA conducted supplemental analysis of soil samples retained from the original KIF-107 borehole using polarized light microscopy (PLM). PLM is a laboratory method used to identify the potential presence of ash on a percentage basis. The results of the PLM analyses indicated that a 3-foot-thick interval consisting of 30% to 38% CCR material existed within the screened interval. The zone containing CCR material was identified from 9.0 to 12.0 feet bgs. The analytical results of water samples collected from well KIF-107 are therefore representative of pore water, not groundwater.

Because of the results of PLM testing of solid material samples collected from the boring for well KIF-107, a review of boring logs and additional PLM testing was conducted for monitoring wells that have reported concentrations of CCR constituents above a GSL. The PLM investigation was conducted from September to October 2021 and consisted of drilling three borings near well 6AR and two borings near well AD-2 and collecting samples for PLM analysis from ground surface to a depth near the base of the well screen. The results indicated that the presence of ash was non-detect to 23% near well 6AR and non-detect to 17% near well AD-2. This indicates that CCR material is present near and may have been encountered in the borings for these wells. While the screened interval of these monitoring wells is not within the depth interval where CCR material was reported, the presence of CCR material near or directly above the well screens and construction of the wells without an outer casing to isolate the CCR material creates uncertainty about the representativeness of groundwater samples collected from these wells. The results of the boring log review and PLM testing may lead to a re-evaluation of the certified groundwater monitoring systems for compliance with the CCR Rule and TDEC permitted landfill groundwater monitoring programs. Laboratory reports for the PLM analysis are provided in Attachment H.1-A.

5.1.3.2 Lithology and Hydrostratigraphic Units

Chapter 2.4 provides a discussion of the regional geologic setting for the KIF Plant. This chapter provides a discussion of the site-specific lithology and hydrostratigraphic units of the KIF Plant. Use of the terminology “fill material” in the following discussions excludes CCR material. A discussion of CCR material is provided in Chapter 4.

The natural unconsolidated materials consist primarily of residuum and alluvium overlying bedrock. Residuum is the material that remains after bedrock has weathered to a point that it is no longer considered rock. Alluvium refers to native materials that are deposited by moving water. The alluvium can be differentiated into silts, clays, and sands, which exhibit a coarsening downward sequence. The upper fine-grained alluvium layer varies in thickness from 2.5 to 27.5 feet and is primarily comprised of clay and silty clays. Clay soils of variable thickness are present under the TDEC Order CCR management units, although they are believed to be discontinuous in areas based on geotechnical drilling records. The lower alluvial layer, ranging in thickness from 0.5 to 52.5 feet, is primarily sand and silty sand. Bedrock underlying the TDEC Order CCR management units is the Conasauga Group Shale, which is comprised of sandstone, siltstone, shale, limestone, and dolomite and is of low permeability. Based on the geology and hydraulic conductivities in the vicinity of the TDEC Order CCR management units, the unconsolidated materials are considered to be the uppermost aquifer.

The following figures show three-dimensional representations of the various geological deposits and CCR material. The first figure shows a lithologic model, including the locations of the CCR management units and a representation of the extent of CCR material at the KIF Plant. The second figure shows the extent of the unconsolidated materials consisting primarily of silts and clays colored brown. The third figure shows the extent of unconsolidated materials consisting primarily of sands and silty sands colored light yellow. The fourth figure shows the bedrock surface colored gray. The dikes surrounding the CCR management units are shown in the brighter yellow color.

KIF Plant CCR and Unconsolidated Materials

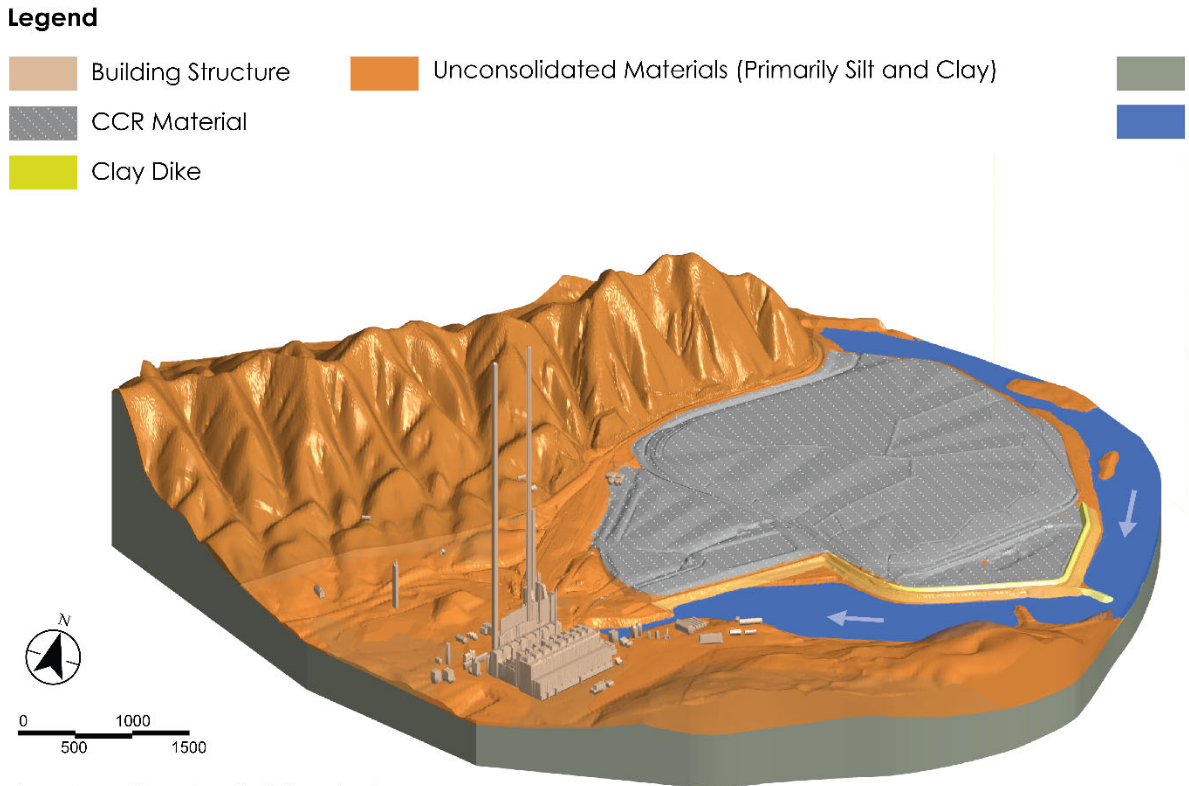


Image is an oblique view of a 3-dimensional model at 3X vertical exaggeration. The scale above is valid only in the horizontal direction.

KIF Plant Unconsolidated Materials (Primarily Silts and Clays)

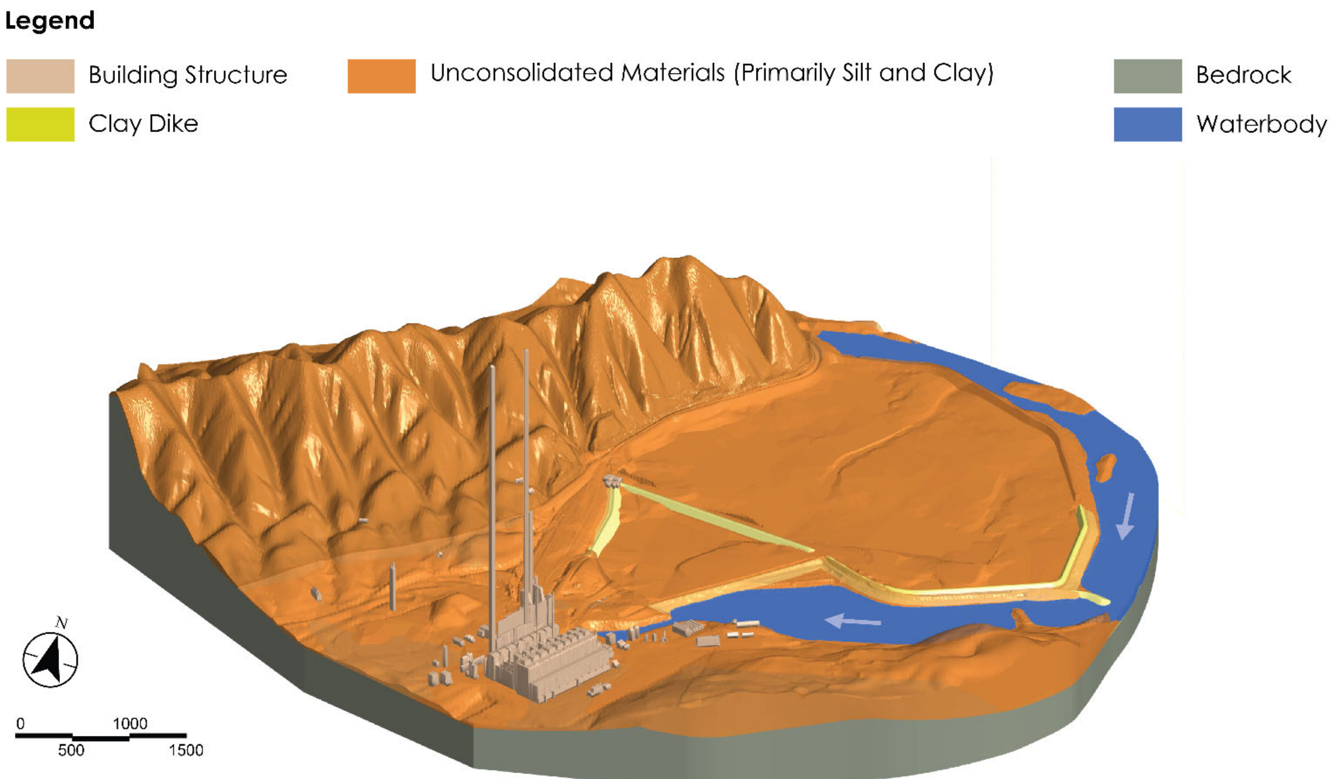


Image is an oblique view of a 3-dimensional model at 3X vertical exaggeration. The scale above is valid only in the horizontal direction.

KIF Plant Unconsolidated Materials (Primarily Sand and Silty Sand)

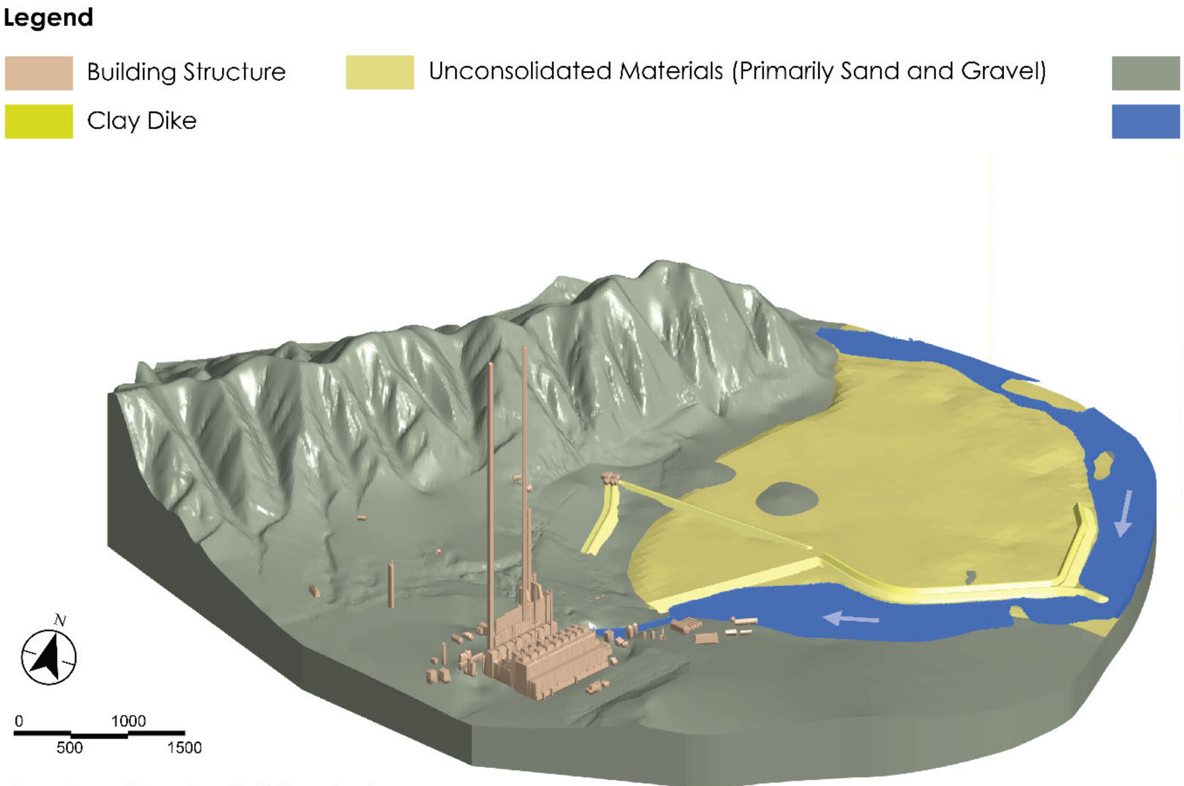


Image is an oblique view of a 3-dimensional model at 3X vertical exaggeration. The scale above is valid only in the horizontal direction.

KIF Plant Bedrock Surface

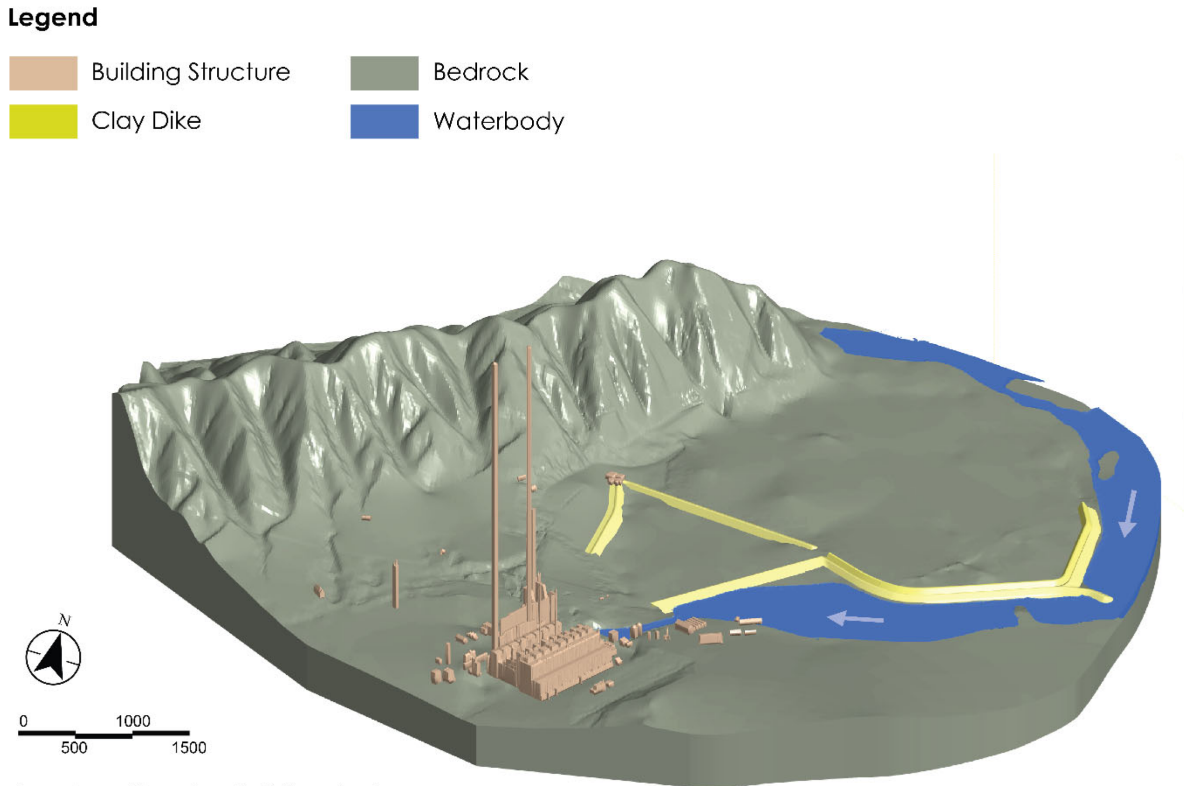


Image is an oblique view of a 3-dimensional model at 3X vertical exaggeration. The scale above is valid only in the horizontal direction.

Representative cross sections, showing the underlying lithologic units and CCR material are provided in Appendix D. Exhibit D-1 is a transect location map for the cross-sections. Exhibit D-2 depicts the profiles across the Interim Ash Staging Area, Sluice Trench and Area East of Sluice Trench, and Stilling Pond. Hydrostratigraphic units are geological formations that have been defined to characterize the hydrogeology of the KIF Plant to understand where and how groundwater is flowing. Geological formations capable of yielding useable quantities of groundwater are called aquifers. Aquifers are targeted for development as water sources by property owners. The hydraulic characteristics of aquifers are used to classify them. If an aquifer's boundary forms the water table, then the aquifer is called an unconfined aquifer.

In state and federal regulations, the term uppermost aquifer is used. This is the aquifer closest to ground surface. Regulations are designed to protect the groundwater in the uppermost aquifer because it could be used by property owners as a source of water. The term uppermost aquifer is used in this report.

5.1.3.3 Uppermost Aquifer and Groundwater Flow

This section provides a discussion of how groundwater flows at the KIF Plant. Groundwater flow occurs because gravity moves groundwater from areas of higher groundwater elevations to areas of lower elevations along flow paths that are generally perpendicular to groundwater elevation contours. Physiographic and hydrogeological features affect how groundwater flows. Hydrogeological barriers (i.e., rivers and surface streams) and divides (i.e., ridges that form watershed boundaries) bound the extent of groundwater flow. Groundwater flows toward, but not across, hydrogeological barriers and away from hydrogeological divides.

Based on the geology and hydraulic conductivities measured in the vicinity of the TDEC Order CCR management units, the unconsolidated materials are defined as the uppermost aquifer and are under unconfined conditions. Appendix H.1 provides additional details regarding the characterization of the uppermost aquifer.

During the EI and CCR Rule groundwater monitoring program, groundwater levels were measured within the uppermost aquifer prior to the six groundwater sampling events to evaluate the direction and rate of groundwater flow in the uppermost aquifer. Surface water elevations were measured at the Emory River because the elevations of surface streams affect groundwater flow.

The available data indicated that groundwater generally flows to the east-southeast toward the Emory River or Plant Intake Channel. Calculated groundwater flow rates ranged from approximately one foot/year to 16 feet/year, which is generally much slower than water flow in surface streams or rivers. Flow rates in surface streams or rivers generally are measured in feet per second (USGS 1999). Exhibit 5-1 is a representative groundwater contour map. Physiographic features that affect groundwater flow in the vicinity of the KIF Plant include the steep topography of Pine Ridge to the northwest, and the Emory River and the Plant Intake Channel to the east-southeast and downgradient of the CCR management units (see the figure below). To the west and upgradient of the plant is Pine Ridge, which serves as a topographic divide to groundwater flow. In the vicinity of the CCR management units, groundwater flow is bounded to the east and southeast by the Emory River and Plant Intake Channel. Groundwater flow directions, boundaries, and the topographic divide are shown in the following figure. Additional discussion of the hydrogeology and groundwater flow is provided in Appendix H.1.

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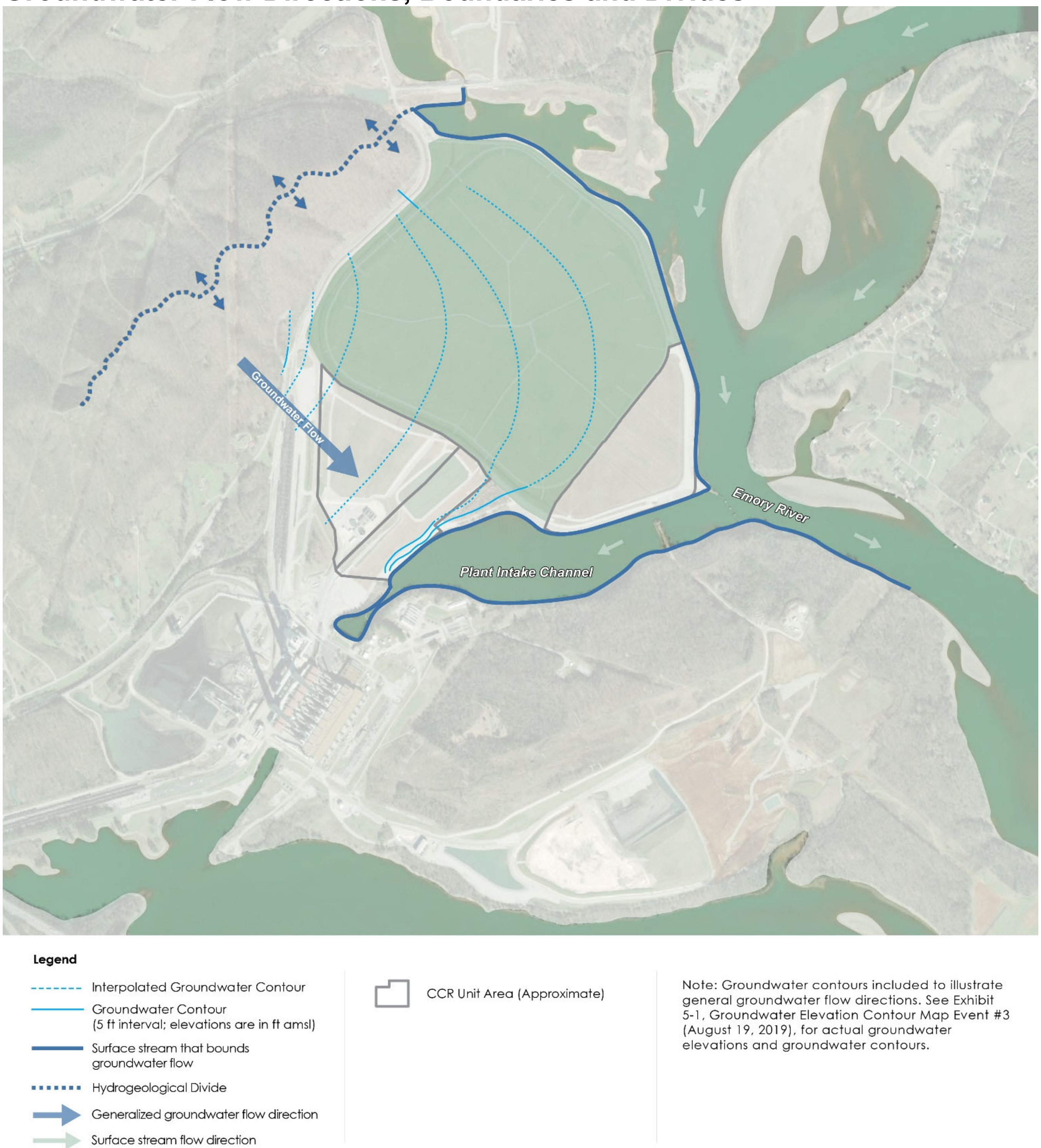
Groundwater Flow Directions, Boundaries and Divides



Note: Groundwater contours included to illustrate general groundwater flow directions. See Exhibit 5-1, Groundwater Elevation Contour Map Event #3 (August 19, 2019), for actual groundwater elevations and groundwater contours.

5.1.3.4 Groundwater/Surface Stream/Pore Water Relationships

TVA measured pore water levels within the temporary wells monthly for six months. In addition, the wells were gauged during bi-monthly groundwater sampling events. This information was combined with available information from other instruments to develop maps of the phreatic surfaces for the Interim Ash Staging Area, Sluice Trench and Area East of Sluice Trench, and Stilling Pond at the time of gauging. The phreatic surface is the surface of pore water at which pressure is atmospheric and below which CCR material may be saturated with pore water. The use of the term “saturated” or references to the moisture content of CCR material does not imply that the pore water is readily separable from the CCR material. Saturated CCR material can have a range of moisture contents based on the characteristics of the material. In addition, some of the other instruments that measure pore water, groundwater, and surface stream levels have been automated to provide time-series data, which have been plotted to evaluate the relationships of the elevations of pore water, groundwater, and surface streams. Detailed discussion of these relationships is provided below and in Appendix H.1.

The inferred groundwater and pore water elevations in the vicinity of the TDEC Order CCR management units were similar. The elevations of pore water levels within and groundwater levels in the vicinity of the Stilling Pond were generally within five feet of the Emory River stage.

For the Stilling Pond, the pore water and groundwater level fluctuations at most locations showed a similar, but subdued, correlation with the fluctuation pattern of the Emory River stage. Pore water level fluctuations were more subdued in comparison to groundwater level fluctuations. At the Sluice Trench and Area East of Sluice Trench and Interim Ash Staging Area, the pore water and groundwater hydrographs generally show a correlation with the river stage trends, but do not have the resolution to make comparisons to short-term river level fluctuations or precipitation events.

Each of the TDEC Order CCR management units was previously closed in accordance with applicable regulations in effect at the time of closure. The pore water levels reported herein may not represent steady-state conditions.

5.1.3.5 Groundwater Quality Evaluation

This section provides a discussion of the analytical results for groundwater samples collected from monitoring wells installed as part of the EI and previously installed wells monitored as part of the TDEC permitted landfill and CCR Rule groundwater monitoring programs. The groundwater quality evaluation is based on a statistical evaluation of constituents listed in Appendix I of TDEC Rule 0400-11-01-.04 (TDEC Appendix I) and Appendices III and IV of the CCR Rule. The analytical results were compared to GSLs approved by TDEC (see Table 1-1 and Appendix A.2). The statistical evaluation of groundwater analytical data is provided in Appendix E.3. Additional discussion of the results of the statistical evaluation are provided in Appendix H.1.

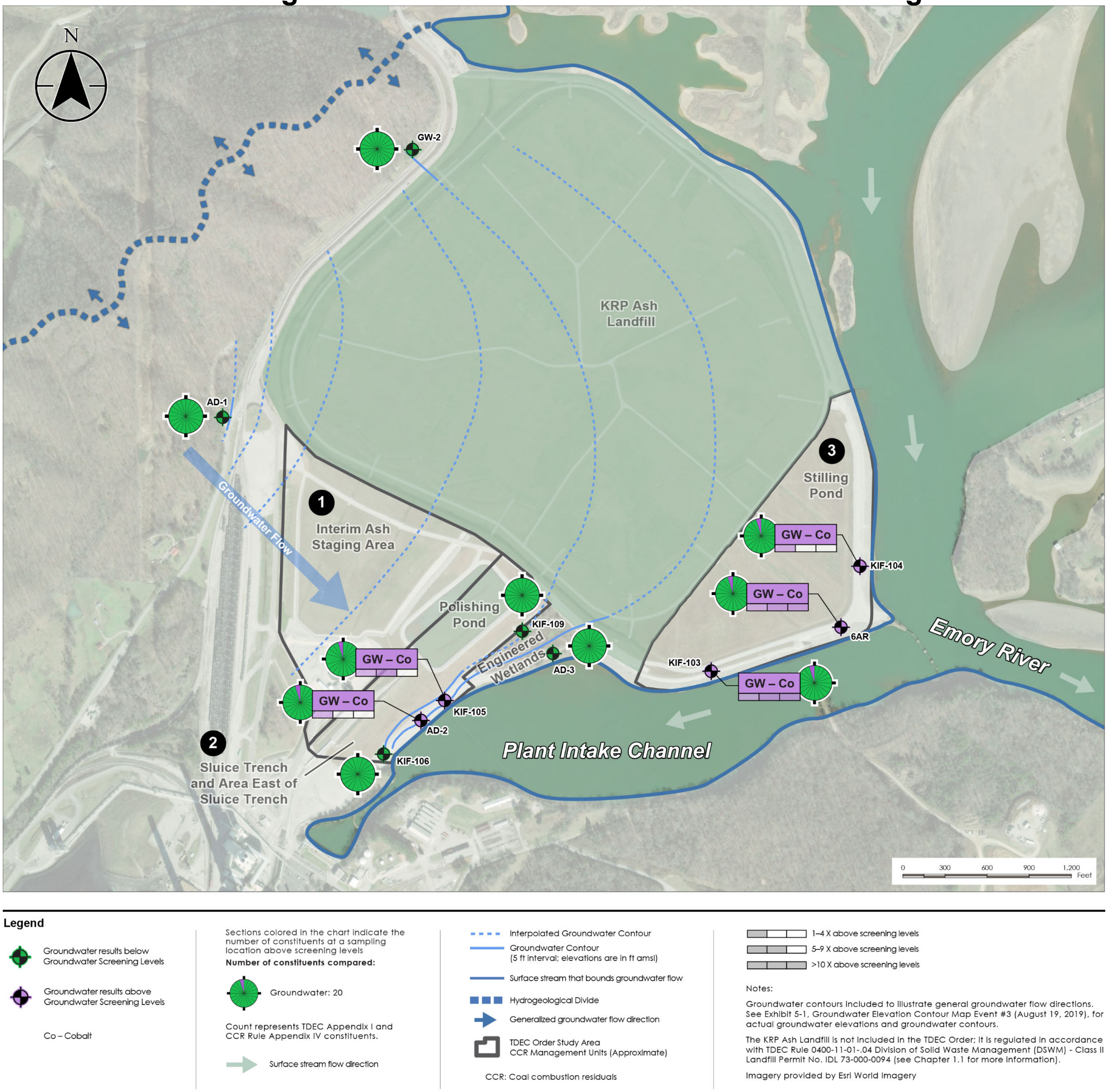
The dataset compiled for statistical analysis includes available analytical data for groundwater samples collected between June 2009 and December 2022, although the specific start date and frequency of sampling may vary between wells based on date of well installation and the applicable monitoring program. This time period was selected because it includes data that met the requirements of the data quality objectives for the TDEC Order program.

Downgradient of the TDEC Order CCR management units, one CCR Rule Appendix IV CCR constituent, cobalt (which is also a TDEC Appendix I constituent), had statistically significant concentrations in onsite groundwater above a GSL in five wells, including 6AR, AD-2, KIF-103, KIF-104, and KIF-105, that require further evaluation in the CARA Plan to determine the need for corrective action that will be based on statistically significant concentrations above an established GWPS.

The groundwater impacts described above are limited to onsite areas downgradient along the perimeter of the TDEC Order CCR management units.

The following figure shows the results of the statistical evaluation of CCR Rule Appendix IV and TDEC Appendix I constituents. Each monitoring well is represented by a symbol that is divided into 20 slices within a circle. The slices are colored green for each of the 20 CCR constituents that was detected at concentrations below the GSLs. Slices colored purple represent constituents that were detected above GSLs. The small boxes provide the constituents that were detected above the GSL. The bars below the boxes provide a gauge for how much the concentrations were above the GSL. See the legend in the figure for further explanation of the symbols. Additional discussion of the results of the statistical evaluation are provided in Appendix H.1.

Groundwater Findings Near the KIF Plant TDEC Order CCR Management Units

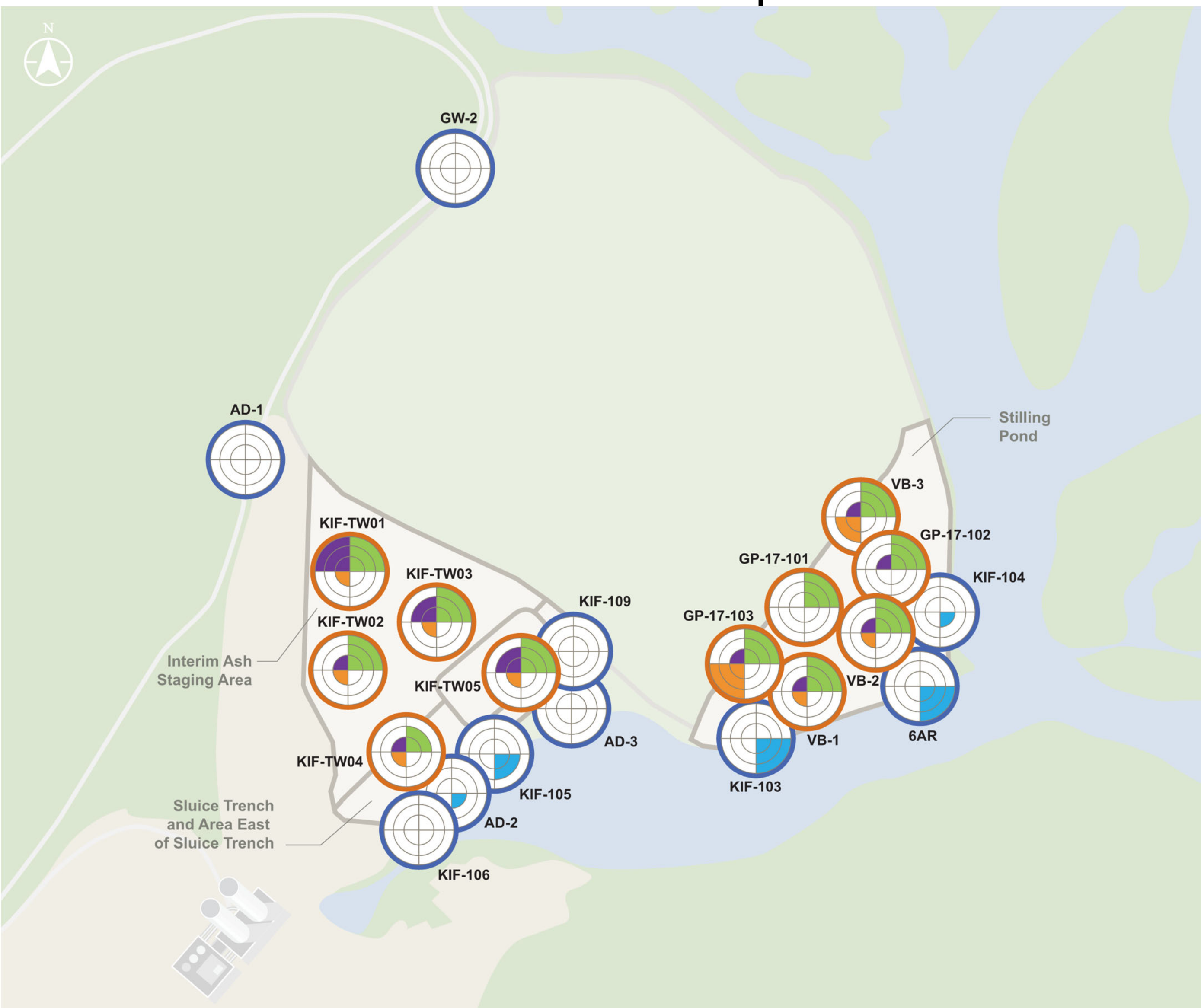


The figure shows that most constituents were detected below the GSLs. Five wells had cobalt with statistically significant concentrations above a GSL.

In addition, the quality of pore water was compared to groundwater quality. The following two figures illustrate the difference between pore water quality (symbol with orange outer ring) measured within the TDEC Order CCR management units and groundwater quality (symbol with blue outer ring) measured at the edge of the TDEC Order CCR management units. The first figure is a plan view showing the differences in water quality by comparison of the colors within the symbols. The CCR constituents detected are represented by different colors, as shown in the legend. The relative concentration of the constituent detected compared to the GSLs is represented by the number of colored sections within each slice.

The second figure is a cross section through the Stilling Pond that also shows the same differences in water quality. These two figures show that generally the constituents detected in downgradient groundwater along the edge of the TDEC Order CCR management units are different than those detected in pore water within the TDEC Order CCR management units or that they were detected at lower concentrations. This can be explained by geochemical reactions that can occur as water flows through natural geological materials.

Pore Water and Groundwater Concentration Comparison



Legend

Pore Water Sample

Groundwater Sample

Arsenic

Cobalt

Molybdenum

Lithium

GSL = Groundwater Screening Levels

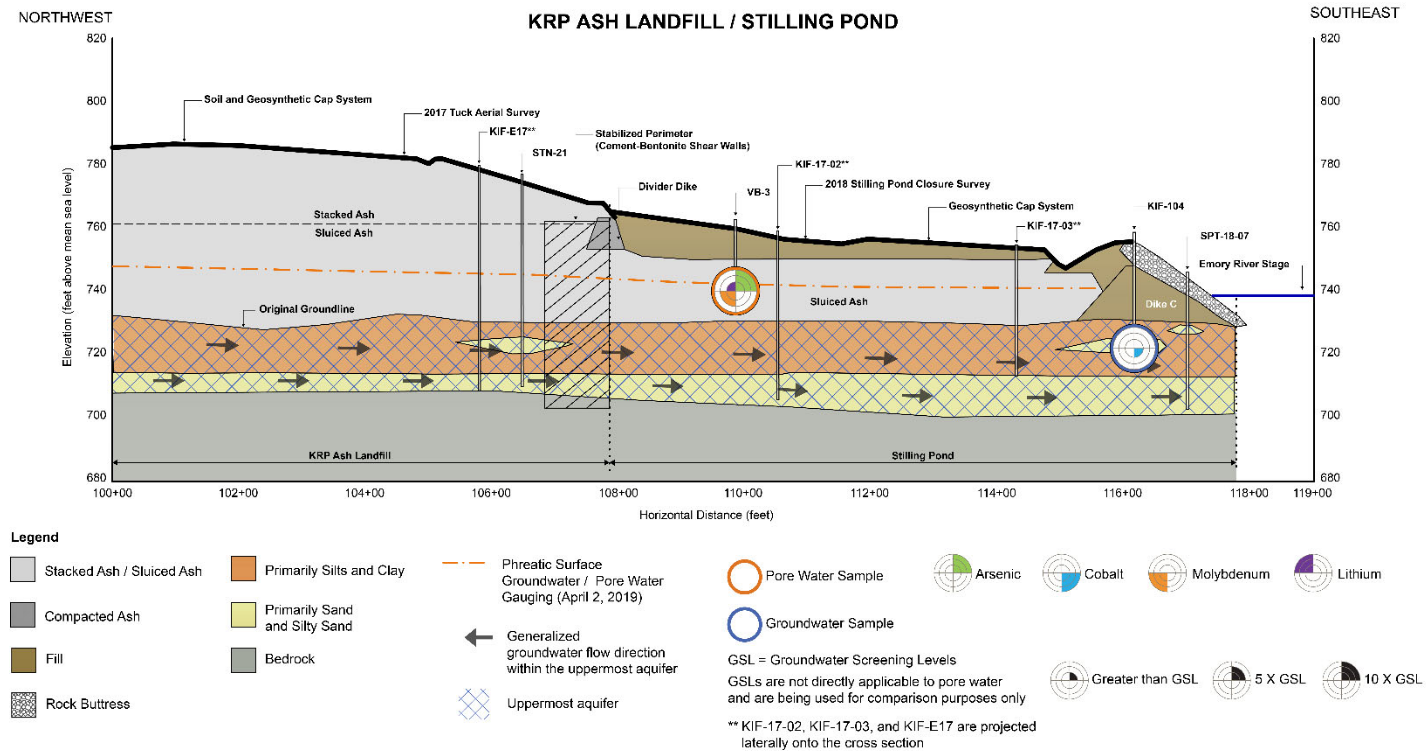
GSLs are not directly applicable to pore water and are being used for comparison purposes only

Greater than GSL

5 X GSL

10 X GSL

Cross Section View of Pore Water and Groundwater Comparison



5.2 Geochemical Evaluation of Groundwater Data

Groundwater quality is affected by numerous geochemical processes during groundwater flow through geological materials. The distinct difference between the chemical characteristics of pore water within the CCR material, presented in Chapter 4, and the characteristics of groundwater quality downgradient of the TDEC Order CCR management units at the KIF Plant is difficult to explain without the aid of geochemistry. It is well documented in the literature that certain CCR constituents that are detected in pore water (typically at higher concentrations than in groundwater) can be affected by geochemical processes that occur between constituents dissolved in groundwater and geological materials through which it flows. The effects of these geochemical processes, which often result in the attenuation of CCR constituents (i.e., reduced concentrations) can explain observed differences between the characteristics of pore water and groundwater. The extent of the interactions between dissolved constituents in groundwater and geological materials ranges from limited interaction for constituents such as boron, chloride, and sulfate, to strong interactions for constituents such as arsenic and cobalt.

Observations of groundwater and pore water chemistry can indicate the extent to which geochemical processes chemically change groundwater and influence groundwater quality at the KIF Plant. Boron, chloride, and sulfate commonly occur in high concentrations in pore water and are minimally attenuated by geochemical processes. Thus, they can be used to infer locations in the groundwater monitoring program where there is an influence from pore water. In contrast, those CCR constituents most likely to be influenced by interactions between geological materials and groundwater (e.g., arsenic, lithium, and molybdenum) typically show concentrations in groundwater monitoring wells that are much different than those observed in pore water, indicating that groundwater is being chemically changed relative to pore water by some physical or geochemical process (or a combination of both) occurring as it flows through geological materials.

Understanding the geochemistry of geological materials is important in interpreting the processes influencing current conditions of groundwater chemistry at the KIF Plant and evaluating effects of activities, such as drainage modifications or groundwater remediation, on the evolution of groundwater quality. Further evaluation of the geochemical processes acting in the upgradient system at the KIF Plant to influence groundwater quality will be included in the CARA Plan during assessments of remedies, where needed.

5.3 Water Use Survey

The objectives of the EI water use survey are to identify and sample usable private water supply wells and surface water sources potentially being used for domestic purposes within 0.5-mile of the boundary of the KIF Plant TDEC Order CCR management units, herein referred to as the Survey Area as outlined in the EIP and shown in the figure below. For this study, TVA defined 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. A detailed discussion of the water use survey is provided in Appendix H.9.

5.3.1 Desktop Survey

The first step of the water use survey was a desktop survey (the Survey) to identify usable private wells and springs. This included a review of registered well information obtained from TDEC, historical hydrogeologic reports, aerial photographs, and contacting public water supply providers in the vicinity of the KIF Plant. The goal of the Survey was to identify potential and known wells or springs within the Survey Area.

5.3.1.1 Desktop Survey Results

Based on the results of the Survey, 18 parcels were identified in the Survey Area that may contain potentially usable wells for domestic or business purposes. No springs were identified in the Survey Area.

5.3.1.2 Usable Water Well and/or Spring Identification

In addition to conducting the Survey, the KIF Plant *Water Use Survey SAP* outlines a process to identify offsite areas where groundwater has the potential to be affected by the KIF Plant TDEC Order CCR management units using results of investigative activities required as part of the EI. This process includes consideration of geologic and hydrogeological conditions (i.e., hydraulic barriers [rivers/streams], topography, groundwater flow direction, and watershed boundaries).

The available data indicated that groundwater generally flows to the east-southeast toward the Emory River or Plant Intake Channel. In the vicinity of the TDEC Order CCR management units, groundwater flow is bounded to the east and southeast by the Emory River and Plant Intake Channel. Groundwater flow directions, boundaries, and the topographic divide are shown in the following figure. Because of the groundwater flow directions and hydraulic barriers, it is unlikely that groundwater in areas located west of the KIF Plant and Pine Ridge or east and northeast of the Emory River have been impacted by the KIF Plant TDEC Order CCR management units based on the current groundwater flow patterns. Additional information regarding groundwater flow conditions is included in the Appendix H.1.

Considering the geologic and hydrogeologic conditions present at and in the vicinity of the KIF Plant, one parcel has the potential of being impacted by CCR management operations. The parcel within the area of interest is shown in the figure below. Other potential wells identified in the desktop survey were located outside the area of interest.

5.3.1.3 Parcel Owner Outreach

On February 1, 2024, a letter and stamped postcard containing basic inquiries into the presence of a well or spring within the Area of Interest was mailed to the parcel owner; which was TVA. On February 12, 2024, TVA's KIF Plant Manager returned a completed postcard and reported that there were no known water supply wells or springs on the portion of the parcel located within the Area of Interest. Based on the overall results of the Water Use Survey, current and historical CCR management associated with the KIF Plant has not affected water supply wells or springs located in the vicinity of the KIF Plant.

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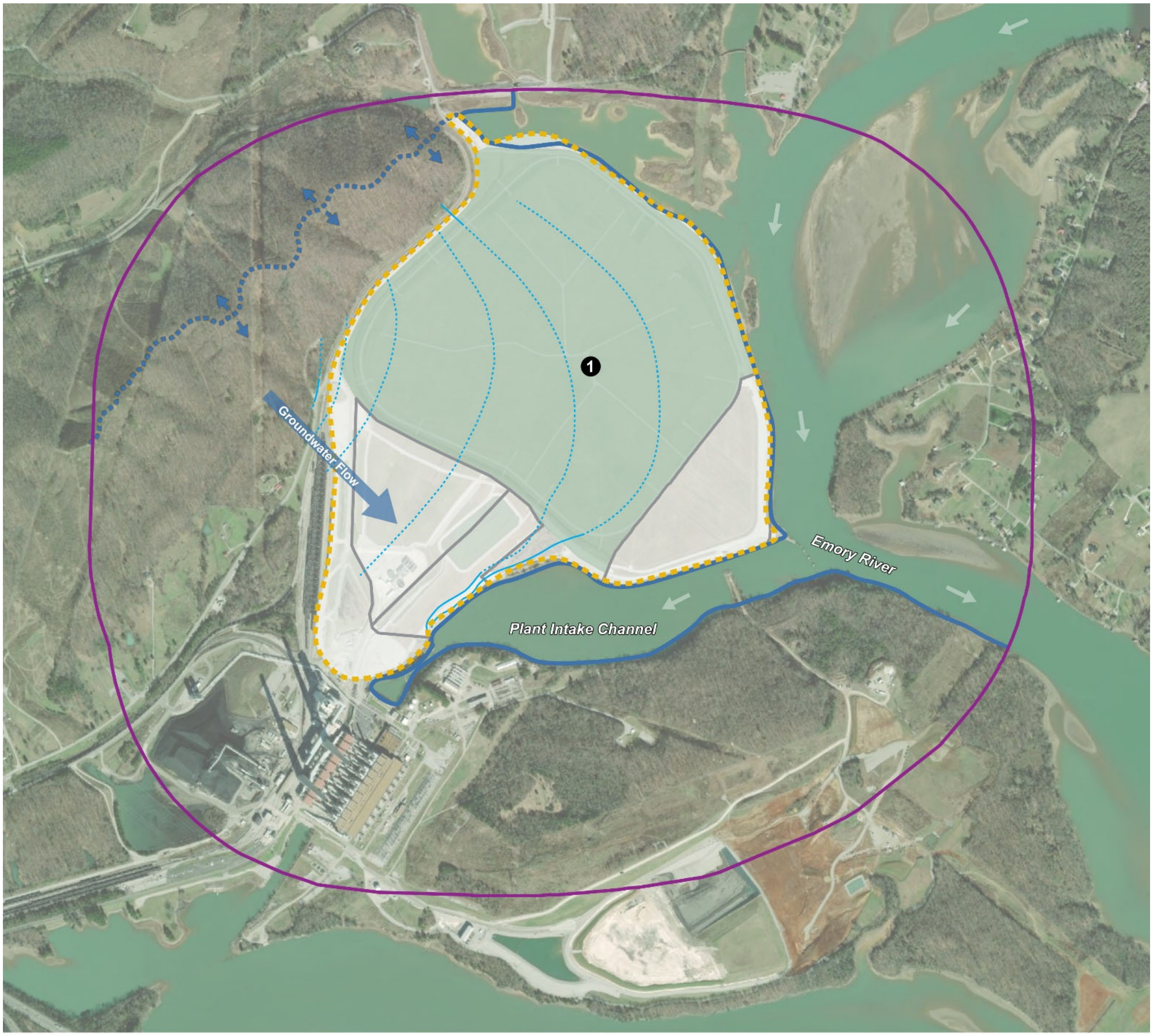
Water Use Survey Area



Legend

- Interpolated Groundwater Contour
- Groundwater Contour (5 ft interval; elevations are in ft amsl)
- Surface stream that bounds groundwater flow
- Hydrogeological Divide
- Generalized groundwater flow direction
- Surface stream flow direction
- CCR Unit Area (Approximate)
- WUS Survey Area
- Water Use Survey Area of Interest
- # Parcel Identifier

Note: Groundwater contours included to illustrate general groundwater flow directions. See Exhibit 5-1, Groundwater Elevation Contour Map Event #3 (August 19, 2019), for actual groundwater elevations and groundwater contours.

5.4 Hydrogeological Investigation Summary

The objectives of the TDEC Order hydrogeological and groundwater investigations were to characterize the hydrogeology and groundwater quality and evaluate groundwater flow conditions in the vicinity of the KIF Plant TDEC Order CCR management units. The key findings of the KIF Plant hydrogeological and groundwater investigations are summarized below:

- TVA evaluated analytical results for groundwater in support of the EAR based on data collected under three groundwater monitoring programs (some of which overlap), including the EI, CCR Rule, and TDEC permitted landfill monitoring programs. Monitoring well locations and the CCR constituent that will require further evaluation in the CARA Plan are provided below.

Summary of Findings Requiring Further Evaluation in the CARA Plan	
TDEC Order CCR Management Unit	**Groundwater**
Interim Ash Staging Area	Cobalt (Wells AD-2 and KIF-105)
Sluice Trench and Area East of Sluice Trench	Cobalt (Wells AD-2 and KIF-105)
Stilling Pond	Cobalt (Wells 6AR, KIF-103 and KIF-104)

- The results of a review of boring logs and PLM testing results indicated that the presence of CCR material within or near the screened interval of monitoring wells might be influencing the analytical results of groundwater samples collected from the existing groundwater monitoring systems. This finding may lead to a re-evaluation of the certified groundwater monitoring systems for compliance with the CCR Rule and TDEC permitted landfill groundwater monitoring programs.

- Drainage improvements or potential corrective actions are expected to reduce concentrations of CCR constituents to below GSLs in groundwater at downgradient monitoring locations

- Pore water within the CCR material has specific chemical characteristics that are different from the characteristics of groundwater downgradient of the TDEC Order CCR management units. Certain CCR constituents that have been detected in pore water are affected by geochemical processes during transport by groundwater through geological materials. The effect of these geochemical processes, which can result in the attenuation of CCR constituents and reduced dissolved groundwater concentrations, can explain the observed differences between the characteristics of pore water and groundwater quality.

- The inferred groundwater and pore water elevations in the vicinity of the TDEC Order CCR management units were similar. The elevations of pore water levels within and groundwater levels in the vicinity of the Stilling Pond were generally within five feet of the Emory River stage. Pore water level fluctuations at most locations within the TDEC Order CCR management units showed a similar, but subdued, correlation with the fluctuation pattern of the Emory River stage. Pore water level fluctuations were more subdued in comparison to groundwater level fluctuations, suggesting that foundation soils are impeding the flow of pore water. The use of the term flow, or other terms such as “saturated” in reference to the moisture content of CCR material does not imply that the pore water is readily separable from the CCR material.

- The unconsolidated materials are considered to be the uppermost aquifer and are under unconfined conditions. The bedrock underlying the KIF Plant was found to have low hydraulic conductivity based on pressure testing.
- The groundwater flow direction within the uppermost aquifer beneath the CCR management units is generally to the east-southeast toward the Emory River or Plant Intake Channel. Groundwater flow in the vicinity of the CCR management units is bounded to the east and southeast by the Emory River and Plant Intake Channel. Pine Ridge to the west and upgradient of the plant serves as a topographic divide to groundwater flow.

TVA will continue to monitor the trends of cobalt and conduct further evaluation in the CARA Plan to determine if corrective actions are needed. The influence of geochemical processes on groundwater quality will be further evaluated in the CARA Plan as part of the assessment of remedies, where needed.

Chapter 6 Seep Investigation

To evaluate potentially active seeps and collect data to assess potential seepage to surface water streams adjacent to the KIF Plant TDEC Order CCR management units, TVA reviewed historical seep management information and conducted a seep investigation as part of the TDEC Order EI. A summary of the historical seep information for the KIF TDEC Order Plant CCR management units is presented in Chapter 6.1. Because historical seep management at the CCR management units did not include collecting soil or surface water for analysis, samples of these media were obtained and analyzed for the EI as described in Chapter 6.2. The overall evaluation of the EI seep investigation results, including relevant historical data, are presented in Chapter 6.3. Additional information regarding the investigation field activities and sampling results is provided in the *Seep SAR* (Appendix I.1).

6.1 Historical Information

This section provides a brief summary of the historical information available that formed the basis of scope of the EI seep investigation. A detailed compilation of historical seep locations, remedial actions, and monitoring actions is presented in Appendix S of the EIP.

TVA has conducted annual CCR management unit dike inspections since 1967. TVA currently performs quarterly visual inspections of the dikes and toe areas in accordance with NPDES Permit No. TN0005452. TVA also maintains a Seepage Action Plan (Stantec 2018j) which identifies areas of concern (AOC) by a unique number and documents the date of discovery, description, size, mitigation status, and current status. Historical reports and inspections identified seeps, evaluated potential impacts, and documented remedial activities as summarized in the EIP. Remedial activities include the construction of a seepage collection system and reverse graded filter at the East Dike in 2017. The seepage collection system discharges seep water to the Water Quality Channel and Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001.

Historically, TVA addressed wet areas and potential seepage areas in a conservative manner to anticipate possible structural concerns at the CCR management units. Identified wet areas were classified as seeps unless observational evidence suggested an alternative water source such as poor drainage or precipitation. Eighteen historical seeps and five AOCs are identified on Exhibit 6-1.

Historical Seeps A, B, F, G, H, I, J, and Q are within the KRP Ash Landfill which is not part of the study area defined in the EI. Historical Seep E is monitored under the KIF Plant NPDES permit. Historical Seeps N/AOC #4, O/AOC #5 and P/AOC #6 were located along the former dike separating the KRP Ash Landfill and the Stilling Pond and are also not part of the seep investigation. Historical Seeps L/AOC#2, M/AOC#3, K, C, D and R were located adjacent to Emory River and were included in the EI (Appendix I.1).

6.2 TDEC Order Investigation Activities

The primary objectives of the TDEC Order EI seep investigation at the KIF Plant TDEC Order CCR management units were to identify and collect information regarding the potential presence of unmitigated active seepage, and if identified, evaluate the data obtained to assess potential movement of groundwater or pore water with dissolved CCR constituents into adjacent surface water streams. Seep investigation field activities and statistical evaluation of the data collected were performed in general accordance with the *Seep SAP* (Stantec 2018k) and the *QAPP* (EnvStds 2018b), including TVA-and TDEC-approved programmatic and project-specific changes made following approval of the EIP. Sample location selection, collection methodology, analyses, and QA/QC completed for the investigation are provided in the *Seep SAR* included in Appendix I.1.

The seep investigation consisted of inspecting accessible areas by foot or vehicle; investigating inaccessible areas (i.e., structural mitigation areas covered by riprap) by boat; observing exposed shoreline in areas where historical seep locations could only be accessed by boat; and measuring field parameters in surface water in areas monitored by boat.

6.3 Seep Investigation Results Summary

Based on the investigation findings, there are no known areas of interest (AOIs) associated with historical seeps/AOC at the KIF Plant.

Accessible Areas

During the visual walkdown inspection conducted in April 2019, no AOIs were identified so no water or soil samples were collected for laboratory analysis (Exhibit 6-1).

Inaccessible Areas

Historical seeps, L/AOC#2, K, C, R, M/AOC#3, and D were identified in areas adjacent to the Emory River banks for additional investigation by boat (Exhibit 6-1). Due to their close proximity, the areas for historical seeps C and R were combined into a single evaluation area for the EI. Similarly, the areas for historical seeps M/AOC#3 and D were also combined into a single evaluation area due to their proximity. Water quality parameters were measured in surface water adjacent and upstream of these locations, and a statistical analysis of the results was performed to evaluate whether there were statistically significant differences between areas adjacent to and upstream of potential seep locations. As detailed in Appendix E.4, the statistical results indicated that there were no adjacent locations where the four measured water quality parameters indicated statistically significant differences when compared with upstream locations. Based on the statistical analysis of water quality parameter measurements, no additional AOIs were identified for further investigation or data collection in the EI, nor is there a need for further evaluation of these results in the CARA Plan.

Chapter 7 Surface Streams, Sediment and Ecological Investigations

As discussed in Chapter 2, the KRP took place after the 2008 structural failure at the KIF Plant that resulted in the release of approximately 5.4 million cubic yards of CCR material into the adjacent Swan Pond Embayment with transport into the Emory, Clinch, and Tennessee River systems. The KRP included ecological investigations to evaluate potential risks to human health and ecological receptors, develop remedial actions, and implement SAPs to monitor recovery. The scope of the KRP ecological investigations included approximately 20,000 samples of air, water, sediment, CCR material, and biota resulting in more than 500,000 chemical analyses; toxicity testing of both water and sediments (including partial life-cycle tests); field and laboratory studies conducted by TVA staff, consultants, government research agencies, and universities; all of which culminated in approximately 50 papers published in peer-reviewed journals. As noted in Chapter 1.3.2, data collected for the KRP were governed by comprehensive QA requirements and are considered to be of comparable quality as data collected under the EI. Due to the existing extensive ecological analytical results and ongoing ecological data collection activities conducted as part of the LTM SAPs (described below), additional ecological and surface water sampling was not proposed in the EIP that was approved by TDEC.

The following sections summarize findings from the KRP ecological investigations. The KRP documents use the term “ash” to refer to the released material. For consistency within this EAR, the term “CCR material” is used when referring to the released material.

7.1 Baseline Ecological Risk Assessment

In August 2012, the USEPA approved a BERA (Arcadis 2012) for the KRP. That BERA evaluated potential ecological effects on biota from CCR material residuals in the river system at the KIF Plant Release Site. The BERA focused primarily on data collected post-dredging and was developed in support of the *Kingston Ash Recovery Project, Non-Time Critical Removal Action, River System Engineering Evaluation/Cost Analysis (EE/CA)* (TVA 2012a), which evaluated alternatives for restoration of the river system impacted by the December 22, 2008, CCR material release. The BERA identified benthic macroinvertebrate exposure to CCR material, arsenic, and selenium in sediment and potential dietary exposure to insectivorous birds that feed on benthic macroinvertebrates (killdeer and tree swallow) as the critical receptors and pathways requiring actions to manage risks.

7.2 Phase 3 Action Memorandum for the River System

In November 2012, TVA submitted the *Phase 3 Action Memorandum for the River System* (*Action Memorandum*; TVA 2012b), which USEPA approved. The *Action Memorandum* recommended MNR as the preferred removal action. MNR relies on natural processes such as mixing, scouring/redeposition and sedimentation (burial) to reduce the relatively low risks posed to benthic macroinvertebrates and to birds that prey on them. Remedial action objectives (RAOs) were established as part of this *Action Memorandum* (TVA 2012b). Given the relatively low levels of risk to most ecological receptor groups as identified in the BERA, objectives for monitoring the natural recovery of the river system were to confirm that risks associated with the CCR material release remain low and that CCR material-related metals concentrations in sediment and benthic invertebrate tissue decline with time.

As outlined in the *Action Memorandum* (TVA 2012b), the RAOs were as follows:

- Protect benthic invertebrate populations in Watts Bar Reservoir from adverse effects due to arsenic and selenium in CCR material-contaminated sediment
- Protect riparian-feeding bird (e.g., killdeer) and aerial-feeding bird (e.g., tree swallow) populations from adverse effects due to uptake of arsenic and selenium in CCR material-contaminated sediment through their diet (benthic invertebrates)
- Restore the ecological function and recreational use of the river system to pre-release conditions
- Dispose of waste streams from removal action in accordance with Applicable or Relevant and Appropriate Requirements.

As part of the *Action Memorandum* (TVA 2012b), remedial goals (RGs) for constituents of concern (COCs) in sediment and tissue monitoring endpoints (TMEs) for COCs in benthic invertebrate tissue were established.

7.3 Long-Term Monitoring Sampling and Analysis (2013 – 2017)

The following sections summarize the sampling and analysis program and results for the first five-year long-term monitoring period.

7.3.1 Summary of LTM Sampling and Analysis Plan (First Five-Year Monitoring Period)

In May 2013, the USEPA approved a *LTM SAP* (TVA 2013) for a five-year period for the river system near the KIF Plant. The *LTM SAP* described the data quality objectives (DQOs), sampling design, and sampling procedures for data collections necessary to assess the effectiveness of the selected removal action of MNR on the river system. The *LTM SAP* was prepared in accordance with USEPA's *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA 1993) and monitors the effectiveness of the MNR removal action.

Surface water sampling in the Emory and Clinch Rivers was not included in the *LTM SAP* based on findings of negligible risk to human health and ecological receptors following the completion of the *River System EE/CA* (TVA 2012a) and associated Human Health and Ecological Risk Assessments.

Sediment sampling is a component of the *LTM SAP* to evaluate the effectiveness of MNR, to support sediment transport modeling, COC monitoring, and toxicity testing, and to provide additional information used in evaluations of benthic community survey results. Sediment sampling was conducted biennially in the fall of 2013, 2015, and 2017 from four transects on the Emory River and one reference location upstream on the Emory River, and from three transects and one reference location on the Clinch River. Sediment samples also were collected annually at two other transects on the Emory River, for a total of 11 transect locations for sediment collections. Samples were analyzed for % ash, grain size distribution, arsenic, and selenium.

Sediment samples for sediment toxicity testing were collected in 2013 and 2017 from ERM 1.0, one reference location upstream on the Emory River, CRM 3.0, and one reference location on the Clinch River, a total of four locations. Toxicity testing consisted of laboratory bioassays in which benthic invertebrate species were exposed to sediment samples in the laboratory and observed for adverse effects, specifically growth and survival of the test species. Consistent with USEPA guidance, the composite sediment samples for bioassays were characterized for porewater pH and ammonia, organic carbon content; particle size distribution (% sand, silt, clay); % moisture; % ash; and CCR material-related metals and metalloids, pesticides, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons.

The United States Army Corps of Engineers Engineer Research and Development Center (ERDC) performed baseline fate and transport modeling of the Emory and Clinch Rivers sediments to evaluate long-term effectiveness of MNR (ERDC 2012). The sediment fate and transport model was updated in 2013 and in 2017 using updated sediment samples collected from 14 locations on the Emory, Clinch, and Tennessee Rivers. Sediment samples collected between 2013 and 2017 were also used to evaluate whether the model results accurately predicted in situ conditions (i.e., to evaluate the model's predictive performance). Samples were evaluated in the field for CCR material thickness and were analyzed in offsite analytical laboratories for % ash, grain size distribution, arsenic, and selenium. Updated bathymetry data were also collected to support sediment transport modeling.

The LTM included biennial sampling of larval and adult mayflies for chemical analysis beginning in 2013. There was a total of 12 locations: one reference location upstream in each of the Emory, Little Emory, Clinch, and Tennessee Rivers; four locations in the impacted reaches of the Emory River; two locations in the impacted reaches of the Clinch River, and two locations in the Tennessee River. Composite mayfly tissue samples from each location were analyzed for % moisture and whole-body metals and metalloids.

Snails were collected in 2013 for chemical analysis at ten locations: one reference location upstream in each of the Emory, Little Emory, Clinch, and Tennessee Rivers; three locations in the impacted reaches of the Emory River; two locations in the impacted reaches of the Clinch River, and one location in the Tennessee River. The composite snail tissue samples collected were analyzed for % moisture and whole-body metals and metalloids.

Biosurveys of benthic communities were conducted biennially to evaluate the response of benthic invertebrate communities to CCR material through their exposure in CCR material-contaminated sediments and sediment pore water. Benthic invertebrate community sampling for the *LTM SAP* was performed in 2013, 2015, and 2017 at the following 11 locations: one reference location upstream in each of the Emory and Clinch Rivers; six locations in the impacted reaches of the Emory River, and three locations in the impacted reaches of the Clinch River. Annual community assemblage samples were collected at ERM 0.7 and ERM 1.0. Each benthic invertebrate community sample was analyzed for taxonomic identification and enumeration of benthic invertebrates, with results reported for taxa abundance, richness, and diversity as indicators of environmental quality.

Aerial-feeding birds were considered to be at low risk in the BERA due to bio-uptake of selenium in their diet. Therefore, annual sampling of tree swallow eggs was conducted from a colony established near ERM 1.0 and a reference colony at Tennessee River Mile 572. Egg contents (excluding shells) were analyzed for metals and metalloids. These surveys also documented deformity incidences, clutch size, hatching success, and 15-day hatchling survival.

The risk assessments conducted for the *River System EE/CA* (TVA 2012a) identified no unacceptable risks to humans or biota that consume fish, nor unacceptable risks to the fish community. However, fish sampling was included in the *LTM SAP* to evaluate recovery of the ecological function and recreational use of the river system, and for natural resources assessment. Although TVA conducted bioaccumulation studies on several species of fish (largemouth bass, bluegill, redear sunfish, crappie, channel catfish, and gizzard shad) for the first four years after the CCR material release, the first five-year *LTM SAP* limited fish bioaccumulation collections to bluegill, redear sunfish, and largemouth bass.

Biennial fish bioaccumulation samples were collected in the spring from two locations in the Emory River (including one upstream reference location) and from two locations (including one upstream reference location) in the Clinch River while annual sampling was conducted at ERM 1.0. The fish tissue samples collected were analyzed for metals and metalloids. Fish also were processed for a suite of health and reproductive condition measures concurrent with the bioaccumulation sampling.

Biennial biosurveys of the fish community were conducted in the fall for comparisons with historical surveys. A total of three reaches were surveyed in the Emory, Clinch and Tennessee Rivers. Fish collected were identified as to species enumerated, and examined for anomalies, with results reported for species abundance, richness, diversity, and physical condition (anomalies). In addition, biennial surveys of black bass populations were conducted at one location on the Emory River and one location on the Clinch River for comparison with historical surveys.

7.3.2 Summary of Long-Term Monitoring Results (First Five-Year Monitoring Period)

Throughout the first five-year monitoring period, sediment transport modeling and sediment COC monitoring indicated continued deposition of native sediments over residual CCR material deposits and successful dilution of CCR material-related COCs in native sediments. Sediment toxicity tests found no impacts to benthic invertebrate growth or survival. Sediment and biota tissue concentrations of arsenic and selenium, and sediment % ash declined over time and were below their respective RGs and/or TMEs during the first five-year monitoring period. Community studies for benthic invertebrates did not identify negative relationships between arsenic or selenium concentrations, or sediment % ash relative to key benthic invertebrate community metrics (e.g., abundance, diversity, or richness).

Similarly, community, health and reproductive studies for fish did not identify any negative relationships between arsenic or selenium concentrations, or sediment % ash relative to key fish community metrics or spring sportfish surveys, or visible impacts to overall fish health and reproduction. Studies conducted through 2017 indicated that fish and benthic communities continued to be present in numbers and conditions typically observed for similar water bodies (Arcadis 2020).

LTM SAP tree swallow biosurveys and egg tissue evaluations found no negative relationships between selenium concentrations and overall tree swallow fecundity, indicating no adverse impacts to the overall reproduction of the tree swallow population near the release. As a result, the tree swallow investigations were discontinued after 2015.

The 2017 sediment transport modeling (Arcadis 2020) results indicated that deposition and natural attenuation are occurring as predicted in the Watts Bar Reservoir. Bed change, in the form of sediment deposition, occurred at all 14 observation points and ranged from 2 to 11 inches. This deposition provided adequate capping potential for remaining CCR material deposits. The sediment transport model predicted minimal accumulation of CCR material in the Tennessee River. This was confirmed by sampling for the *River System EE/CA*, therefore sampling of sediment in the Tennessee River was not included in the LTM. The progression of measured CCR material dilution in the Clinch and Emory Rivers agreed with the modeling results for the simulated time period. CCR material dilution was further supported by the moderate to low flows that occurred during the first five-year monitoring period, which allowed the system to recover rapidly. These results represented a successful MNR response based on numerical modeling results and field measurements.

Based on the review of the 2017 data, the results for the sediment transport monitoring, sediment toxicity tests, benthic invertebrate bioaccumulation and community surveys, and fish bioaccumulation, community surveys and biosurveys all indicate that the selected MNR remedy is functioning as intended. The results of the first five-year monitoring period demonstrated that risks associated with the CCR material release remained low, and that CCR material-related metal and metalloid concentrations in sediment and biota tissue will likely continue to decline over time.

In addition to the *LTM SAP* program, TVA submitted biological monitoring data from Fall 2013, 2015, and 2017 as part of the application for its KIF Plant NPDES permit renewal. The biological monitoring data for the sites upstream and downstream of the KIF Plant were similar and within the acceptable range of variation, such that these data meet requirements of a balanced indigenous population (TDEC 2018), further supporting the effectiveness of the MNR remedy.

TVA has systematically monitored the ecological conditions of its reservoirs since 1990 as part of the Vital Signs Monitoring Program. The fish assemblage in the Clinch River in Watts Bar Reservoir has been rated "good" or "fair" on a "Good—Fair—Poor" evaluation system that incorporates several different fish community measures. The quality of the Watts Bar Reservoir sport fishery has consistently rated at or above the valley-wide average. TVA fish community and benthic community assessments conducted in 2009 and 2010 indicated that within a few months after the release, fish and benthic invertebrates were present in numbers and conditions typically observed for similar water bodies.

The results of the first five-year monitoring period demonstrated that risks associated with the CCR material release remain low, that CCR material-related metal concentrations in sediment and biota tissue will likely continue to decline over time, and that all the remedial targets were achieved.

7.4 Second Five-Year LTM Sampling and Analysis Plan (2019 – 2023, Second Five-Year Monitoring Period)

Given that all of the remedial targets were achieved during the first five-year monitoring period, the results supported a reduction in long-term monitoring requirements for the second five-year monitoring period. Studies conducted during the second five-year monitoring period confirm that remedial targets and risk management recommendations related to fish and benthic invertebrates provided in the BERA (Arcadis 2012) continue to be met. The types, numbers, and frequencies of sample collection are established in the second *LTM SAP* for sediment and biota. The second five-year *LTM SAP* (TDEC 2021) describes the DQOs, sampling design, and sampling procedures to be used for collecting the data necessary to assess the continued effectiveness of the selected removal action for the second five-year review period, from 2019 to 2023.

During the second five-year monitoring period, sediment sampling is being conducted concurrent with the fall benthic invertebrate community surveys. Sediment samples were collected in 2019 and 2021 from five transects on the Emory River, including one upstream reference location, and from three transects on the Clinch River, including one upstream reference location.

Samples of larval mayflies were collected for chemical analysis in 2019 and 2021 at seven locations: one reference location upstream in the Emory and Clinch Rivers; four locations in the impacted reaches of the Emory River; and one location in the impacted reaches of the Clinch River. While arsenic and selenium are the CCR material-related constituents of interest, larval mayflies are being analyzed for % moisture and whole-body metals and metalloids to support the MNR evaluation.

TVA conducts benthic invertebrate community surveys on a rotating basis at reservoirs throughout the TVA system, including locations in the Clinch and Tennessee Rivers. In conjunction with this system-wide sampling, benthic invertebrate community sampling was conducted in 2019 and 2021 at eight locations: one reference location upstream in each of the Emory and Clinch Rivers; four locations in the impacted reaches of the Emory River, and two locations in the impacted reaches of the Clinch River.

Sampling for fish bioaccumulation has continued during the second five-year monitoring period in order to support evaluation of restoration of ecological function and recreational use of the river system to pre-release conditions. Collections were limited to bluegill and redear sunfish, species that have been shown to have high site fidelity and selenium bioaccumulation, and largemouth bass, an important sport fish. Fish bioaccumulation sampling was performed in the spring of 2019, at three locations (including one upstream reference location) in the Emory River and two locations (including one upstream reference location) in the Clinch River.

Biennial biosurveys of the fish community were conducted in the fall of 2019 and 2020 for comparisons with historical surveys. A total of three reaches were surveyed in the Emory and Clinch Rivers. The results for the sampling conducted in accordance with the second *LTM SAP* will be reported in a separate future submittal.

7.5 Surface Streams, Sediment, and Ecological Investigations Summary

Evaluation of the previous and ongoing extensive investigations conducted for the KRP indicate that surface stream water, sediment, and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health. TVA is continuing long-term monitoring activities to further document these findings. Specific findings are summarized below:

- Surface water sampling in the Emory and Clinch Rivers was discontinued in 2013 based on findings of negligible risk to human health and ecological receptors.
- Sediment transport modeling and sediment monitoring indicate continued deposition of native sediments over residual CCR material deposits and successful dilution of CCR material-related constituents in native sediments.
- Sediment toxicity tests indicate no impacts to benthic invertebrate growth or survival.
- Sediment and biota tissue concentrations of arsenic and selenium, and sediment % ash have declined over time and were below their respective remedial objectives during the first five-year monitoring period.
- Community studies for benthic invertebrates indicate that arsenic and selenium concentrations, and sediment % ash have not negatively affected key benthic invertebrate community metrics (e.g., abundance, diversity, or richness).
- Tree swallow biosurveys and egg tissue evaluations found no negative relationships between selenium concentrations and overall tree swallow fecundity, indicating no adverse impacts to the overall reproduction of the tree swallow population near the release.
- Community, health, and reproductive studies for fish did not identify any negative relationships between arsenic or selenium concentrations, or sediment % ash relative to key fish community metrics or spring sportfish surveys, or visible impacts to overall fish health and reproduction.

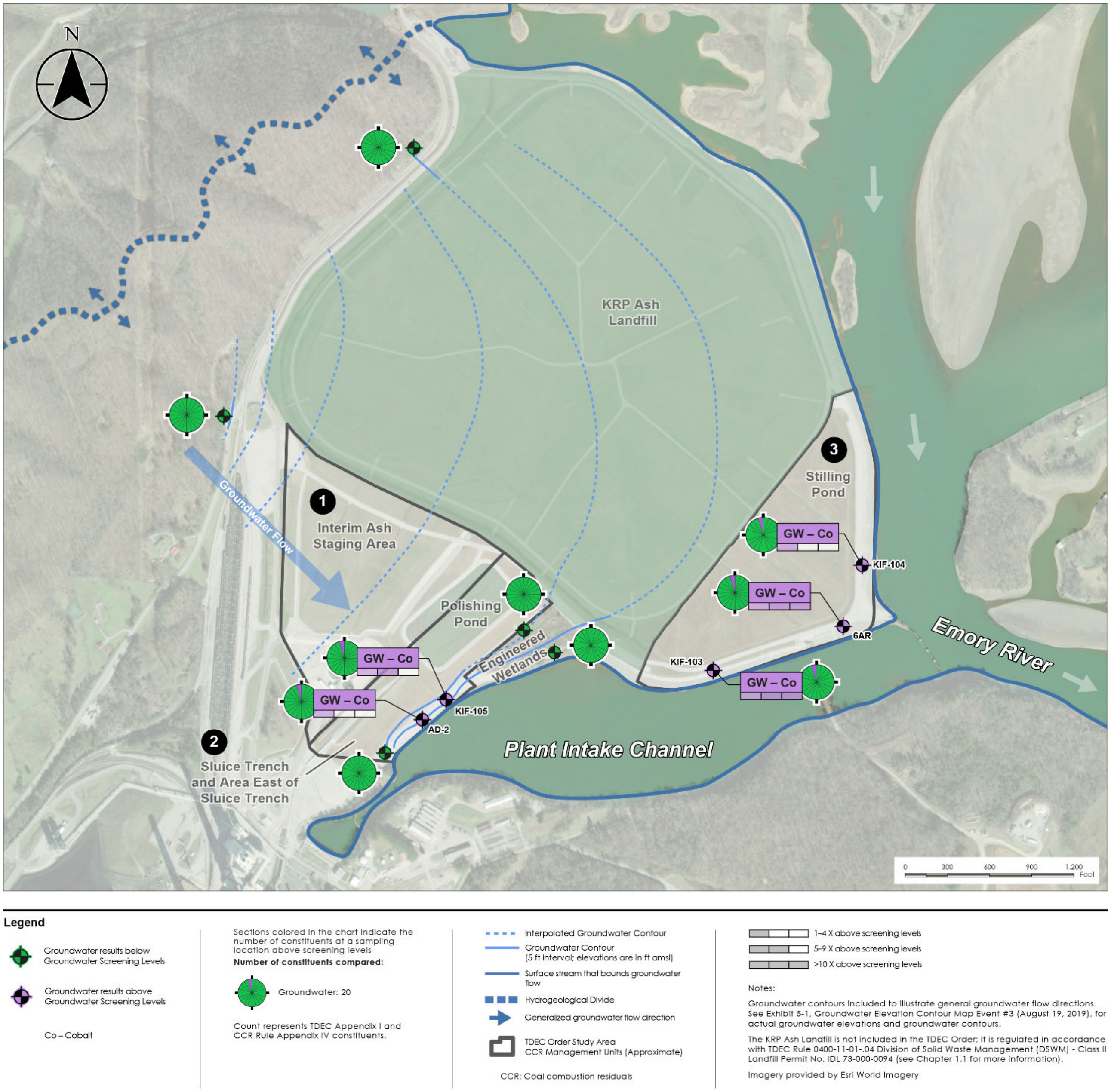
Chapter 8 TDEC Order Investigation Summary and Conceptual Site Model

This section summarizes the assessment of CCR material, structural stability and integrity of the TDEC Order CCR management units, and extent of CCR Parameters within environmental media investigated during the EI at the KIF Plant. CSMs for the TDEC Order CCR management units and overall findings are also presented based on the EI and associated historical and ongoing program results. CSMs describe sources of CCR constituents, pathways by which they can move, and environmental media potentially impacted if they are released.

Analytical results were compared to TDEC-approved EAR screening levels to identify areas that require further evaluation. Most screening levels are not regulatory standards and are conservatively based on published health studies. Concentrations above the screening level do not necessarily mean that an adverse health effect is occurring, but rather, that further evaluation is required in the CARA Plan to determine if an unacceptable risk exists, and if corrective action is required. TDEC Order CCR management units were evaluated for potential slope stability impacts, which were defined as those areas having analysis results (i.e., factors of safety) that do not meet TDEC-approved criteria for one or more load cases. This section provides a summary of potential impacts identified during the EI that will be further evaluated in the CARA Plan (note that seismic mitigation design will be performed in parallel with the CARA Plan, per Chapter 8.3).

Several EI findings are common among the TDEC Order CCR management units and are discussed in Chapter 8.1. Specific EI findings and CSMs for each TDEC Order CCR management unit are described in Chapters 8.2 through 8.4 and presented in Exhibits 8-1 and 8-2. These exhibits depict findings discussed in this EAR on a representative cross-section of subsurface conditions for each unit. Results of the EI are presented for the overall investigation area on Exhibit 8-3 and near the TDEC Order CCR management units as shown on the figure below and on Exhibit 8-4.

Overall Findings Near KIF Plant TDEC Order CCR Management Units



8.1 COMMON FINDINGS

The common TDEC Order EI findings for the KIF Plant TDEC Order CCR management units are as follows:

Structural Stability and Integrity: The three CCR management units have adequate structural integrity, and there is no evidence of voids/cavities in bedrock that could lead to loss of structural support and potential release of overlying CCR material.

Hydrogeology: A review of boring logs and PLM testing results indicated that the presence of CCR material within or near the screened interval of monitoring wells might be influencing the analytical results of groundwater samples collected from the existing groundwater monitoring systems. This finding may lead to a re-evaluation of the certified groundwater monitoring systems for compliance with the CCR Rule and TDEC permitted landfill groundwater monitoring programs.

The unconsolidated materials are considered to be the uppermost aquifer and are under unconfined conditions. The bedrock underlying the KIF Plant was found to have low hydraulic conductivity based on pressure testing.

The horizontal groundwater flow direction within the uppermost aquifer beneath the CCR management units is generally to the east-southeast toward the Emory River or Plant Intake Channel. Groundwater flow in the vicinity of the CCR management units is bounded to the east and southeast by the Emory River and the Plant Intake Channel. Pine Ridge to the west and upgradient of the plant, serves as a topographic divide to groundwater flow.

Each of the TDEC Order CCR management units was previously closed in accordance with applicable regulations in effect at the time of closure. The pore water levels reported herein may not represent steady-state conditions.

Pore water within the CCR material has specific chemical characteristics that are different from the characteristics of groundwater downgradient of the CCR management units. Certain CCR constituents that have been detected in pore water are affected by geochemical processes during transport by groundwater through geological materials. The effect of these geochemical processes, which can result in the attenuation of CCR constituents and reduced dissolved groundwater concentrations, can explain the observed differences between the characteristics of pore water and groundwater quality.

Surface Streams, Sediment, Bioaccumulation and Benthic Communities: Evaluation of the previous and ongoing extensive investigations conducted for the KRP indicate that surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health, or to aerial-feeding insectivorous birds. TVA is continuing long-term monitoring activities to document these findings.

Seeps: No seeps were identified during the EI. Previously identified seepage is mitigated by a seepage collection system that discharges seep water to the Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001.

8.2 Interim Ash Staging Area

A summary of EI evaluation findings and a CSM for the Interim Ash Staging Area are provided on Exhibit 8-1 in cross-sectional view and on Exhibit 8-4 in plan view. These exhibits also illustrate surrounding units and surface streams for the Interim Ash Staging Area.

CCR material in this unit is stacked ash over sluiced ash, and the estimated total volume of CCR material is about 3 million cubic yards. The slope stability evaluation indicates that global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.

All but one TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below GSLs. The primary constituent of interest in groundwater for the Interim Ash Staging Area is cobalt at wells AD-2 and KIF-105.

In summary, potential impacts associated with the Interim Ash Staging Area CCR management unit based on EI sampling results are limited to cobalt in onsite groundwater at two monitoring wells. This constituent will be further evaluated in the CARA Plan to determine if unacceptable risks exist and corrective actions are needed.

8.3 Sluice Trench and Area East of Sluice Trench

A summary of EI evaluation findings and a CSM for the Sluice Trench and Area East of Sluice Trench is provided on Exhibit 8-1 in cross-sectional view, and on Exhibit 8-4 in plan view. These exhibits also illustrate surrounding units and surface streams for the Sluice Trench and Area East of Sluice Trench.

CCR material in this unit is stacked ash over sluiced ash, with an estimated total volume of about 900,000 cubic yards. The slope stability evaluation indicates that global and veneer slope stability meet the established factor of safety criteria for the static load cases. For the seismic load cases, the evaluation indicates that veneer slope stability meets the established factor of safety criteria, but that the pseudostatic global and post-earthquake global load cases do not meet the criteria. TVA is currently evaluating mitigation alternatives, and it is anticipated that the mitigation design process will commence in parallel with the CARA phase of the TDEC Order program.

All but one TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below GSLs. The primary constituent of interest in groundwater for the Sluice Trench and Area East of Sluice Trench is cobalt at wells AD-2 and KIF-105.

In summary, potential impacts associated with the Sluice Trench and Area East of Sluice Trench CCR management unit based on EI sampling results are limited to cobalt in onsite groundwater at two monitoring wells. This constituent will be further evaluated in the CARA Plan to determine if unacceptable risks exist and corrective actions are needed.

8.4 Stilling Pond

A summary of EI findings and a CSM for the Stilling Pond is provided on Exhibit 8-2 in cross-sectional view and on Exhibit 8-4 in plan view. These exhibits also illustrate surrounding units and surface streams for the Stilling Pond.

CCR material is sluiced ash, with an estimated total volume of CCR of about 804,000 cubic yards. The slope stability evaluation indicates that global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.

All but one TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below GSLs. The primary constituent of interest in groundwater for the Stilling Pond is cobalt at wells 6AR, KIF-103 and KIF-104.

In summary, potential impacts associated with the Stilling Pond CCR management unit based on EI sampling results are limited to cobalt in onsite groundwater at three monitoring wells. This constituent will be further evaluated in the CARA Plan to determine if unacceptable risks exist and corrective actions are needed.

Chapter 9 Conclusions and Next Steps

9.1 Conclusions

In accordance with the TDEC Order, TVA prepared an EIP for the KIF Plant TDEC Order CCR management units to obtain and provide information requested by TDEC. As specified in the Order, the primary objective of the EIP was to "identify the extent of soil, surface water, and groundwater contamination by CCR" from onsite management of CCR material in impoundments and landfills. In addition, per TDEC's information requests, the EIP included assessment of CCR management unit structural stability and integrity. Between 2018 and 2021 TVA and Stantec implemented EI activities in accordance with the approved EIP. The EI included characterization of the site hydrogeology and investigations of CCR material, groundwater, background soils, seeps, as well as the Water Use Survey. Investigations associated with surface streams, sediments, and ecology have been addressed as part of the KRP.

This EAR presents the results of those investigations, describes the extent of surface stream water, sediment, and groundwater contamination from the KIF Plant TDEC Order CCR management units, and provides the information, data, and evaluations used to make those assessments. Geotechnical analysis findings and environmental sampling results above TDEC approved screening levels in specific media will be further evaluated in the CARA Plan to determine whether unacceptable risks exist that require corrective action. As required by the TDEC Order, this EAR will be revised to address TDEC comments until the objective of the EIP is met.

In summary, more than 96% of the compared groundwater sample results from over 300 samples collected during the EI were below screening levels. The KRP data included for evaluation of surface stream water, sediment and ecology were collected under a similar quality assurance program as the EI data, and are considered to be of comparable data quality for use in this EAR. Most screening levels are not regulatory standards and are conservatively based on published health studies. The EI data indicate impacts to limited onsite groundwater areas, and extensive investigations conducted for the KRP indicate that there are no adverse impacts to ecological communities in the Clinch, Emory, and Tennessee Rivers.

The following are overall assessment findings for the investigation based on data as presented in this EAR:

- Evaluation of the previous and ongoing extensive investigations conducted for the KRP indicate that surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health in the Clinch, Emory, and Tennessee Rivers, or to aerial-feeding insectivorous birds. TVA is continuing long-term monitoring activities to document these findings, as required by the USEPA and TDEC under the terms of the CERCLA remedy.

- The TDEC Order CCR management units have adequate structural stability, and slopes are stable under current static and seismic loading conditions, except for the seismic global slope stability at the Sluice Trench and Area East of Sluice Trench. TVA is currently evaluating mitigation alternatives, and it is anticipated that the mitigation design process will commence in parallel with the CARA phase of the TDEC Order program.

- No seeps were identified during the EI.
- All but one TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below GSLs, and groundwater impacts are limited to onsite areas downgradient along the perimeter of the TDEC Order CCR management units. However, additional assessments will be included in the CARA Plan to evaluate the need for corrective action for targeted onsite groundwater remediation at locations where statistically significant concentrations of cobalt above the GSL exist. Drainage improvements or potential corrective actions are expected to reduce concentrations of CCR constituents to below GSLs in groundwater at downgradient monitoring locations.
- Groundwater flow in the uppermost aquifer in the vicinity of the CCR management units is bounded to the east and southeast by the Emory River and the Plant Intake Channel. Pine Ridge to the west and upgradient of the plant serves as a topographic divide to groundwater flow.
- Based on the overall results of the water use survey, current and historical CCR management associated with the KIF Plant have not affected water supply wells or springs located in the vicinity of the KIF Plant

The following summary provides the specific findings requiring further evaluation in the CARA Plan.

Summary of Findings Requiring Further Evaluation in the CARA Plan			
TDEC Order CCR Management Unit	**Stability**	**Groundwater**	**Surface Stream, Sediment, Ecology**
Interim Ash Staging Area	None	Cobalt (Wells AD-2 and KIF-105)	None
Sluice Trench and Area East of Sluice Trench	None (seismic mitigation design will commence in parallel with the CARA phase)	Cobalt (Wells AD-2 and KIF-105)	
Stilling Pond	None	Cobalt (Wells 6AR, KIF-103, and KIF-104)	

9.2 Next Steps

Upon approval of the EAR, TVA will prepare and submit a CARA Plan to TDEC in accordance with the TDEC Order. The CARA Plan, which will be subject to a public review and comment process, will evaluate whether unacceptable risks related to management of CCR material exist at the KIF Plant. The EI data will be used to evaluate the basis and methods for TDEC Order CCR management unit closure in the CARA Plan, including an evaluation of the performance of existing closure methods; modifications to closure methodology will be identified, as needed, in the CARA Plan. The CARA Plan will also specify the actions TVA plans to take at the TDEC Order CCR management units and the basis of those actions. It will also incorporate other operational changes planned or in progress by TVA, including details for CCR material beneficial use operations, modification of the TDEC Order CCR management units as needed to meet regulatory standards and long-term closure and monitoring.

TVA continues to evaluate additional ways to beneficially use CCR material in a manner consistent with regulatory requirements while maximizing value to the Tennessee Valley.

Chapter 10 References

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TVA. ENV-TI-05.80.05, Field Sampling Equipment Cleaning and Decontamination.

TVA. ENV-TI-05.80.06, Handling and Shipping of Samples.

TVA. ENV-TI-05.80.21, Monitoring Well Inspection and Maintenance.

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TABLES

Table 1-1. Human Health Screening Levels for Groundwater
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CCR Parameters	Groundwater Screening Levels (µg/L)	Source
CCR Rule Appendix III Constituents :		
Boron	4,000	RSL
Calcium	--	--
Chloride	250,000	SMCL
Fluoride	4,000	MCL
pH	6.5-8.5 S.U.	SMCL
Sulfate	250,000	SMCL
Total Dissolved Solids	500,000	SMCL
CCR Rule Appendix IV Constituents :		
Antimony	6	MCL
Arsenic	10	MCL
Barium	2,000	MCL
Beryllium	4	MCL
Cadmium	5	MCL
Chromium (total)	100	MCL
Cobalt	6	CCR Rule GWPS
Fluoride	4,000	MCL
Lead	15	CCR Rule GWPS
Lithium	40	CCR Rule GWPS
Mercury	2	MCL
Molybdenum	100	CCR Rule GWPS
Radium-226 & 228	5 pCi/L	MCL
Selenium	50	MCL
Thallium	2	MCL
TDEC Appendix I Constituents :		
Copper	1,300	MCLG
Nickel	100	TN MCL
Silver	100	TN SMCL
Vanadium	86	RSL
Zinc	5,000	SMCL

Notes:
ug/L: micrograms per liter
SMCL: USEPA secondary maximum contaminant level
MCL: USEPA maximum contaminant level
MCLG: Maximum contaminant level goal
TN MCL: maximum contaminant level promulgated by State of Tennessee
TN SMCL: secondary maximum contaminant level promulgated by State of Tennessee
RSL: USEPA regional screening level (November 2018)

Table 3-1 - Lithologic Summary
Kingston Fossil Plant
March 2019 - February 2020

Geologic Unit	Boring IDs	Depth Range	Soil Type and Particle-size Range	Color Range	Additional Observations
Conasauga Group (Undivided)	KIF-BG01, KIF-BG02, KIF-BG03, KIF-BG04, KIF-BG05, KIF-BG06, KIF-BG07; KIF-BG08, KIF-BG09	Ground surface to between 7.8 and 53.0 feet bgs.	Generally, lean to fat clay with occasional sand, clayey sand, and silt layers extending to the top of bedrock or grading to medium to coarse gravel.	Color is highly variable; brown to yellowish brown, yellowish red to dark reddish brown, to gray and greanish grey.	Expanding clay observed in KIF-BG08 from 10.0 feet bgs to 22.5 feet bgs.
Knox Group	KIF-BG10, KIF-BG11, KIF-BG12	Ground surface to between 22.2 and 40.0 feet bgs	Fat to silty lean clay with chert fragments grading to layers of clayey gravel, silty sand and clayey sands.	Generally brown to strong brown from ground surface to refusal in borings KIF-BG10 and KIF-BG11. KIF-BG12 is red to yellowish red to 21.5 feet bgs and then dark brown to yellowish brown to refusal.	Expanding clay observed at each location.

Notes:

bgs - below ground surface
ID - identification

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Table 3-2 - Rock Outcrop Phase 2 Geochemical Analytical Results
Kingston Fossil Plant

Sample Location		Area 01-01			Area 01-02			Area 01-03		
Sample Date		22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21
Sample ID		KIF-WR-A01-01-A-20210622	KIF-WR-A01-01-B-20210622	KIF-WR-A01-01-C-20210622	KIF-WR-A01-02-A-20210622	KIF-WR-A01-02-B-20210622	KIF-WR-A01-02-C-20210622	KIF-WR-A01-03-A-20210622	KIF-WR-A01-03-B-20210622	KIF-WR-A01-03-C-20210622
Parent Sample ID										
Sample Type	Units	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample
General Chemistry										
Cation Exchange Capacity	meq/100gm	10.7	13.0	14.9	27.6	24.1	24.1	14.3	13.9	14.0
SEP Metals*										
Aluminum	mg/kg	1,030	1,190	1,360	1,430	1,470	1,500	1,410	1,420	1,540
Antimony	mg/kg	<0.287	<0.286	<0.284	<0.290	<0.292	<0.296	<0.288	<0.578	<0.287
Arsenic	mg/kg	1.98	2.05	2.87	0.643	0.630	0.623	2.28	1.14	2.35
Barium	mg/kg	14.3	15.4	6.72	1.01 J	1.17 J	1.31 J	20.3	14.9	13.7
Beryllium	mg/kg	0.108 J	0.0872 J	0.101 J	0.105 J	0.115 J	0.112 J	0.0582 J	0.0506 J	0.0799 J
Cadmium	mg/kg	<0.0113	<0.0112	<0.0112	<0.0114	<0.0115	<0.0116	<0.0113	<0.0227	<0.0113
Calcium	mg/kg	4.70 J	5.10 J	4.78 J	4.91 J	4.66 J	5.28 J	5.03 J	6.34 J	4.81 J
Chromium	mg/kg	1.74	1.85	1.95	1.62	1.73	1.61	1.62	1.89	1.58
Cobalt	mg/kg	13.3 J	20.2 J	8.55 J	1.80 J	2.97 J	4.11 J	14.7 J	22.5 J	10.9 J
Copper	mg/kg	1.77	2.37	1.73	1.18 J	1.29 J	1.34	2.93	4.34	2.57
Iron	mg/kg	4,820 J	4,710 J	5,460 J	2,450 J	2,840 J	2,740 J	3,430 J	2,520 J	3,510 J
Lead	mg/kg	2.39	2.16	1.09	0.260 J	0.319 J	0.376 J	0.723	0.401 J	0.667
Lithium	mg/kg	1.66 J	2.27 J	0.799 J	0.238 J	0.323 J	0.304 J	0.259 J	0.458 J	0.372 J
Manganese	mg/kg	832 J	1,310 J	354 J	27.5 J	70.1 J	118 J	1,570 J	3,350 J	932 J
Molybdenum	mg/kg	<0.0840	<0.0837	<0.0832	<0.0850	<0.0855	<0.0868	<0.0845	<0.169	<0.0840
Nickel	mg/kg	3.93	5.67	1.80 J	0.809 J	0.867 J	0.977 J	4.60	14.6	4.67
Potassium	mg/kg	134 J	137 J	180 J	141 J	144 J	147 J	171 J	178 J	148 J
Selenium	mg/kg	<0.174	0.540 J	<0.173	<0.176	<0.177	<0.180	0.450 J	<0.878	0.196 J
Silver	mg/kg	<0.113	0.178 J	<0.112	<0.114	<0.115	<0.116	0.210 J	0.386 J	0.151 J
Thallium	mg/kg	0.215 UJ	<0.429	<0.213	<0.218	<0.219	<0.222	<0.433	<1.08	0.215 UJ
Vanadium	mg/kg	1.87 J	1.91 J	2.30 J	2.12 J	2.34 J	2.31 J	1.43 J	1.15 J	1.48 J
Zinc	mg/kg	2.42 U*	2.40 U*	1.36 U*	1.56 U*	1.48 U*	1.49 U*	2.65 U*	4.81 U*	2.39 U*
Total Metals										
Aluminum	mg/kg	13,700 J	13,100 J	14,300 J	14,500 J	15,400 J	15,100 J	11,300 J	14,100 J	12,900 J
Antimony	mg/kg	0.0390 UJ	0.0420 J	0.0432 UJ	0.0405 UJ	0.0449 UJ	0.0429 UJ	0.0422 UJ	0.0411 UJ	0.0342 UJ
Arsenic	mg/kg	9.99	11.4	13.6	6.75	5.38	6.11	13.7	13.9	12.7
Barium	mg/kg	143 J	78.9 J	121 J	72.0 J	85.4 J	89.4 J	644 J	274 J	164 J
Beryllium	mg/kg	0.809	0.908	1.02	0.902	0.954	0.890	1.70	1.32	1.56
Cadmium	mg/kg	0.0403 U*	0.0401 U*	0.0362 U*	0.0210 U*	<0.0177	<0.0170	0.0834 U*	0.0476 U*	0.0478 U*
Calcium	mg/kg	5,040 J	4,430 J	9,040 J	154 U*	134 U*	154 U*	5,950 J	4,980 J	6,320 J
Chromium	mg/kg	27.8 J	29.3 J	31.2 J	37.3 J	35.8 J	36.0 J	17.0 J	27.1 J	22.6 J
Cobalt	mg/kg	42.2 J	10.9 J	19.2 J	8.44 J	10.2 J	11.5 J	60.6 J	35.7 J	22.4 J
Copper	mg/kg	19.8	21.6	23.0	18.6	16.7	20.4	42.7	32.1	29.1
Iron	mg/kg	32,000 J	34,200 J	37,100 J	41,700 J	35,800 J	37,100 J	41,400 J	30,900 J	31,000 J
Lead	mg/kg	24.9	21.9	21.6	9.59	12.5	12.4	25.2	19.3	21.5
Lithium	mg/kg	27.4	22.0	23.8	16.6	18.1	19.1	18.2	27.1	21.0
Manganese	mg/kg	2,120 J	307 J	855 J	78.9 J	120 J	220 J	7,530 J	2,350 J	772 J
Molybdenum	mg/kg	0.182 J	0.178 J	0.180 J	0.163 J	<0.170	<0.163	0.201 J	0.194 J	0.144 J
Nickel	mg/kg	28.6 J	25.6 J	28.5 J	15.4 J	16.1 J	16.5 J	48.7 J	33.5 J	28.1 J
Potassium	mg/kg	1,490	1,540	1,760	2,480	2,630	2,460	2,120	2,060	2,380
Selenium	mg/kg	0.195 J	0.202 J	0.123 UJ	0.115 UJ	0.127 UJ	0.122 UJ	0.120 UJ	0.117 UJ	0.0969 UJ
Silver	mg/kg	<0.0245	<0.0260	<0.0271	<0.0254	<0.0282	<0.0270	0.0619 J	<0.0258	<0.0214
Thallium	mg/kg	0.326	0.196	0.284	0.267	0.284	0.284	0.283	0.198	0.183
Vanadium	mg/kg	19.6 J	20.3 J	21.0 J	25.9 J	24.6 J	26.4 J	15.4 J	20.0 J	17.4 J
Zinc	mg/kg	47.5 J	44.2 J	46.5 J	41.2 J	41.2 J	42.7 J	46.5 J	51.1 J	42.8 J
SEM Bulk Mineral										
AL-RICH	%mass	0.0931	0.00400	0.00521	<0.000147	0.00260	<0.0000748	0.0645	0.0342	0.00164
BA-S RICH	%mass	<0.000227	<0.000140	<0.000104	<0.000147	<0.0000339	<0.0000748	<0.000145	<0.0000668	<0.0000441
CA-RICH	%mass	0.106	0.263	1.95	0.0927	0.175	0.0310	0.00241	<0.0000668	0.00375
CA-S RICH	%mass	<0.000227	<0.000140	<0.000104	<0.000147	<0.0000339	<0.0000748	<0.000145	<0.0000668	<0.0000441
FE-RICH	%mass	0.355	0.453	2.95	0.935	0.455	0.0851	2.26	2.12	0.593
FE-S RICH	%mass	<0.000227	<0.000140	<0.000104	<0.000147	<0.0000339	<0.0000748	<0.000145	<0.0000668	<0.0000441
MN-RICH	%mass	0.00685	0.101	1.11	<0.000147	<0.0000339	<0.0000748	1.66	0.969	0.246
XRD Bulk Mineral										
ALBITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1
AMORPHOUS	%mass	<10	<10	<10	<10	<10	<10	<10	<10	<10
ANORTHOCLASE	%mass	5	4	4	7	8	8	6	6	5
CALCITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1
CHLORITE	%mass	7	10	11	7	9	9	7	7	6
Clay	%mass	2	3	3	5	5	6	5	5	5
Crystalline Silica, Quartz	%mass	56	65	60	27	28	25	45	45	47
DOLOMITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1
HEMATITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1
KAOLINITE	%mass	18	11	14	30	29	29	20	18	19
MICA/ILLITE	%mass	11	7	8	24	21	22	18	20	18
MICROCLINE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1
PYRITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1

See notes on last page.

Table 3-2 - Rock Outcrop Phase 2 Geochemical Analytical Results
Kingston Fossil Plant

Sample Location		Area 02-01				Area 02-02						
Sample Date		22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21
Sample ID		KIF-WR-A02-01-A-20210622	KIF-WR-A02-01-B-20210622	KIF-WR-A02-01-C-20210622	KIF-WR-FD01-20210622	KIF-WR-A02-02A-A-20210622	KIF-WR-A02-02A-B-20210622	KIF-WR-A02-02A-C-20210622	KIF-WR-A02-02B-A-20210622	KIF-WR-A02-02B-B-20210622	KIF-WR-A02-02B-C-20210622	KIF-WR-A02-02C-A-20210622
Parent Sample ID					KIF-WR-A02-01-20210622							
Sample Type	Units	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Field Duplicate **	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample
General Chemistry												
Cation Exchange Capacity	meq/100gm	18.3	17.1	22.1	12.0	46.0	11.8	6.12	12.3	13.5	13.2	11.6
SEP Metals*												
Aluminum	mg/kg	537	465	479	510	222	247	217	336 J	351 J	384	579
Antimony	mg/kg	<0.284	<0.284	<0.285	<0.283	<0.282	<0.282	<0.281	<0.282	<0.281	<0.283	<0.281
Arsenic	mg/kg	0.714	0.603	0.615	0.576	0.388 J	0.435 J	0.369 J	<0.131	0.142 J	0.157 J	0.180 J
Barium	mg/kg	48.6	56.5	51.3	54.3	57.5	39.8	33.1	45.1	38.5	36.2	83.7
Beryllium	mg/kg	0.154 J	0.128 J	0.130 J	0.132 J	0.0382 J	0.0424 J	0.0371 J	0.0564 J	0.0663 J	0.0602 J	0.127 J
Cadmium	mg/kg	<0.0111	<0.0112	<0.0112	<0.0111	<0.0111	<0.0111	<0.0110	<0.0111	<0.0111	<0.0111	<0.0110
Calcium	mg/kg	4.84 J	4.71 J	4.49 J	4.57 J	6.11 J	5.54 J	5.63 J	5.59 J	5.53 J	5.37 J	7.17 J
Chromium	mg/kg	1.41	1.10	1.08	1.11	1.56	1.36	1.04	0.835	0.822	0.765	1.24
Cobalt	mg/kg	10.4 J	6.62 J	8.27 J	8.25 J	4.71 J	5.36 J	3.83 J	4.87 J	5.65 J	6.20	4.01
Copper	mg/kg	5.66	5.67	5.08	5.22	1.12 J	1.18 J	0.753 J	3.04	3.71	4.27	3.81
Iron	mg/kg	2,510 J	1,990 J	1,860 J	1,820 J	1,280 J	1,010 J	775 J	798 J	784 J	746	2,050
Lead	mg/kg	0.494 J	0.389 J	0.378 J	0.410 J	1.97	1.85	1.55	0.322 J	0.271 J	0.232 J	0.882
Lithium	mg/kg	0.608 J	0.481 J	0.572 J	0.723 J	0.712 J	0.749 J	0.680 J	1.47 J	0.932 J	0.993 J	0.859 J
Manganese	mg/kg	142 J	173 J	155 J	217 J	2,880 J	2,240 J	1,590 J	1,200 J	1,100 J	886	2,360
Molybdenum	mg/kg	<0.0831	<0.0832	<0.0836	<0.0830	<0.0825	<0.0827	<0.0823	<0.0826	<0.0824	<0.0830	<0.0823
Nickel	mg/kg	1.62 J	1.68 J	2.47	2.91	5.32	5.24	4.26	9.36	7.92	5.32	9.61
Potassium	mg/kg	164 J	151 J	153 J	161 J	112 J	107 J	101 J	111 J	117 J	107 J	255
Selenium	mg/kg	<0.172	<0.172	<0.173	<0.172	<0.855	<0.858	<0.341	<0.342	<0.342	<0.172	<0.853
Silver	mg/kg	<0.111	<0.112	<0.112	<0.111	0.392 J	0.298 J	0.225 J	0.166 J	0.135 J	0.126 J	0.254 J
Thallium	mg/kg	<0.213	<0.213	<0.214	<0.213	<1.06	<1.06	<0.421	<0.423	<0.422	<0.213	<1.05
Vanadium	mg/kg	1.98 J	1.78 J	1.57 J	1.74 J	0.946 J	0.843 J	0.676 J	0.730 J	0.794 J	0.796 J	1.30 J
Zinc	mg/kg	1.99 U*	1.85 U*	1.90 U*	2.10 U*	3.85	2.86	2.62 U*	4.71 U*	4.35 U*	4.22 U*	5.10 U*
Total Metals												
Aluminum	mg/kg	11,200 J	11,800 J	11,900 J	13,200 J	8,090 J	3,310 J	4,550 J	8,160 J	10,700 J	7,680	8,640
Antimony	mg/kg	0.0389 UJ	0.0341 UJ	0.0430 UJ	0.0399 UJ	0.0424 UJ	0.0425 UJ	0.0293 UJ	0.0376 UJ	0.0346 UJ	0.0407 UJ	0.0375 UJ
Arsenic	mg/kg	4.78	5.01	5.14	5.20	8.92	3.19	5.22	4.13	5.32	4.12	3.52
Barium	mg/kg	268 J	348 J	267 J	352 J	266 J	127 J	151 J	306 J	381 J	321 J	504 J
Beryllium	mg/kg	0.884	0.859	0.900	0.934	0.717	0.294	0.434	0.590	0.705	0.498	0.597
Cadmium	mg/kg	<0.0154	<0.0135	<0.0170	<0.0158	<0.0168	0.0193 U*	<0.0116	0.0209 U*	<0.0137	<0.0161	0.0549 U*
Calcium	mg/kg	1,430 J	1,780 J	1,710 J	1,700 J	7,090 J	67,600 J	10,300 J	26,100 J	7,170 J	40,400 J	2,800 J
Chromium	mg/kg	32.2 J	30.9 J	33.3 J	34.6 J	25.8 J	8.01 J	13.3 J	22.4 J	29.6 J	20.9 J	22.3 J
Cobalt	mg/kg	13.3 J	9.25 J	11.3 J	11.9 J	16.7 J	5.44 J	8.11 J	12.9 J	16.5 J	11.0 J	13.9 J
Copper	mg/kg	42.1	54.4	47.5	57.1	8.44	4.02	3.33	38.0	51.7	32.4	33.7
Iron	mg/kg	27,700 J	28,700 J	27,200 J	29,100 J	20,200 J	9,100 J	11,100 J	19,600 J	25,600 J	19,100	24,400
Lead	mg/kg	6.56	6.69	6.62	6.50	26.9	16.9	23.0	5.96	6.23	5.55	5.48
Lithium	mg/kg	20.0	21.6	19.2	22.0	14.7	7.15	9.23	20.4	24.8	17.8	16.0
Manganese	mg/kg	115 J	277 J	223 J	103 J	2,050 J	2,800 J	1,470 J	2,860 J	1,630 J	2,030	4,500
Molybdenum	mg/kg	<0.148	<0.129	<0.163	<0.151	0.212 J	<0.161	0.131 J	<0.143	<0.131	<0.154	0.144 J
Nickel	mg/kg	25.8 J	32.3 J	28.1 J	28.3 J	24.7 J	8.82 J	12.7 J	26.2 J	34.4 J	24.9	37.5
Potassium	mg/kg	2,800	2,640	2,920	3,010	2,380	960	1,220	2,150	2,540	1,750	2,480
Selenium	mg/kg	0.110 UJ	0.0967 UJ	0.122 UJ	0.113 UJ	0.120 UJ	0.121 UJ	0.0833 UJ	0.107 UJ	0.0981 UJ	0.115 UJ	0.106 UJ
Silver	mg/kg	<0.0244	<0.0214	<0.0270	<0.0251	<0.0266	<0.0267	<0.0184	<0.0236	<0.0217	<0.0255	<0.0236
Thallium	mg/kg	0.258	0.268	0.270	0.288	0.257	<0.0682	0.109	0.234	0.266	0.187	0.249
Vanadium	mg/kg	22.8 J	24.5 J	23.8 J	25.4 J	16.4 J	6.42 J	8.64 J	17.4 J	22.5 J	15.9	18.4
Zinc	mg/kg	53.0 J	56.4 J	53.5 J	58.0 J	41.7 J	15.1 J	23.2 J	42.0 J	53.2 J	39.8 J	48.3 J
SEM Bulk Mineral												
AL-RICH	%mass	<0.0000545	<0.0000701	<0.000110	0.000856	<0.0000189	0.0536	0.0471	0.00804	0.0373	0.0162	0.0296
BA-S RICH	%mass	<0.0000545	0.00174	<0.000110	<0.0000111	0.00160	<0.0000255	<0.0000235	0.00466	<0.00000605	<0.0000241	<0.0000103
CA-RICH	%mass	<0.0000545	0.0290	0.0100	<0.0000111	1.16	5.79	10.4	0.326	0.862	4.29	0.151
CA-S RICH	%mass	<0.0000545	<0.0000701	<0.000110	<0.0000111	<0.0000189	<0.0000255	<0.0000235	<0.00000563	<0.00000605	<0.0000241	0.000832
FE-RICH	%mass	0.440	0.487	2.24	0.464	0.262	5.91	1.69	1.25	4.49	1.13	0.812
FE-S RICH	%mass	<0.0000545	<0.0000701	<0.000110	<0.0000111	<0.0000189	<0.0000255	<0.0000235	<0.00000563	0.0424	<0.0000241	<0.0000103
MN-RICH	%mass	<0.0000545	0.0552	<0.000110	0.0220	0.0421	0.0220	0.410	0.00727	0.0298	0.165	0.0749
XRD Bulk Mineral												
ALBITE	%mass	6	6	6	7	10	8	9	9	8	9	10
AMORPHOUS	%mass	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
ANORTHOCLASE	%mass	6	7	7	6	<1	<1	<1	<1	<1	<1	<1
CALCITE	%mass	<1	<1	<1	<1	6	19	20	5	4	12	1
CHLORITE	%mass	5	4	4	5	3	4	4	10	10	7	7
Clay	%mass	9	9	9	8	3	4	3	6	8	6	6
Crystalline Silica, Quartz	%mass	25	25	23	31	53	41	48	39	34	34	41
DOLOMITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
HEMATITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
KAOLINITE	%mass	19	19	21	18	12	9	6	10	11	9	10
MICA/ILLITE	%mass	31	31	32	26	14	13	9	18	20	18	20
MICROCLINE	%mass	<1	<1	<1	<1	<1	3	2	4	5	5	4
PYRITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	1

See notes on last page.

Table 3-2 - Rock Outcrop Phase 2 Geochemical Analytical Results
Kingston Fossil Plant

Sample Location		Area 02-02		Area 05-04									
Sample Date		22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21	22-Jun-21
Sample ID		KIF-WR-A02-02C-B-20210622	KIF-WR-A02-02C-C-20210622	KIF-WR-A05-04A-A-20210622	KIF-WR-A05-04A-B-20210622	KIF-WR-A05-04A-C-20210622	KIF-WR-FD02-20210622	KIF-WR-A05-04B-A-20210622	KIF-WR-A05-04B-B-20210622	KIF-WR-A05-04B-C-20210622	KIF-WR-A05-04C-A-20210622	KIF-WR-A05-04C-B-20210622	KIF-WR-A05-04C-C-20210622
Parent Sample ID							KIF-WR-A05-04A-20210622						
Sample Type	Units	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Field Duplicate **	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample
General Chemistry													
Cation Exchange Capacity	meq/100gm	13.1	12.4	22.4	18.8	23.9	20.3	25.7	20.6	21.7	12.9	12.8	10.6
SEP Metals*													
Aluminum	mg/kg	649	701	1,120	1,090	1,130	1,030	1,150	1,200	1,130	932	863	942
Antimony	mg/kg	<0.281	<0.281	<0.601	<0.624	<0.599	<0.609	<0.297	<0.296	<0.596	<0.285	<0.287	<0.283
Arsenic	mg/kg	0.174 J	<0.130	1.59	1.26	1.58	1.23	0.389 J	0.649	0.656 J	0.736	0.783	0.737
Barium	mg/kg	99.9	149	0.310 J	0.313 J	0.306 J	0.391 J	26.1	3.87	2.61 J	161	87.7	108
Beryllium	mg/kg	0.0798 J	0.0988 J	0.154 J	0.138 J	0.145 J	0.153 J	0.125 J	0.145 J	0.134 J	0.103 J	0.170 J	0.0889 J
Cadmium	mg/kg	0.0166 J	0.0251 J	<0.0236	<0.0245	<0.0235	<0.0239	<0.0117	<0.0116	<0.0234	<0.0112	<0.0113	<0.0111
Calcium	mg/kg	7.36 J	7.65 J	5.55 J	5.58 J	5.31 J	5.60 J	4.82 J	6.15 J	5.11 J	7.05 J	6.08 J	6.46 J
Chromium	mg/kg	1.59	1.88	0.921 J	0.796 J	0.777 J	0.797 J	1.63	1.36	1.07	3.44	2.84	3.14
Cobalt	mg/kg	3.55	4.49	9.92	13.6	11.5	14.0	20.4	12.4	10.7	33.1	21.2	30.8
Copper	mg/kg	3.80	3.29	2.15 J	2.16 J	2.12 J	2.25 J	4.01	3.00	2.63	8.44	5.90	8.15
Iron	mg/kg	2,790	2,260	3,260	2,800	2,850	3,170	2,430	2,760	2,490	2,570	2,300	2,440
Lead	mg/kg	0.651	1.22	<0.236	0.283 J	<0.235	<0.239	3.77	2.16	1.61	1.78	2.14	1.69
Lithium	mg/kg	0.683 J	1.12 J	<0.322	0.449 J	0.395 J	0.430 J	0.317 J	0.413 J	0.255 J	3.05	3.06	3.72
Manganese	mg/kg	3,360	3,790	93.5	155	109	126	1,550	566	385	3,670	2,560	3,460
Molybdenum	mg/kg	<0.0823	<0.0823	<0.176	<0.183	<0.176	<0.178	<0.0870	<0.0868	<0.175	<0.0834	<0.0841	<0.0828
Nickel	mg/kg	10.6	20.2	3.48 J	5.05	3.50 J	4.79	6.39	3.68	3.14 J	15.6	11.0	14.3
Potassium	mg/kg	186 J	246 J	62.7 J	63.8 J	63.6 J	58.3 J	92.9 J	67.1 J	58.2 J	70.2 J	52.9 J	74.5 J
Selenium	mg/kg	<0.853	<0.853	<0.365	<0.379	<0.364	<0.370	0.440 J	<0.180	<0.362	<0.865	<0.871	<0.858
Silver	mg/kg	0.371 J	0.414 J	<0.236	<0.245	<0.235	<0.239	0.207 J	<0.116	<0.117	0.449 J	0.273 J	0.376 J
Thallium	mg/kg	<1.05	<1.05	<0.451	<0.468	<0.450	<0.457	<0.446	<0.222	<0.447	<1.07	<1.08	<1.06
Vanadium	mg/kg	1.68 J	1.41 J	2.70 J	2.18 J	2.40 J	2.46 J	1.66 J	1.78 J	1.74 J	1.58 J	1.25 J	1.55 J
Zinc	mg/kg	5.23 U*	6.90 U*	5.12 U*	5.36 U*	5.07 U*	5.29 U*	6.23 U*	4.54 U*	4.59 U*	9.17 U*	7.21 U*	9.52 U*
Total Metals													
Aluminum	mg/kg	11,100	12,500	12,900	13,800	14,100	14,100	9,390	12,800	12,100	6,510	6,110	6,270
Antimony	mg/kg	0.0415 UJ	0.0359 UJ	0.0405 UJ	0.0377 UJ	0.0404 UJ	0.0396 UJ	0.0322 J	0.0325 UJ	0.0449 UJ	0.0371 UJ	0.0374 UJ	0.0347 UJ
Arsenic	mg/kg	3.60	3.44	6.10	8.20	9.10	5.18	9.40	8.95	10.8	11.4	11.5	11.3
Barium	mg/kg	406 J	400 J	175 J	194 J	192 J	214 J	386 J	200 J	183 J	1,090 J	921 J	1,110 J
Beryllium	mg/kg	0.783	0.774	1.02	1.31	1.16	1.14	1.57	1.51	2.17	1.84	1.98	1.84
Cadmium	mg/kg	0.0570 J	0.0326 J	<0.0160	0.0171 J	<0.0160	<0.0157	0.0143 J	<0.0129	<0.0177	0.0389 J	0.0373 J	0.0335 J
Calcium	mg/kg	1,850	26,700	295	637	341	337	89.9	50.1	90.3	3,400	2,770	3,000
Chromium	mg/kg	25.9 J	28.9 J	27.6 J	32.0 J	30.4 J	32.2 J	22.6 J	28.7 J	34.2 J	15.1 J	15.0 J	15.2 J
Cobalt	mg/kg	13.9	14.9	20.0	29.4	15.2	19.9	56.8	27.1	26.9	53.7	74.8	64.0
Copper	mg/kg	25.0	42.4	17.1	20.6	18.4	17.5	31.1	41.9	34.9	23.7	25.7	29.1
Iron	mg/kg	26,900	29,100	23,900	27,800	18,900	19,800	40,200	44,600	61,100	19,700	26,100	21,000
Lead	mg/kg	5.12	4.21	8.55	11.4	13.5	10.8	19.9	19.5	18.3	16.1	13.6	15.5
Lithium	mg/kg	18.3	23.1	13.2	17.2	14.0	15.7	12.5	28.0	16.8	19.3	17.3	25.0
Manganese	mg/kg	3,450 J	2,890 J	130 J	216 J	114 J	130 J	5,450 J	1,340 J	1,230 J	5,820 J	5,740 J	7,250 J
Molybdenum	mg/kg	<0.157	0.146 J	<0.154	<0.143	<0.153	<0.150	0.139 J	<0.123	<0.170	0.330 J	0.371 J	0.298 J
Nickel	mg/kg	67.0 J	49.7 J	32.3 J	40.7 J	29.9 J	36.3 J	50.5 J	44.3 J	65.4 J	50.0 J	59.1 J	62.2 J
Potassium	mg/kg	2,750	3,060	2,540	2,830	2,630	3,230	1,750	1,720	2,060	1,080	1,000	1,110
Selenium	mg/kg	0.118 UJ	0.102 UJ	0.115 UJ	0.107 UJ	0.115 UJ	0.112 UJ	0.0880 UJ	0.0923 UJ	0.127 UJ	0.105 UJ	0.106 UJ	0.0986 UJ
Silver	mg/kg	<0.0260	<0.0226	<0.0254	<0.0237	<0.0254	<0.0249	0.0309 J	<0.0204	<0.0282	0.0339 J	0.0281 J	0.0452 J
Thallium	mg/kg	0.244	0.240	0.291	0.338	0.307	0.343	0.951	0.440	0.421	0.289	0.299	0.439
Vanadium	mg/kg	20.6 J	23.3 J	21.4 J	24.5 J	18.4 J	19.9 J	17.5 J	23.8 J	22.2 J	11.4 J	11.7 J	10.8 J
Zinc	mg/kg	71.0 J	74.5 J	68.9 J	82.7 J	64.3 J	72.4 J	70.8 J	86.9 J	84.6 J	39.5 J	41.1 J	45.8 J
SEM Bulk Mineral													
AL-RICH	%mass	0.0339	0.185	0.270	<0.0000215	<0.0000405	0.0586	0.285	<0.0000474	<0.000297	<0.0000427	0.000141	<0.000129
BA-S RICH	%mass	<0.0000173	<0.0000390	<0.0000469	<0.0000215	<0.0000405	<0.0000338	<0.0000280	<0.0000474	<0.000297	<0.0000427	<0.0000455	<0.000129
CA-RICH	%mass	1.61	0.0754	0.0952	0.00693	0.00111	0.0197	<0.0000280	<0.0000474	<0.000297	<0.0000427	0.00161	0.00700
CA-S RICH	%mass	<0.0000173	<0.0000390	<0.0000469	<0.0000215	<0.0000405	<0.0000338	<0.0000280	<0.0000474	<0.000297	<0.0000427	<0.0000455	<0.000129
FE-RICH	%mass	0.481	2.83	0.967	0.0847	0.126	0.103	1.47	0.814	0.0728	6.57	0.423	2.09
FE-S RICH	%mass	<0.0000173	<0.0000390	<0.0000469	<0.0000215	<0.0000405	<0.0000338	<0.0000280	<0.0000474	<0.000297	<0.0000427	<0.0000455	<0.000129
MN-RICH	%mass	0.0369	0.504	<0.0000469	<0.0000215	0.0170	<0.0000338	0.00941	0.00481	<0.000297	0.303	0.178	1.37
XRD Bulk Mineral													
ALBITE	%mass	11	15	4	7	4	<1	<1	9	5	<1	<1	<1
AMORPHOUS	%mass	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
ANORTHOCLASE	%mass	<1	<1	<1	<1	<1	1	<1	<1	<1	1	1	1
CALCITE	%mass	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CHLORITE	%mass	8	5	2	3	3	9	9	9	6	3	2	3
Clay	%mass	4	6	13	17	16	6	11	9	17	<1	<1	<1
Crystalline Silica, Quartz	%mass	41	49	30	23	28	28	34	36	21	75	72	73
DOLOMITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
HEMATITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
KAOLINITE	%mass	7	7	16	17	16	27	15	15	23	12	13	12
MICA/ILLITE	%mass	19	18	33	28	30	29	30	22	28	8	9	8
MICROCLINE	%mass	3	1	1	6	3	<1	1	2	1	<1	<1	<1
PYRITE	%mass	1	<1	<1	<1	<1	<1	<1	<1	<1	2	2	2

See notes on last page.

Table 3-2 - Rock Outcrop Phase 2 Geochemical Analytical Results
Kingston Fossil Plant

Sample Location		Area 05-05									Area 05-G01		
Sample Date		23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21
Sample ID		KIF-WR-A05-05A-A-20210623	KIF-WR-A05-05A-B-20210623	KIF-WR-A05-05A-C-20210623	KIF-WR-A05-05B-A-20210623	KIF-WR-A05-05B-B-20210623	KIF-WR-A05-05B-C-20210623	KIF-WR-A05-05C-A-20210623	KIF-WR-A05-05C-B-20210623	KIF-WR-A05-05C-C-20210623	KIF-WR-A05-G01A-A-20210623	KIF-WR-A05-G01A-B-20210623	KIF-WR-A05-G01A-C-20210623
Parent Sample ID													
Sample Type	Units	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample
General Chemistry													
Cation Exchange Capacity	meq/100gm	24.3	29.3	21.0	12.4	10.6	12.7	25.6	25.0	23.3	14.5	15.4	16.3
SEP Metals*													
Aluminum	mg/kg	1,090	1,190	1,200	549	537	546	1,580	1,670	1,660	868	770	764
Antimony	mg/kg	<0.583	<0.580	<0.581	<0.282	<0.281	<0.282	<0.582	<0.293	<0.294	<0.285	<0.286	<0.285
Arsenic	mg/kg	0.594 J	0.532 J	0.532 J	<0.131	<0.130	<0.131	0.765 J	0.902	0.877	2.36	2.00	1.77
Barium	mg/kg	8.79	10.3	21.4	3.28	2.98	3.99	4.96	0.951 J	1.24 J	1.60 J	2.05 J	3.00
Beryllium	mg/kg	0.164 J	0.176 J	0.148 J	0.0634 J	0.0627 J	0.0639 J	0.151 J	0.156 J	0.165 J	0.0933 J	0.0878 J	0.105 J
Cadmium	mg/kg	<0.0229	<0.0228	<0.0228	<0.0111	<0.0110	<0.0111	<0.0229	<0.0115	<0.0115	<0.0112	<0.0112	<0.0112
Calcium	mg/kg	<1.56	<3.11	<3.11	4.13 J	4.13 J	4.29 J	5.74 J	7.30 J	7.49 J	4.10 J	4.36 J	4.62 J
Chromium	mg/kg	1.25	1.11	1.17	0.307 J	0.314 J	0.372 J	0.680	0.620	0.623	1.72	1.39	1.21
Cobalt	mg/kg	13.8	16.3	30.1	17.2	18.9	25.2	16.7	8.14	6.78	0.533 J	0.410 J	4.08
Copper	mg/kg	1.80 J	2.29 J	2.44 J	0.477 J	0.479 J	0.552 J	0.910 J	0.778 J	0.917 J	0.854 J	0.787 J	0.603 J
Iron	mg/kg	4,620	4,360	4,650	816	823	869	4,540	4,320	4,640	5,280	6,030	6,230
Lead	mg/kg	<0.229	<0.228	0.264 J	0.531	0.509	0.764	<0.229	<0.115	<0.115	<0.112	<0.112	<0.112
Lithium	mg/kg	0.358 J	0.444 J	0.750 J	1.01 J	1.20 J	1.57 J	0.534 J	0.223 J	0.373 J	<0.153	<0.153	0.170 J
Manganese	mg/kg	481	552	841	261	278	372	308	160	181	12.1	11.0	50.7
Molybdenum	mg/kg	<0.171	<0.170	<0.170	<0.0826	<0.0823	<0.0825	<0.170	<0.0857	<0.0860	<0.0836	<0.0837	<0.0834
Nickel	mg/kg	1.89 J	1.94 J	2.83 J	6.93	7.66	10.7	1.87 J	0.639 J	1.03 J	0.178 J	<0.0858	0.465 J
Potassium	mg/kg	46.9 J	<53.8	<54.0	40.2 J	41.0 J	41.0 J	51.1 J	60.0 J	60.1 J	84.7 J	93.4 J	95.1 J
Selenium	mg/kg	0.410 J	<0.352	<0.353	<0.171	<0.171	<0.171	0.374 J	<0.178	<0.178	<0.173	<0.174	<0.173
Silver	mg/kg	<0.229	<0.228	<0.228	<0.111	<0.110	<0.111	<0.114	<0.115	<0.115	<0.112	<0.112	<0.112
Thallium	mg/kg	<0.437	<0.435	<0.436	<0.211	<0.211	<0.211	<0.436	<0.220	<0.220	<0.214	<0.214	<0.214
Vanadium	mg/kg	2.78 J	2.69 J	2.75 J	0.567 J	0.551 J	0.557 J	2.15 J	2.21 J	2.20 J	1.83 J	1.73 J	1.78 J
Zinc	mg/kg	4.33 U*	4.45 U*	4.82 U*	3.94 U*	4.04 U*	4.76 U*	3.32 U*	2.60 U*	2.84 U*	2.42 U*	2.38 U*	2.38 U*
Total Metals													
Aluminum	mg/kg	12,600	14,200	12,100	8,580	8,590	9,830	17,100	16,100	10,800	9,370	11,500	10,100
Antimony	mg/kg	0.0317 UJ	0.0428 UJ	0.0375 UJ	0.0264 UJ	0.0345 UJ	0.0357 UJ	0.0595 J	0.0510 J	0.0696 J	0.0331 J	0.0330 UJ	0.0391 UJ
Arsenic	mg/kg	5.89	6.02	6.43	1.58	1.78	1.61	5.99	8.64	6.47	15.7	9.42	11.0
Barium	mg/kg	330 J	333 J	295 J	80.6 J	75.4 J	86.9 J	180 J	158 J	137 J	405 J	835 J	488 J
Beryllium	mg/kg	1.40	1.62	1.52	0.734	0.826	0.787	2.13	2.79	1.20	1.08	0.967	1.18
Cadmium	mg/kg	<0.0125	<0.0169	<0.0148	<0.0104	<0.0137	<0.0141	<0.0170	<0.0171	<0.0102	0.0377 J	0.0282 J	0.0350 J
Calcium	mg/kg	203	199	182	53.2	60.8	61.4	328	162	193 J	6,610 J	4,630 J	6,020 J
Chromium	mg/kg	25.6 J	26.4 J	25.4 J	10.2 J	11.0 J	11.4 J	28.1 J	33.2 J	26.8	21.0	18.1	16.4
Cobalt	mg/kg	45.9	30.4	30.6	30.6	29.6	34.9	11.4	18.2	9.20	6.25	6.13	7.16
Copper	mg/kg	23.5	33.6	25.4	7.43	6.49	7.41	15.7	15.6	13.5	22.1	18.1	14.7
Iron	mg/kg	35,700	40,100	37,900	24,200	24,200	24,700	42,400	72,700	32,100	29,300	27,300	31,100
Lead	mg/kg	6.66	6.96	5.37	4.05	4.77	4.60	7.60	5.74	7.23	19.9	14.8	14.8
Lithium	mg/kg	22.9	28.1	17.3	27.4	24.5	27.8	20.0	29.1	16.6	11.6	11.7	10.3
Manganese	mg/kg	1,040 J	1,040 J	865 J	487 J	496 J	556 J	136 J	415 J	101	119	88.5	99.4
Molybdenum	mg/kg	<0.120	<0.162	<0.142	<0.100	<0.131	<0.136	<0.163	<0.164	0.136 J	<0.109	<0.125	<0.148
Nickel	mg/kg	25.5 J	29.9 J	22.1 J	55.0 J	46.8 J	52.9 J	28.4 J	34.2 J	23.5	27.9	25.8	25.8
Potassium	mg/kg	2,160	2,320	2,130	795	1,010	1,130	4,370	2,600	2,120	1,280	1,700	1,870
Selenium	mg/kg	0.0900 UJ	0.121 UJ	0.106 UJ	0.0749 UJ	0.0980 UJ	0.101 UJ	0.122 UJ	0.123 UJ	0.0731 UJ	0.0890 J	0.0936 UJ	0.111 UJ
Silver	mg/kg	<0.0199	<0.0269	<0.0235	<0.0166	<0.0217	<0.0224	<0.0270	<0.0271	<0.0162	<0.0180	<0.0207	<0.0245
Thallium	mg/kg	0.253	0.236	0.249	0.0867	0.0824	0.0984	0.274	0.229	0.224	0.0739	0.0913	0.0874 J
Vanadium	mg/kg	21.3 J	22.3 J	21.8 J	9.89 J	9.64 J	11.1 J	24.1 J	25.3 J	22.7	13.8	14.3	15.1
Zinc	mg/kg	57.8 J	62.6 J	50.5 J	64.8 J	56.6 J	63.7 J	62.1 J	71.0 J	53.1 J	43.4 J	48.3 J	42.5 J
SEM Bulk Mineral													
AL-RICH	%mass	<0.000112	<0.0000819	<0.0000966	0.0836	<0.000171	0.00614	0.00205	0.0946	<0.000191	0.0423	1.54	0.0172
BA-S RICH	%mass	<0.000112	<0.0000819	<0.0000966	<0.000123	<0.000171	<0.000124	<0.0000680	<0.0000939	<0.000191	<0.000257	<0.000271	<0.000324
CA-RICH	%mass	0.0657	0.00554	0.0445	<0.000123	<0.000171	<0.000124	0.00388	0.0899	<0.000191	0.130	<0.000271	0.159
CA-S RICH	%mass	0.0141	<0.0000819	<0.0000966	<0.000123	<0.000171	<0.000124	<0.0000680	<0.0000939	<0.000191	<0.000257	<0.000271	<0.000324
FE-RICH	%mass	0.337	1.60	0.412	4.54	2.82	0.928	1.09	0.250	13.3	2.87	3.74	4.25
FE-S RICH	%mass	<0.000112	<0.0000819	<0.0000966	<0.000123	<0.000171	<0.000124	<0.0000680	<0.0000939	<0.000191	<0.000257	<0.000271	<0.000324
MN-RICH	%mass	<0.000112	0.0199	<0.0000966	0.0332	0.00689	<0.000124	0.00278	<0.0000939	<0.000191	<0.000257	<0.000271	<0.000324
XRD Bulk Mineral													
ALBITE	%mass	5	2	6	<1	<1	<1	<1	<1	<1	<1	<1	<1
AMORPHOUS	%mass	<10	<10	<10	<10	<10	<10	17	28	16	<10	<10	<10
ANORTHOCLASE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CALCITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CHLORITE	%mass	3	4	2	7	5	7	9	10	13	8	9	11
Clay	%mass	19	13	17	3	3	4	6	8	8	5	5	5
Crystalline Silica, Quartz	%mass	32	35	29	70	74	72	31	22	29	73	71	71
DOLOMITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
HEMATITE	%mass	<1	<1	<1	<1	<1	<1	4	3	4	1	2	1
KAOLINITE	%mass	11	10	14	6	5	5	<1	<1	<1	<1	<1	<1
MICA/ILLITE	%mass	29	35	31	13	12	12	33	28	29	13	14	13
MICROCLINE	%mass	3	1	2	2	2	2	1	2	3	<1	<1	<1
PYRITE	%mass	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

See notes on last page.

Table 3-2 - Rock Outcrop Phase 2 Geochemical Analytical Results
Kingston Fossil Plant

Sample Location		Area 05-G01						
Sample Date		23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21	23-Jun-21
Sample ID		KIF-WR-A05-G01B-A-20210623	KIF-WR-A05-G01B-B-20210623	KIF-WR-A05-G01B-C-20210623	KIF-WR-A05-G01C-A-20210623	KIF-WR-A05-G01C-B-20210623	KIF-WR-A05-G01C-C-20210623	KIF-WR-FD03-20210623
Parent Sample ID								KIF-WR-A05-G01C-20210623
Sample Type	Units	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Normal Environmental Sample	Field Duplicate **
General Chemistry								
Cation Exchange Capacity	meq/100gm	26.4	25.7	23.2	19.2	16.9	18.2	14.2
SEP Metals*								
Aluminum	mg/kg	1,510	1,330	1,380	1,480	1,350	1,340	1,240
Antimony	mg/kg	<0.309	<0.306	<0.312	<0.677	<0.580	<0.291	<0.572
Arsenic	mg/kg	0.666	0.656	0.738	2.92	2.68	2.54	2.67
Barium	mg/kg	1.36 J	1.51 J	1.49 J	2.09 J	3.14	8.13	2.97
Beryllium	mg/kg	0.117 J	0.115 J	0.124 J	0.121 J	0.101 J	0.105 J	0.105 J
Cadmium	mg/kg	<0.0121	<0.0120	<0.0123	<0.0266	<0.0228	<0.0114	<0.0225
Calcium	mg/kg	5.06 J	5.90 J	5.73 J	6.38 J	4.91 J	5.62 J	4.97 J
Chromium	mg/kg	1.22	1.95	1.40	1.26	1.04	1.59	1.49
Cobalt	mg/kg	1.87 J	2.14 J	1.32 J	3.43 J	3.51 J	6.39	2.54 J
Copper	mg/kg	0.749 J	0.742 J	0.749 J	1.18 J	1.08 J	1.14 J	0.902 J
Iron	mg/kg	2,890	3,450	3,300	4,930	4,410	5,320	4,920
Lead	mg/kg	<0.121	<0.120	<0.123	0.322 J	0.284 J	0.402 J	0.363 J
Lithium	mg/kg	<0.166	<0.164	<0.167	0.183 J	0.223 J	0.386 J	0.180 J
Manganese	mg/kg	40.6	42.2	28.5	142	122	257	96.2
Molybdenum	mg/kg	<0.0905	<0.0896	<0.0915	<0.198	<0.170	<0.0851	<0.168
Nickel	mg/kg	<0.0927	<0.0918	<0.0937	0.548 J	0.740 J	1.23 J	0.444 J
Potassium	mg/kg	56.6 J	52.6 J	55.3 J	49.2 J	43.7 J	46.6 J	46.3 J
Selenium	mg/kg	<0.188	<0.186	<0.190	<0.411	<0.352	<0.176	<0.347
Silver	mg/kg	<0.121	<0.120	<0.123	<0.266	<0.114	<0.114	<0.112
Thallium	mg/kg	<0.232	<0.229	<0.234	<0.508	<0.435	<0.218	<0.429
Vanadium	mg/kg	1.91 J	1.66 J	1.99 J	2.21 J	1.75 J	2.08 J	1.85 J
Zinc	mg/kg	2.58 U*	2.57 U*	2.76 U*	3.11 U*	2.67 U*	1.76 U*	1.80 U*
Total Metals								
Aluminum	mg/kg	13,400	14,600	12,600	15,800	12,700	15,900	14,800
Antimony	mg/kg	0.0456 UJ	0.0400 J	0.0444 UJ	0.0452 UJ	0.0342 UJ	0.0372 UJ	0.0418 UJ
Arsenic	mg/kg	10.2	11.3	8.16	12.2	11.6	12.8	9.46
Barium	mg/kg	253 J	202 J	251 J	317 J	350 J	386 J	385 J
Beryllium	mg/kg	1.91	1.69	1.71	1.42	1.29	1.27	1.32
Cadmium	mg/kg	<0.0180	0.0156 J	<0.0176	0.0855 J	0.0781 J	0.0802 J	0.0570 J
Calcium	mg/kg	355 J	355 J	345 J	2,780 J	1,530 J	1,500 J	2,650 J
Chromium	mg/kg	26.4	39.8	19.3	23.7	23.3	26.1	22.9
Cobalt	mg/kg	12.5	7.20	7.35	17.0	14.3	42.9	25.8
Copper	mg/kg	15.5	15.9	15.1	23.4	16.6	21.8	21.1
Iron	mg/kg	36,300	33,400	28,900	35,900	27,900	31,100	28,500
Lead	mg/kg	11.7	10.2	10.5	14.4	12.4	12.5	14.1
Lithium	mg/kg	8.61	8.23	8.43	32.6	28.1	36.8	31.0
Manganese	mg/kg	157	77.8	78.6	424	313	975	565
Molybdenum	mg/kg	<0.173	<0.136	<0.168	<0.171	<0.130	<0.141	<0.159
Nickel	mg/kg	16.3	13.4	14.6	59.8	43.0	58.9	53.4
Potassium	mg/kg	3,210	2,740	2,910	2,380	1,940	2,120	2,450
Selenium	mg/kg	0.129 UJ	0.102 UJ	0.126 UJ	0.128 UJ	0.0971 UJ	0.106 UJ	0.119 UJ
Silver	mg/kg	<0.0287	<0.0225	<0.0279	<0.0284	<0.0215	0.0349 J	<0.0263
Thallium	mg/kg	0.286	0.290	0.231	0.207	0.189	0.356	0.254
Vanadium	mg/kg	20.5	20.7	17.6	16.8	15.4	18.2	16.4
Zinc	mg/kg	46.2 J	35.1 J	34.8 J	91.6 J	69.4 J	92.9 J	80.4 J
SEM Bulk Mineral								
AL-RICH	%mass	0.00295	<0.0000560	1.14	0.0273	0.0235	0.0313	0.0153
BA-S RICH	%mass	<0.0000462	<0.0000560	<0.0000505	<0.0000260	<0.0000880	<0.000200	<0.0000913
CA-RICH	%mass	<0.0000462	0.000982	0.0164	0.00139	0.0132	<0.000200	<0.0000913
CA-S RICH	%mass	<0.0000462	<0.0000560	<0.0000505	<0.0000260	<0.0000880	<0.000200	<0.0000913
FE-RICH	%mass	0.530	0.469	0.156	0.104	1.68	0.819	1.79
FE-S RICH	%mass	<0.0000462	<0.0000560	<0.0000505	<0.0000260	<0.0000880	<0.000200	<0.0000913
MN-RICH	%mass	<0.0000462	<0.0000560	<0.0000505	0.154	<0.0000880	0.0103	<0.0000913
XRD Bulk Mineral								
ALBITE	%mass	<1	<1	<1	<1	<1	<1	<1
AMORPHOUS	%mass	20	<10	12	14	<10	23	12
ANORTHOCLASE	%mass	<1	<1	<1	1	2	1	1
CALCITE	%mass	<1	<1	<1	<1	<1	<1	<1
CHLORITE	%mass	<1	<1	<1	13	16	12	15
Clay	%mass	6	7	6	5	7	5	6
Crystalline Silica, Quartz	%mass	32	45	37	49	55	45	48
DOLOMITE	%mass	<1	<1	<1	<1	<1	<1	<1
HEMATITE	%mass	1	1	1	1	1	1	1
KAOLINITE	%mass	12	13	13	<1	<1	<1	2
MICA/ILLITE	%mass	29	33	31	17	19	14	16
MICROCLINE	%mass	<1	<1	<1	<1	<1	<1	<1
PYRITE	%mass	<1	<1	<1	<1	<1	<1	<1

Notes:
Please note that units have been converted automatically in this table, and significant figures may not have been maintained.

15.2	measured concentration did not exceed the indicated standard
<0.03	analyte was not detected at a concentration greater than the Method Detection Limit
-	Parameter not analyzed / not available.
ID	Identification
J	quantitation is approximate due to limitations identified during data validation
U*	result should be considered "not detected" because it was detected in an associated field or laboratory blank at a similar level
UJ	This compound was not detected, but the reporting or detection limit should be considered estimated due to a bias identified during data validation.
meq/100gm	milliequivalents per 100 grams
mg/kg	milligrams per kilogram
%mass	percent mass
SEM	Scanning Electron Microscopy
XRD	X-ray Diffraction
*	SEP Metals data shown is for Step 7 only of the 7 step extraction
**	Duplicate applies to all 3 samples labelled with A, B and C that came from the same bin.

TABLE 4-1 – Pore Water Level Measurements
Kingston Fossil Plant
May - October 2019

Temporary Well / Piezometer ID	Top of Casing Elevation	Piezometer Sensor Elevation	Pore Water Elevation (ft msl)					
	ft msl	ft msl	5/14/2019	6/17/2019	7/30/2019	8/19/2019	9/17/2019	10/21/2019
Monitoring Well								
KIF-107	762.86	n/a	753.19	752.88	753.30	752.36	752.34	751.68
Temporary Wells								
KIF-TW01	775.36	n/a	756.23	NM	756.07	755.62	754.64	754.23
KIF-TW02	774.73	n/a	756.08	NM	756.20	755.27	754.65	753.82
KIF-TW03	778.90	n/a	755.46	NM	755.56	754.88	754.23	753.45
KIF-TW04	769.60	n/a	755.32	NM	755.54	754.71	754.25	753.42
KIF-TW05	773.59	n/a	753.41	NM	753.53	753.07	752.54	751.81
Piezometers								
KIF-17-02-1	n/a	733.3	NM	742.6	NM	742.9	NM	742.7
KIF-17-03-1	n/a	737.0	NM	741.6	NM	NM	NM	NM
PZ-A1	764.43	732.2	762.6	NM	754.0	753.4	753.0	752.3
PZ-B1	766.69	734.1	752.9	NM	753.1	752.5	752.1	751.4

Notes:

ft feet
ID identification
msl mean sea level
n/a not applicable
NM not measured

1. Top of casing elevations were obtained from well survey data.

2. For piezometers, pore water elevations and piezometer data were obtained from geotechnical instrumentation database. Data from piezometers were averaged for the measurement date.

3. Depth to pore water in piezometers and pore water elevations at all locations are calculated values. Accuracy of piezometer data is to 0.1 ft.

4. Pore water levels were not measured in select piezometers as noted above because the sensors were not recording data.

Table 4-2 -Estimated CCR Material Areas, Depths, and Volumes
Kingston Fossil Plant

CCR Unit	CCR Material Above Phreatic Surface (CY)	CCR Material Below Phreatic Surface (CY)	Total (CY)	Minimum CCR Depth (FT)	Maximum CCR Depth (FT)	CCR Unit Area (Acres)
Interim Ash Staging and Sluice Trench Areas	1,190,900	2,699,900	3,890,800	0	56	60
Stilling Pond	328,700	475,200	803,900	0	36	40
Study Area Units Total	**1,519,600**	**3,175,100**	**4,694,700**	**Not Applicable**	**Not Applicable**	**100**

Notes:

1. CCR – coal combustion residuals
2. CY – cubic yards
3. The volumes reported herein may not represent steady-state conditions. In addition, the phreatic surface in the Interim Ash Staging Area would be expected to decrease in elevation if modifications to stormwater drainage or to the existing soil cap system were to be implemented.
4. For details regarding the development of the three-dimensional models of the CCR management units, refer to the MQA SAR

(Appendix G.7).

5. For details regarding water level measurements used to estimate the phreatic surface elevation, refer to Chapter 4.3.3.3.

EXHIBITS

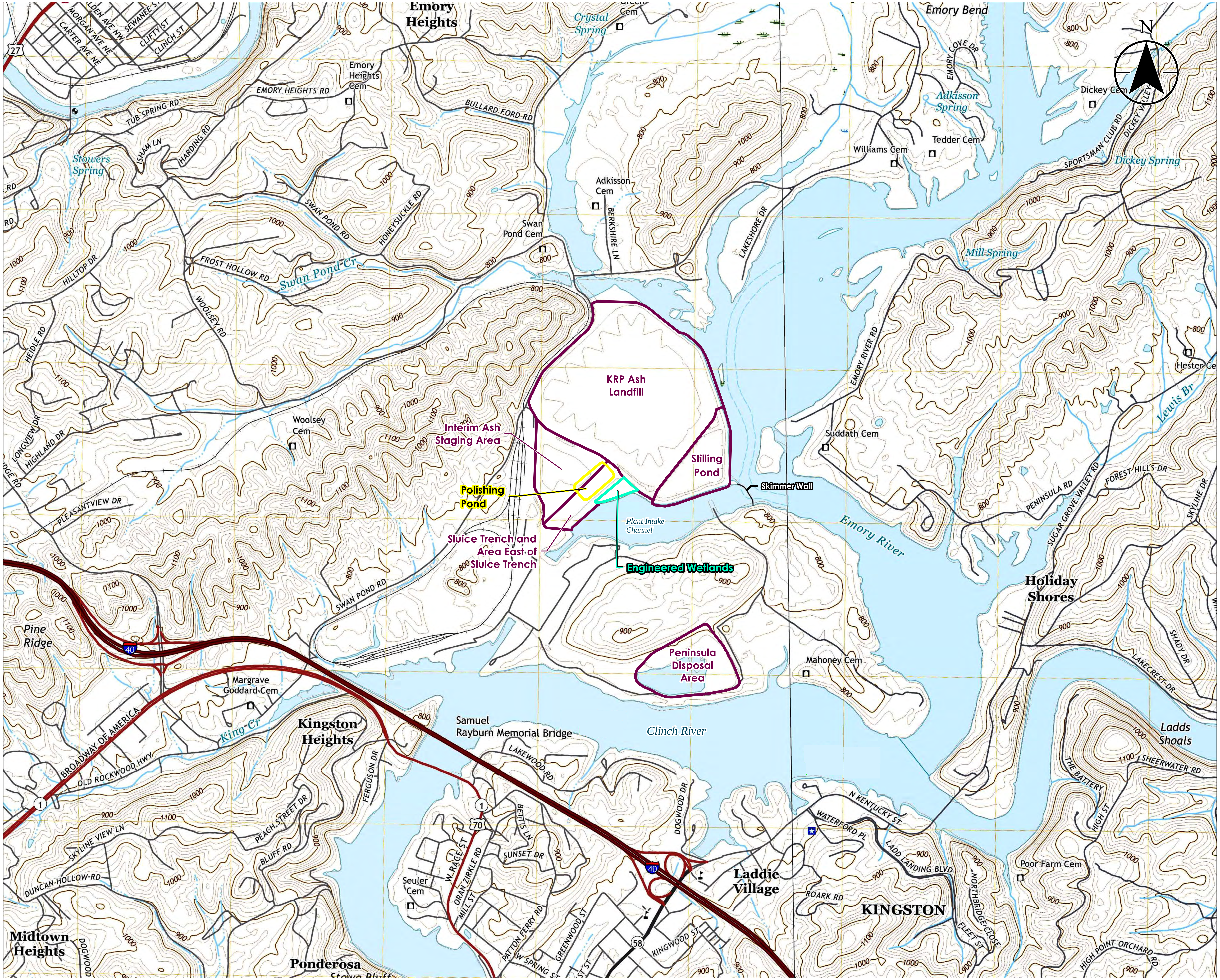
Exhibit No.
1-1

Title
Location Plan and Topographic Map

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location: Roane County, Tennessee
175668043
Prepared by MB on 2023-03-22
Technical Review by EM on 2023-03-22

0 1,000 2,000 3,000 4,000 Feet
1:12,000 (At original document size of 22x34)



Legend

- CCR Management Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

CCR = Coal Combustion Residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Topographic mapping corresponds to the Harriman Quadrangle (Edition of 2019, Scale 1:24,000) and the Elverton Quadrangle (Edition of 2019, Scale 1:24,000)

Stantec TVA

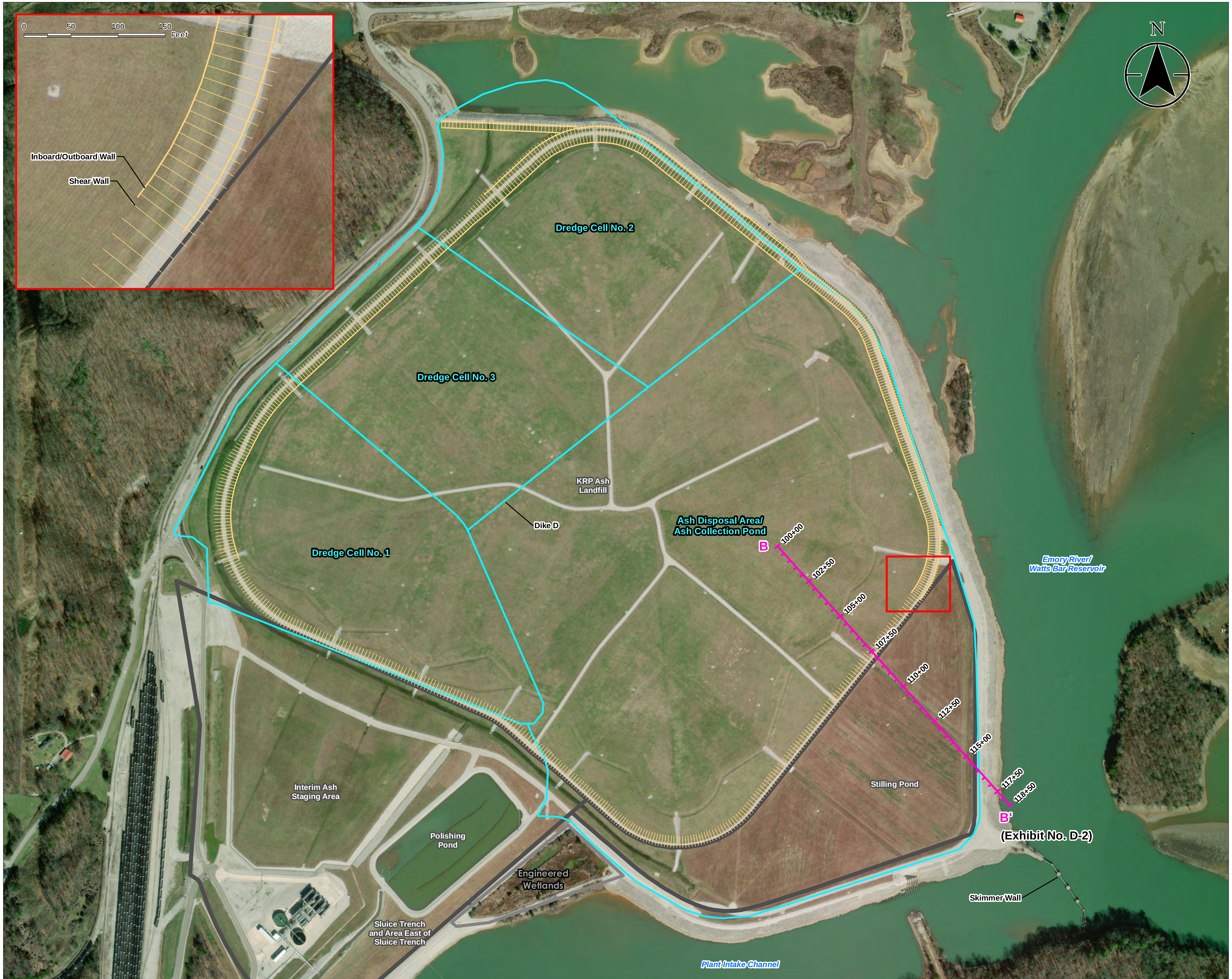


Exhibit No.
1-2

Title
Perimeter Wall Stabilization

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2023-10-12
Technical Review by EM on 2023-10-12

0 250 500 750 1,000 Feet
1:3,000 (At original document size of 22x34)

Legend

- Cross Section Alignment (B-B')

Perimeter Containment Wall

- Inboard/Outboard Wall
- Shear Wall
- Historic CCR Management Area (Approximate)
- CCR Management Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)

CCR = Coal Combustion Residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery

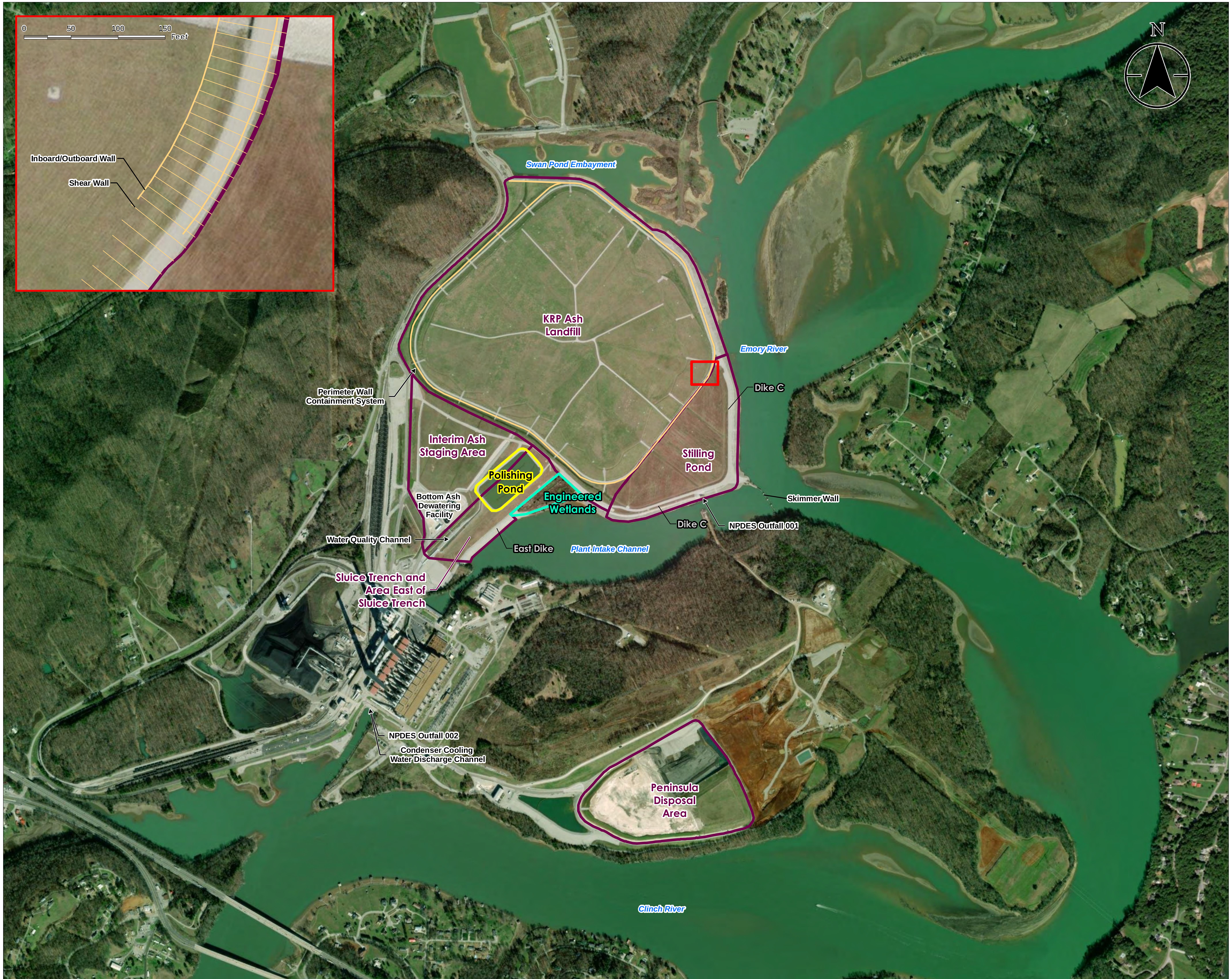


Exhibit No.
2-1

Title
KIF Plant Overview

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by MB on 2023-10-12
Technical Review by EM on 2023-10-12

0 500 1,000 1,500 2,000 Feet
1:7,200 (At original document size of 22x34)

Legend

Subsurface Wall (Approximate)
CCR Management Unit Area (Approximate)
Engineered Wetlands (Approximate)
Polishing Pond (Approximate)

Perimeter Containment Wall (As Shown in Inset)

Inboard/Outboard Wall
Shear Wall

CCR = Coal Combustion Residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Topographic mapping corresponds to the Harriman Quadrangle (Edition of 2019, Scale 1:24,000) and the Elverton Quadrangle (Edition of 2019, Scale 1:24,000)

Stantec TVA

U:\TVA-EIP\175668043_KIF_Phase2\gis\mxd\EAR\2-1_KIF_PlantOverview.mxd Revised: 2023-10-12 By: mbough

Exhibit No.
2-2

Title
Dike Construction History

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2023-03-23
Technical Review by EM on 2023-03-23

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Dike B (Approximate)
- North Dike (Approximate)
- East Dike (Approximate)
- Dike C (Approximate)
- Divider Dike (Approximate)
- Historic CCR Management Area (Approximate)
- Historic Metal Cleaning Pond (Approximate)
- CCR Management Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)

CCR = Coal Combustion Residuals

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery

Stantec TVA

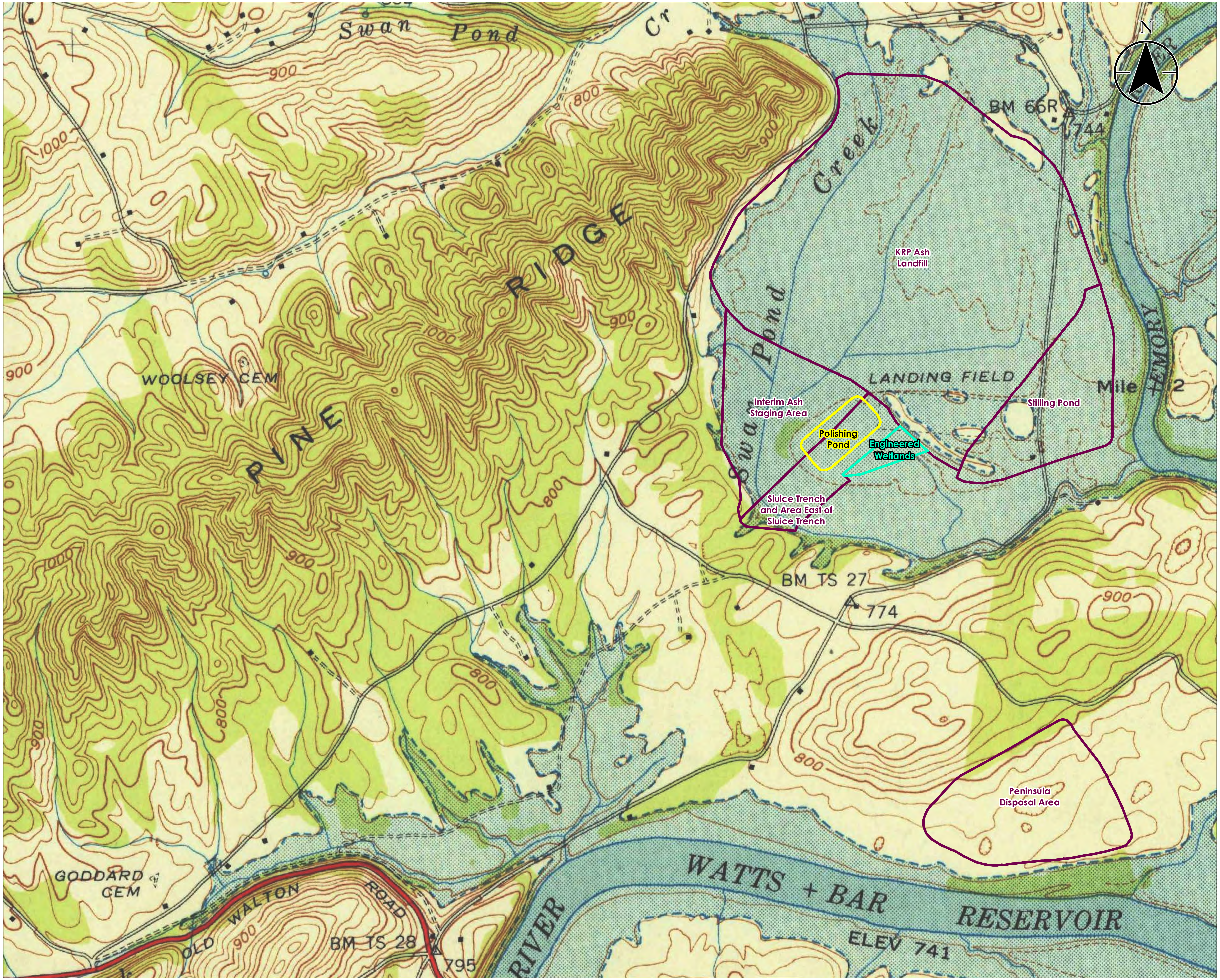


Exhibit No.

2-3

Title

Topographic Map - USGS (1941)

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location

Roane County, Tennessee

175668043
Prepared by DMB on 2022-05-10
Technical Review by EM on 2022-05-10

0 500 1,000 1,500 2,000 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)

Stantec

TVA

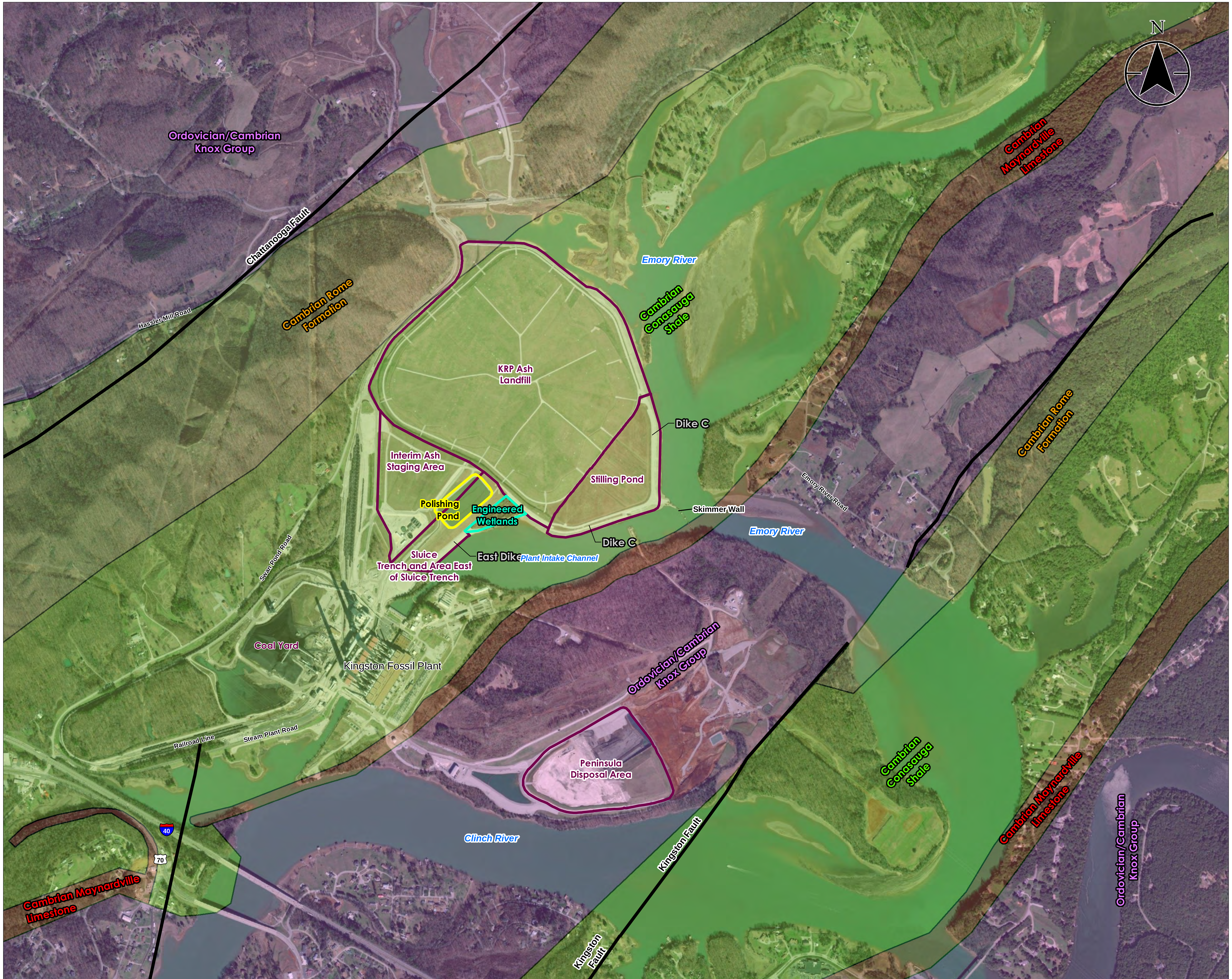


Figure No.
2-4

Title
Regional Geologic Map

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by TKR on 2023-03-08
Technical Review by MB on 2023-03-08
Independent Review by ES on 2023-03-08

0 700 1,400 2,100 2,800 Feet
1:8,400 (At original document size of 22x34)

Legend

- Fault
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Geologic Formations

- Ordovician/Cambrian Knox Group
- Cambrian Maynardville Limestone
- Cambrian Conasauga Shale
- Cambrian Rome Formation

CCR: Coal combustion residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery courtesy of ESRI World Imagery basemap (Dated 2/22/2020)
3. Geologic map corresponds to the "East-Central Sheet Geologic Map of Tennessee" (1966); Moore, James L. et al (1993). "Geologic Map of The Harriman Quadrangle, Tennessee"; and the Site Geologic Map, Figure 2-1 included in the TVA (November 2004) "Kingston Fossil Plant Hydrogeologic Evaluation of Coal-Combustion Byproduct Disposal Facility Expansion".

Stantec TVA

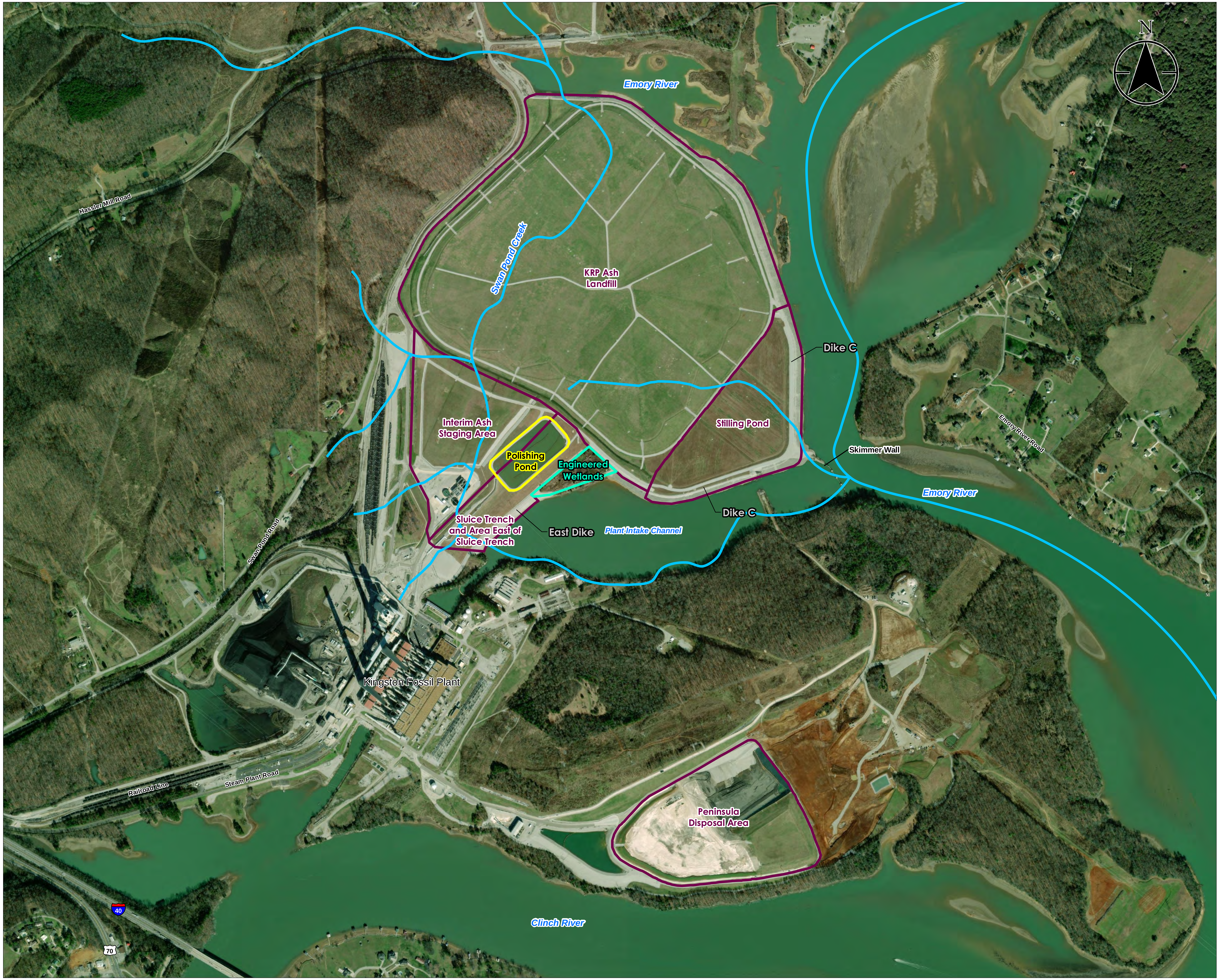


Exhibit No.

2-5

Title

Historic Stream Alignments

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location

Roane County, Tennessee

175668043
Prepared by TKR on 2022-07-01
Technical Review by VS on 2022-07-01
Independent Review by EM & MB on 2022-07-01

0 500 1,000 1,500 2,000 Feet

1:6,000 (At original document size of 22x34)

Legend

- Historic Stream Alignment
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

CCR = Coal Combustion Residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery
3. Historic stream locations obtained from Harriman Quadrangle Tennessee - Roane County 7.5 Minute Series Topographic Map (USGS 1935)

Stantec TVA

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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.

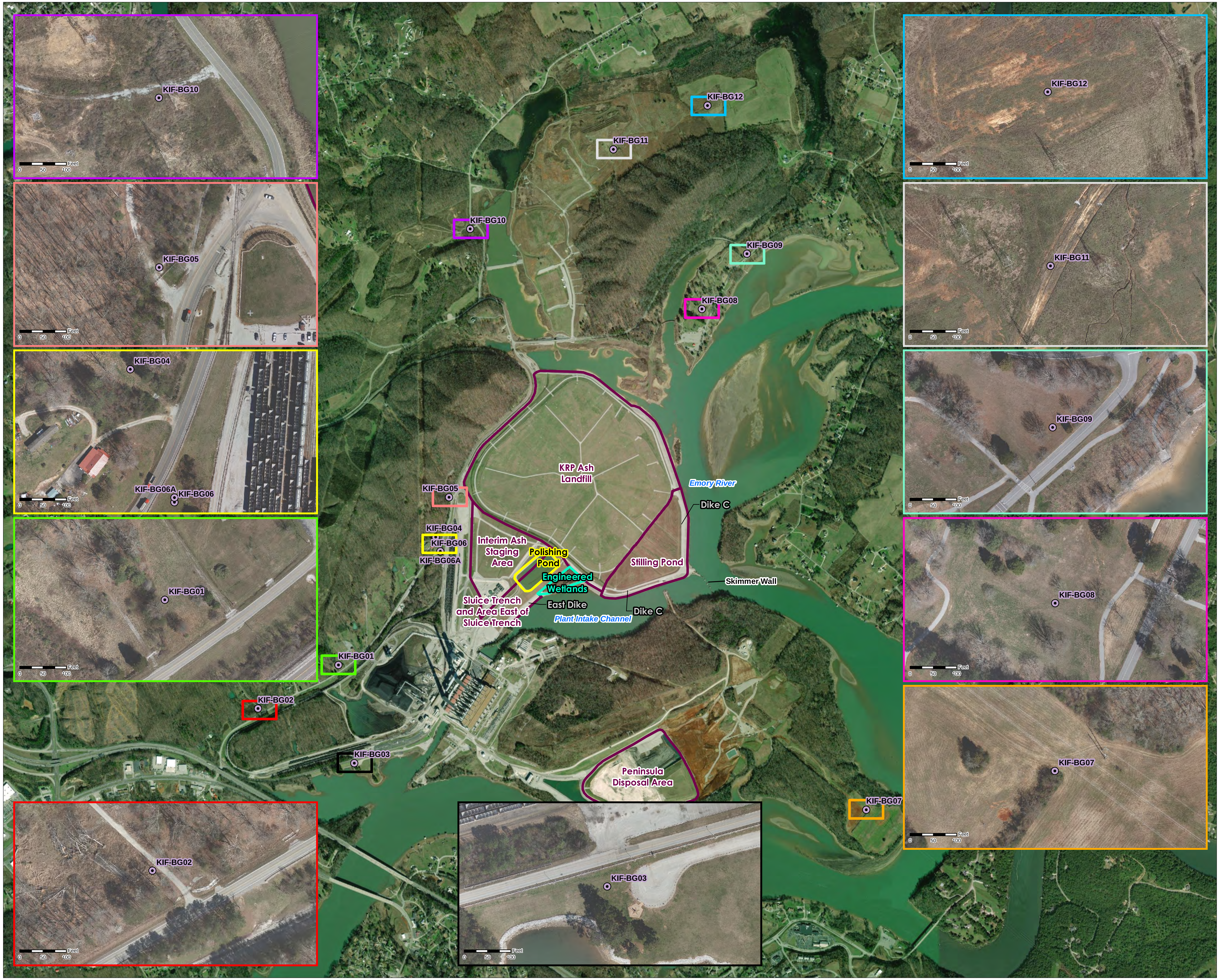

Exhibit No.

3-1

Title

Background Soil Boring Location Map

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location

Roane County, Tennessee

175668043
Prepared by MB on 2023-05-18
Technical Review by AB on 2023-05-18

0 | 900 | 1,800 | 2,700 | 3,600 Feet

1:10,800 (At original document size of 22x34)

Legend

- Background Soil Boring
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

N

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by ESRI World Imagery; Inset mapping imagery provided by TVA and flown by Tuck Mapping on March 16, 2017; 2018 Imagery provided by TVA and is dated September 12, 2018

Stantec TVA

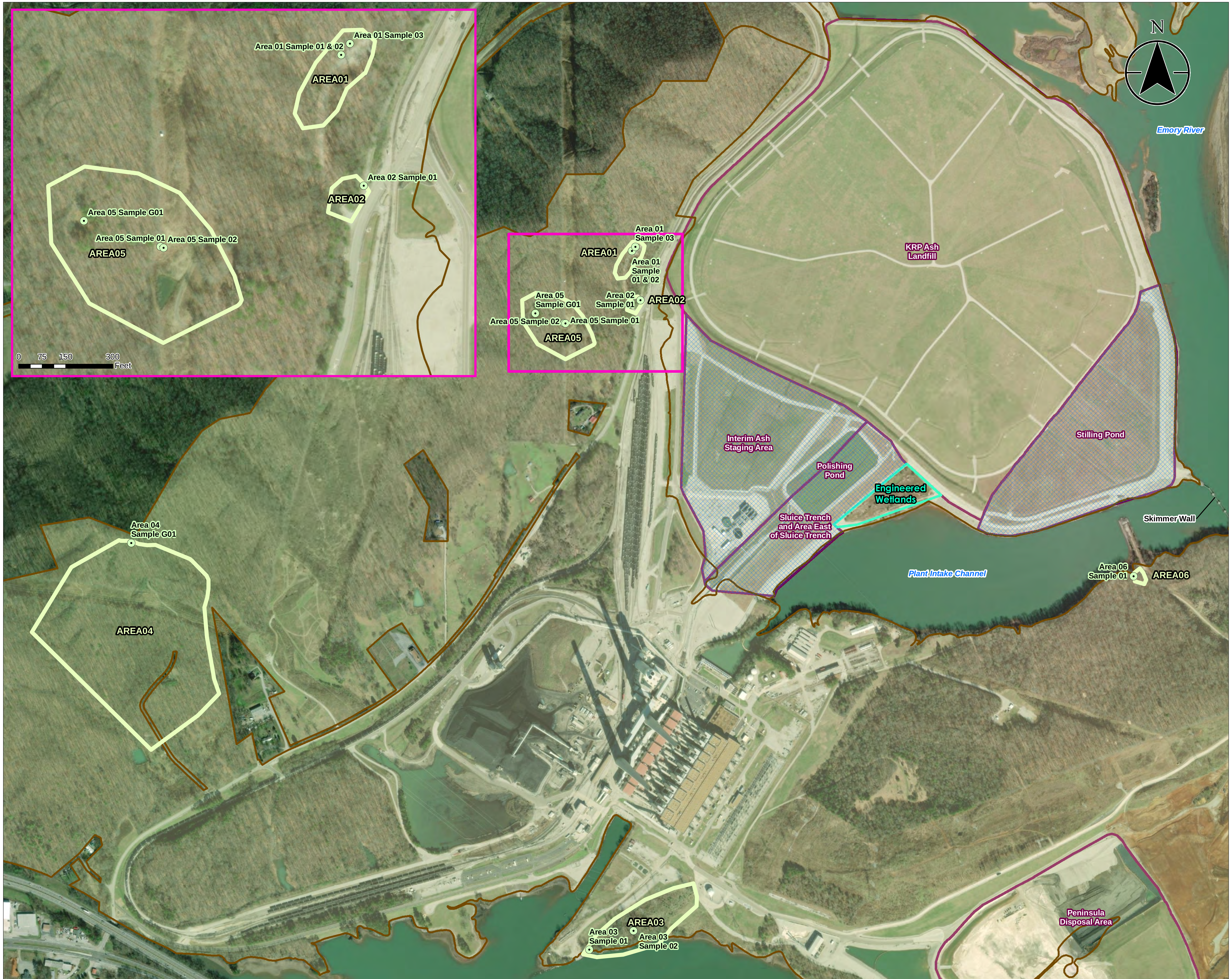

Exhibit No.
3-2

Title
Rock Outcrop Survey

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2023-05-18
Technical Review by EM on 2023-05-18

0 400 800 1,200 1,600
Feet
1:4,800 (At original document size of 22x34)

Legend

- Rock Sample
- Rock Outcrop Survey Area
- KIF Study Area Boundary
- TVA Property Boundary (Approximate)
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)

CCR: Coal combustion residuals

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery

Stantec
TVA

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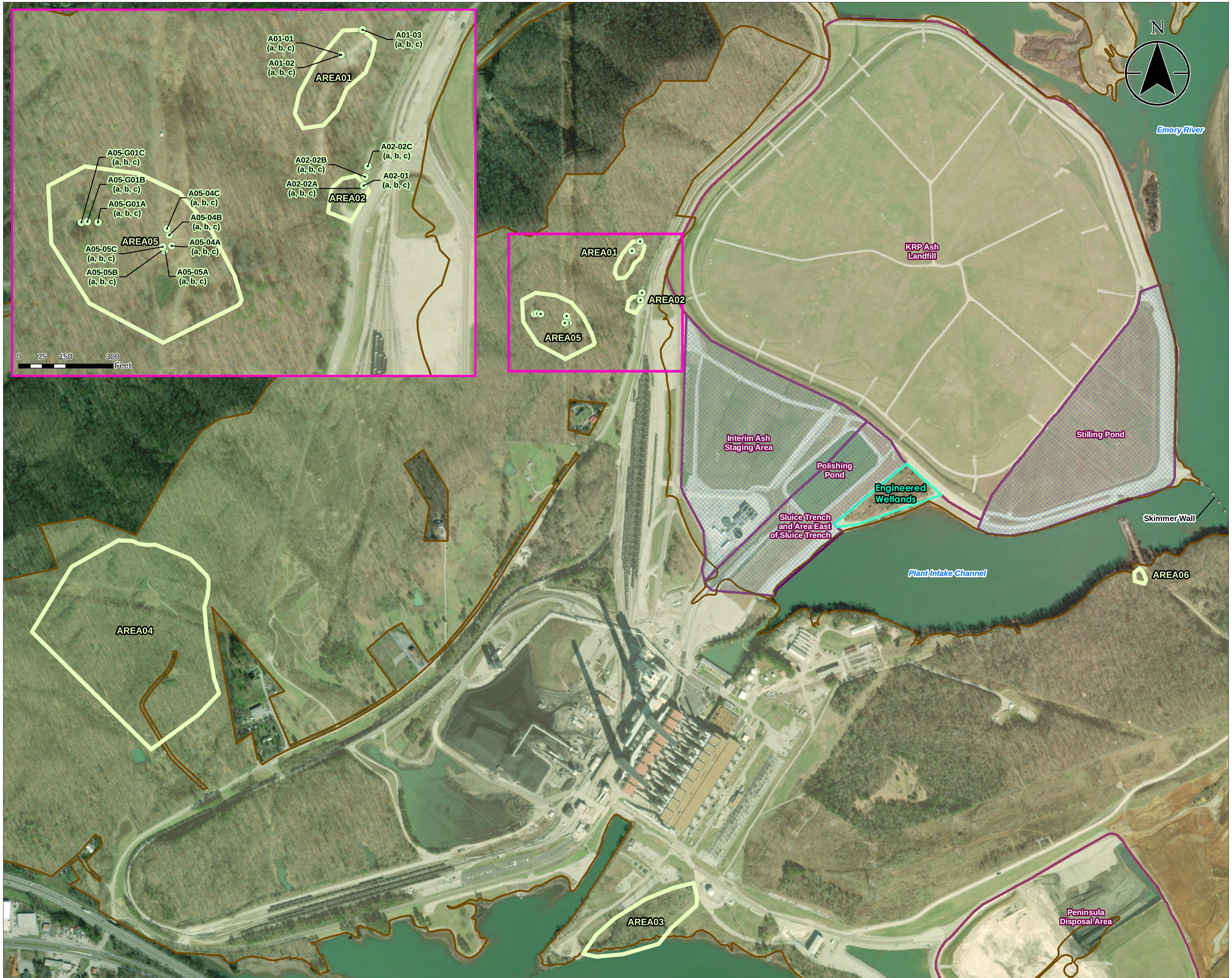

Exhibit No.

3-3

Title

Phase 2 Rock Outcrop Survey

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location

Roane County, Tennessee

175668043
Prepared by DMB on 2023-05-18
Technical Review by EM on 2023-05-18

0 400 800 1,200 1,600
Feet

1:4,800 (At original document size of 22x34)

Legend

- Rock Sample
- Rock Outcrop Survey Area
- KIF Study Area Boundary
- TVA Property Boundary (Approximate)
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)

CCR: Coal combustion residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery

Stantec

TVA

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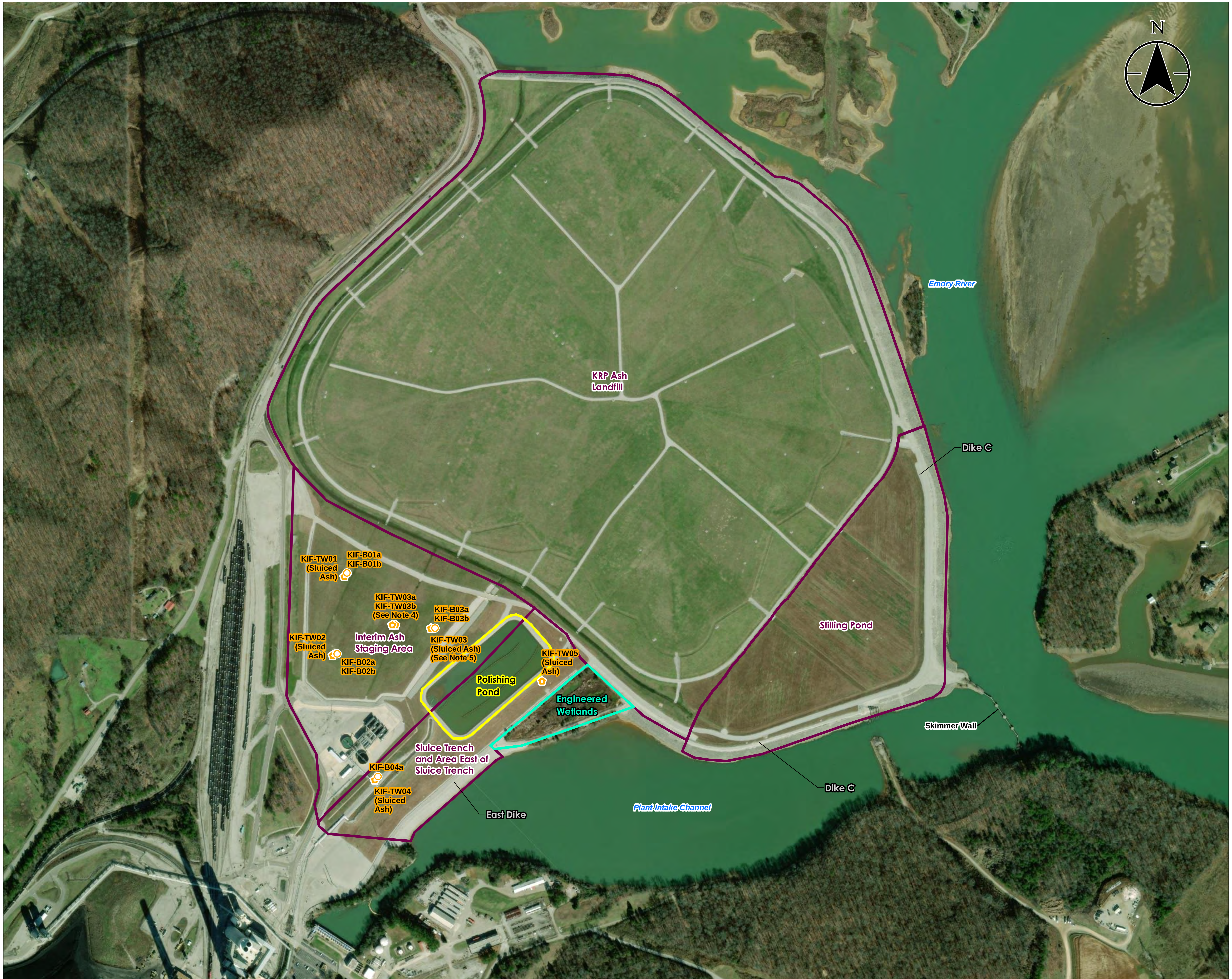


Exhibit No.

4-1

Title

Phase 1 Boring Locations

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location

Roane County, Tennessee

175668043
Prepared by DMB on 2022-06-22
Technical Review by TG on 2022-06-22

0 300 600 900 1,200 Feet

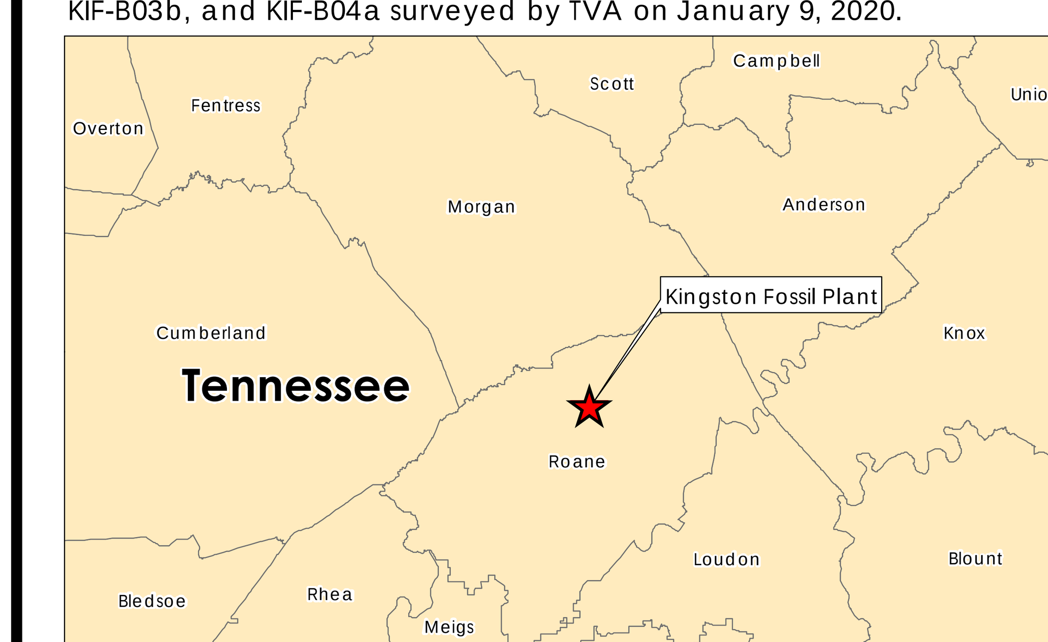
1:3,600 (At original document size of 22x34)

Legend

- Geotechnical Boring
- Temporary Well (Screened 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 Esri World Imagery from February 2020
4. KIF-TW03a and KIF-TW03b were attempted at the KIF-TW03 location referenced in EIP Rev. 4. However, the temporary well could not be installed at this location.
5. KIF-TW03 was drilled at the KIF-TW03Alt location referenced in EIP Rev. 4.
6. Boring locations for KIF-TW01, KIF-TW02, KIF-TW03, KIF-TW04, KIF-TW05 surveyed by the R.L.S. Group on May 2, 2019. Boring locations for KIF-TW03a and KIF-TW03b based on handheld GPS coordinates at the time of drilling.
7. Borings locations for KIF-B01a, KIF-B01b, KIF-B02a, KIF-B02b, KIF-B03a, KIF-B03b, and KIF-B04a surveyed by TVA on January 9, 2020.



Stantec

TVA

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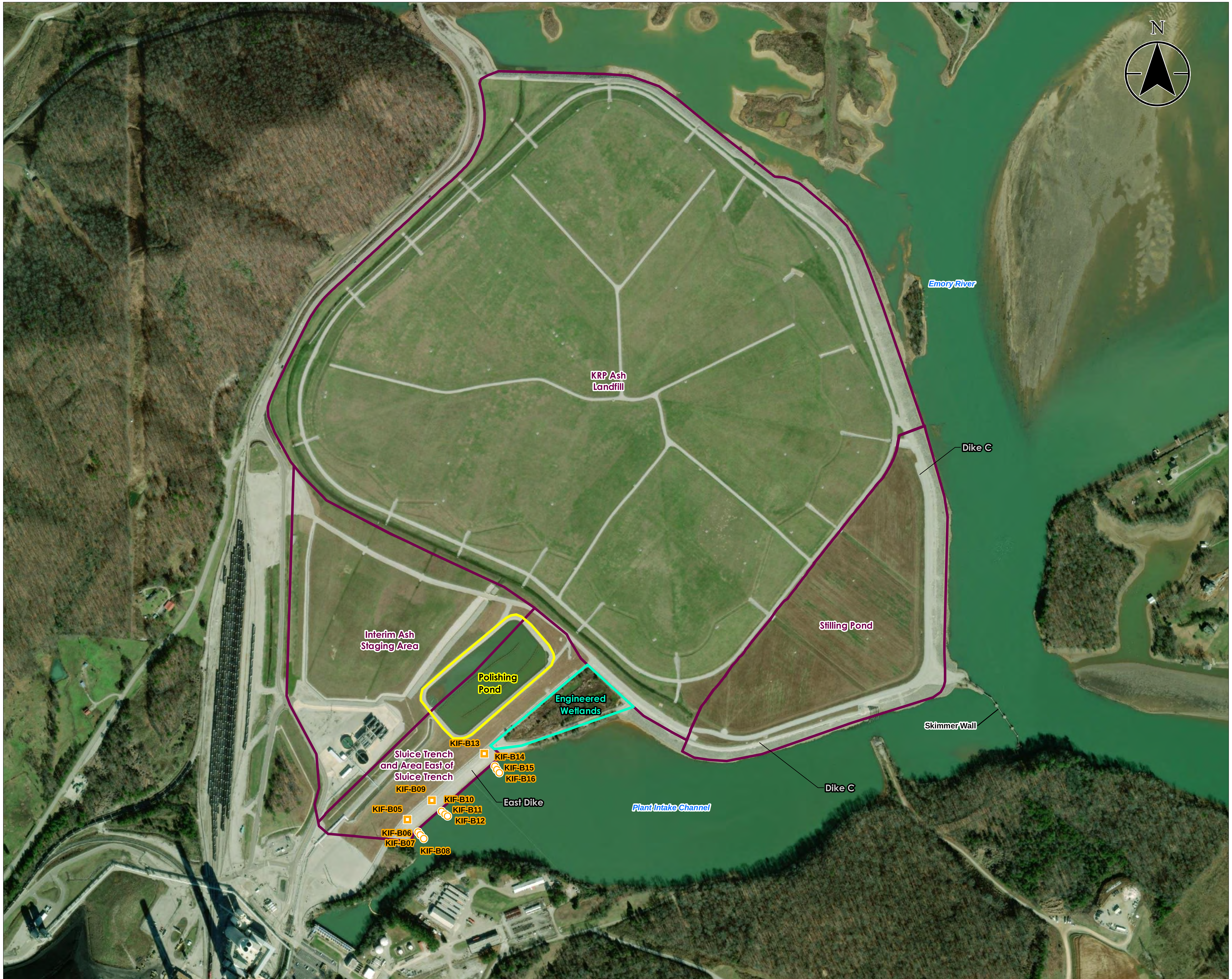


Exhibit No.
4-2

Title

Phase 2 Boring Locations

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2022-06-22
Technical Review by DW on 2022-06-22

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Geotechnical Boring
- Boring with Vibrating Wire Piezometer
- 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 Esri World Imagery from February 2020
4. Boring locations for KIF-B05, KIF-B09, and KIF-B13 surveyed by TVA on March 4, 2021.
5. Borings KIF-B06 through KIF-B08, KIF-B10 through KIF-B12, and KIF-B14 through KIF-B16 were drilled from a barge. For each boring, the top of temporary casing location was surveyed by Stantec prior to moving to the next boring location.

U:\TVA-EIP\175668043_KIF_Phase2\gis\mxd\EAR\4-2_Ph2_BoringLocations.mxd Revised: 2022-06-22 By: mbough

Exhibit No.

4-3

Title

Boring and Well Location Map

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location

Roane County, Tennessee

175668043
Prepared by DMB on 2023-03-09
Technical Review by RN on 2023-03-09

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Boring
- Drilled and Abandoned Borehole
- Vacatur Bedrock Boring
- Temporary Well in CCR Material
- Abandoned Temporary Well in CCR Material
- Pore Water Well
- Subsurface Wall
- CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

CCR: Coal combustion residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery
3. Temporary Well locations shown correspond to survey data provided by the RLS Group on May 15, 2019.
4. Borings surveyed by TVA on January 9, 2020.
5. As-drilled boring location not surveyed. Horizontal coordinates based on proposed boring location.
6. Adjacent boring locations shown as single boring symbol due to close proximity.

Stantec TVA

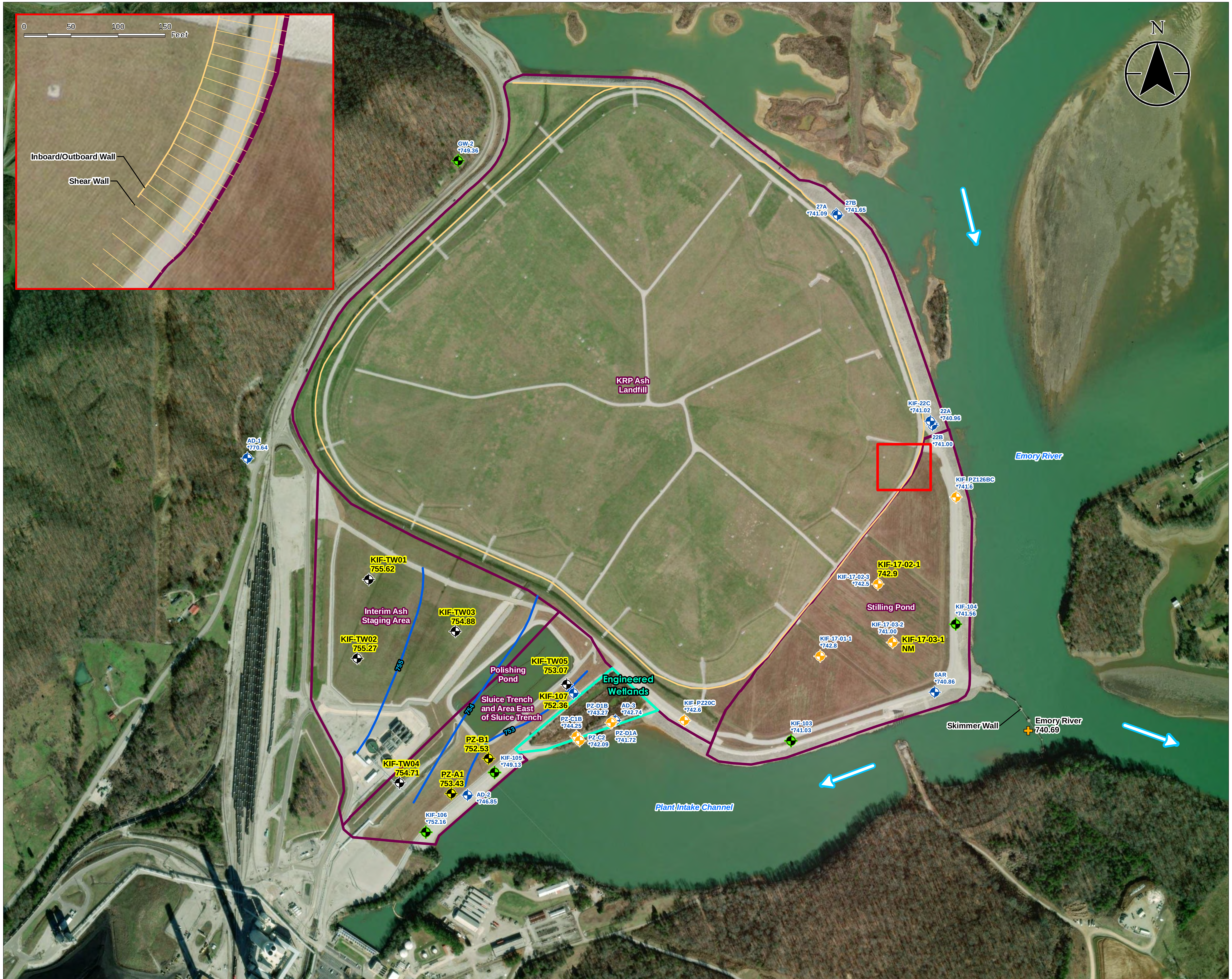


Exhibit No.
4-4

Title
Pore Water Elevation Contour Map, Event #3 (August 19, 2019)

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2023-10-12
Technical Review by MD on 2023-10-12

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Groundwater Investigation Monitoring Well: groundwater elevation in feet above mean sea level (ft amsl); value not used for contouring
- Other Monitoring Well: groundwater elevation in ft amsl; value not used for contouring
- Piezometer: groundwater elevation in ft amsl;value not used for contouring
- Piezometer in CCR Material: pore water elevation in ft amsl
- Temporary well in CCR Material: pore water elevation in ft amsl
- Emory River Gauging Station: surface water elevation in ft amsl
- Pore water Contour (1 ft interval; elevations are in ft amsl)
- Subsurface Wall (Approximate)
- Surface Stream Flow
- CCR Unit Management Area (Approximate)
- Engineered Wetlands Area (Approximate)

Perimeter Containment Wall (As Shown in Inset)

- Inboard/Outboard Wall
- Shear Wall

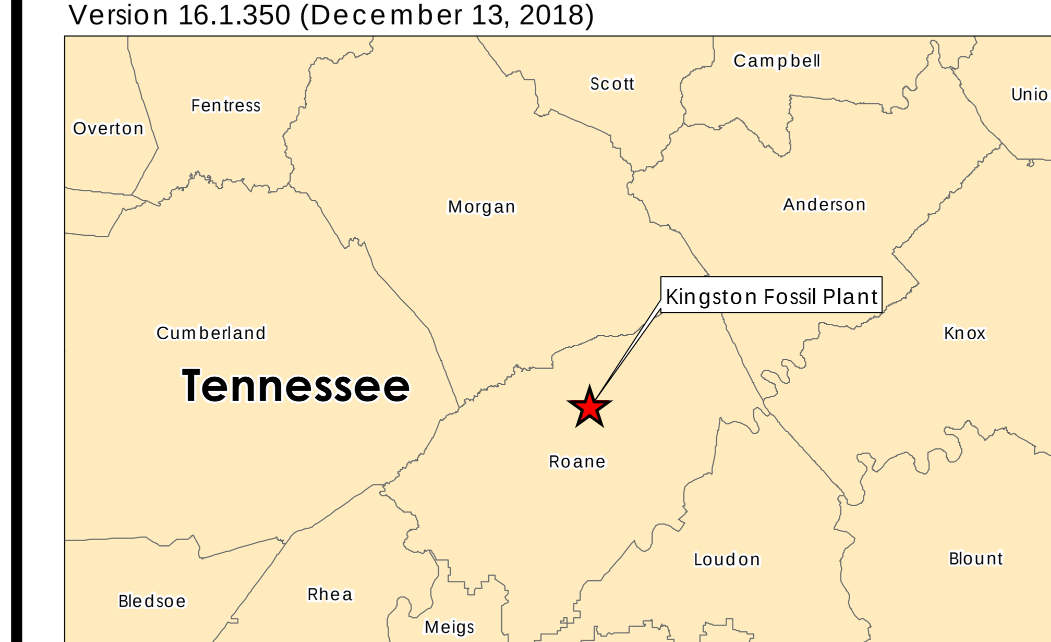
CCR: Coal combustion residuals

*Groundwater elevation displayed but not used as input for contouring

NM: Not measured; data not available

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery
3. Pore water contours were created with manual adjustment using Surfer Version 16.1.350 (December 13, 2018)



Stantec TVA

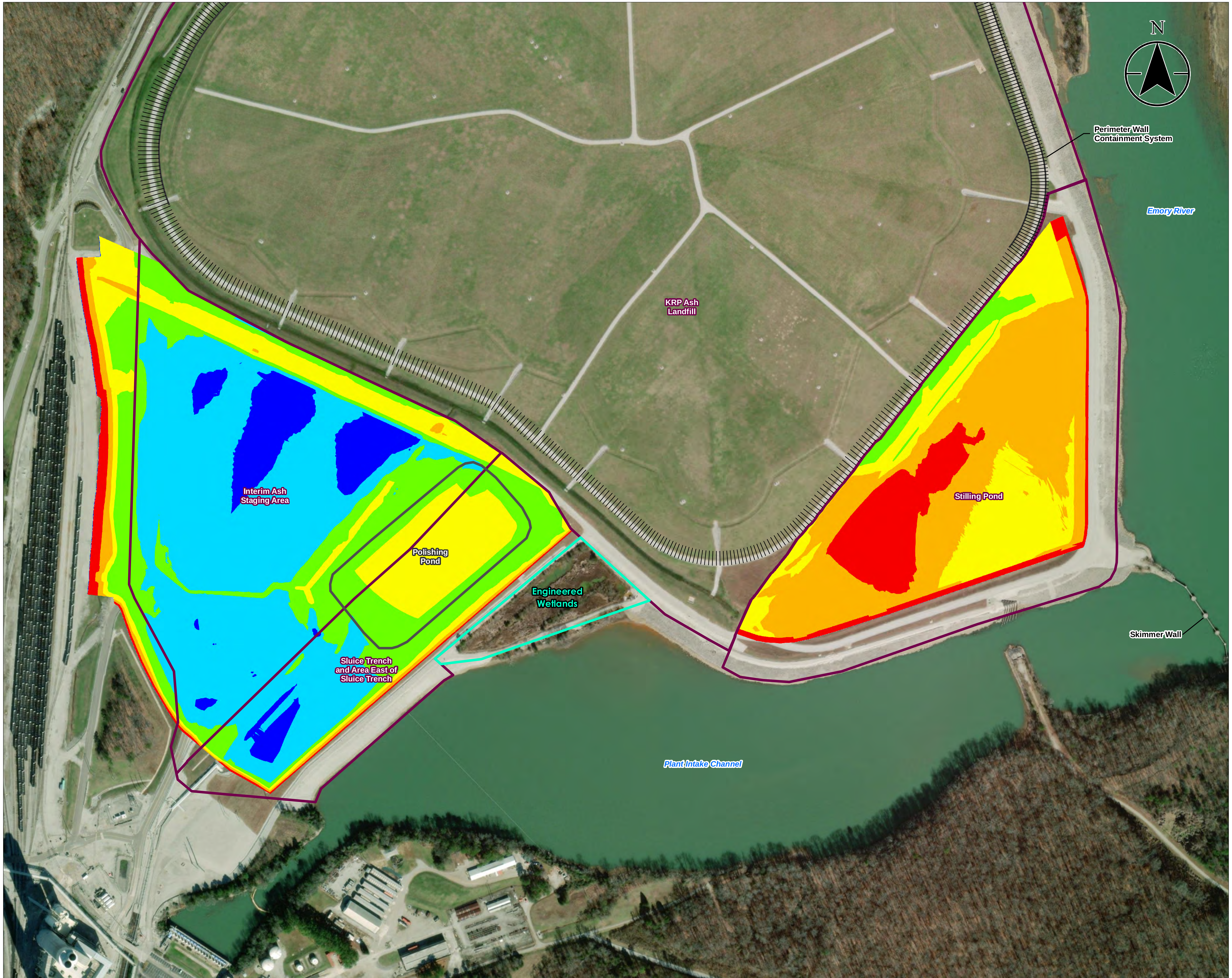


Exhibit No.
4-5

Title
Material Quantity Assessment Study Area Estimated Limits and Depth of CCR Material

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2023-05-18
Technical Review by EM on 2023-05-18

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

Inboard/Outboard Wall
Shear Wall
CCR Management Unit Area (Approximate)
Engineered Wetlands Area (Approximate)
Polishing Pond (Approximate)

SUMMARY TABLE

NUMBER	MIN. DEPTH (FT)	MAX. DEPTH (FT)	AREA (AC)	COLOR
1	0.00	10.00	7	Red
2	10.00	20.00	17	Orange
3	20.00	30.00	20	Yellow
4	30.00	40.00	18	Green
5	40.00	50.00	28	Light blue
6	50.00	60.00	6	Blue

Notes

1. The information presented herein is based on data as of December 7, 2018.
2. The information presented herein applies only to the CCR management unit areas within the scope of the TDEC Order (i.e. Material Quantity Assessment Study Area).
3. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
4. Imagery provided by Esri World Imagery

Stantec
TVA

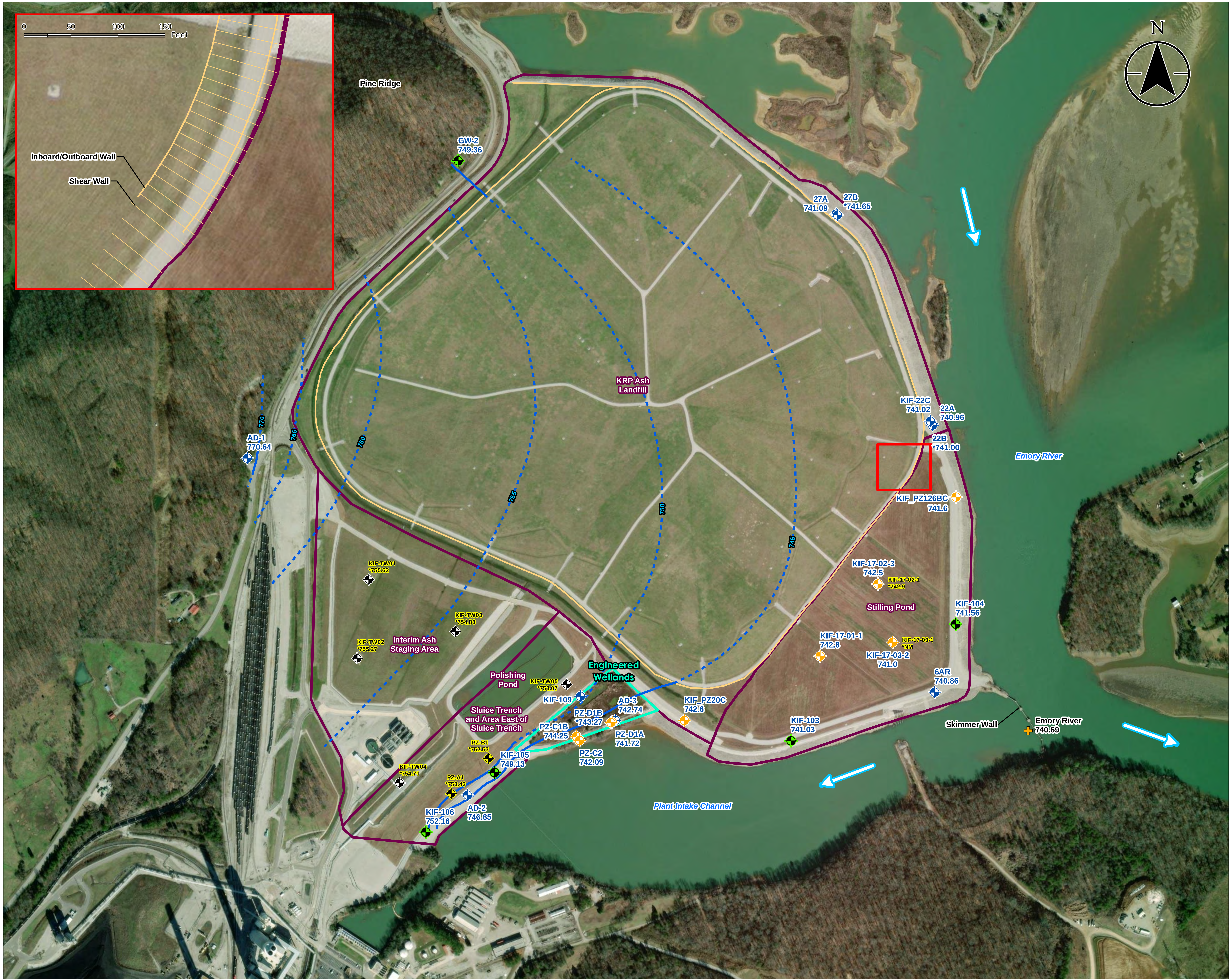


Exhibit No.
5-1

Title
Groundwater Elevation Contour Map, Event #3 (August 19, 2019)

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2023-10-12
Technical Review by MT on 2023-10-12

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Groundwater Investigation Monitoring Well — groundwater elevation in feet above mean sea level (ft amsl)
- Other Monitoring Well — groundwater elevation in ft amsl
- Piezometer — groundwater elevation in ft amsl
- Piezometer in CCR — pore water elevation in ft amsl; value not used for contouring
- Temporary well in CCR — pore water elevation in ft amsl; value not used for contouring
- Emory River Gauging Station — surface water elevation in ft amsl
- Groundwater Contour (5 ft interval; elevations are in ft
- Interpolated Groundwater Contour (5 ft interval; elevations are in ft amsl)
- Subsurface Wall (Approximate)
- Surface Stream Flow
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)

Perimeter Containment Wall (As Shown in Inset)

- Inboard/Outboard Wall
- Shear Wall

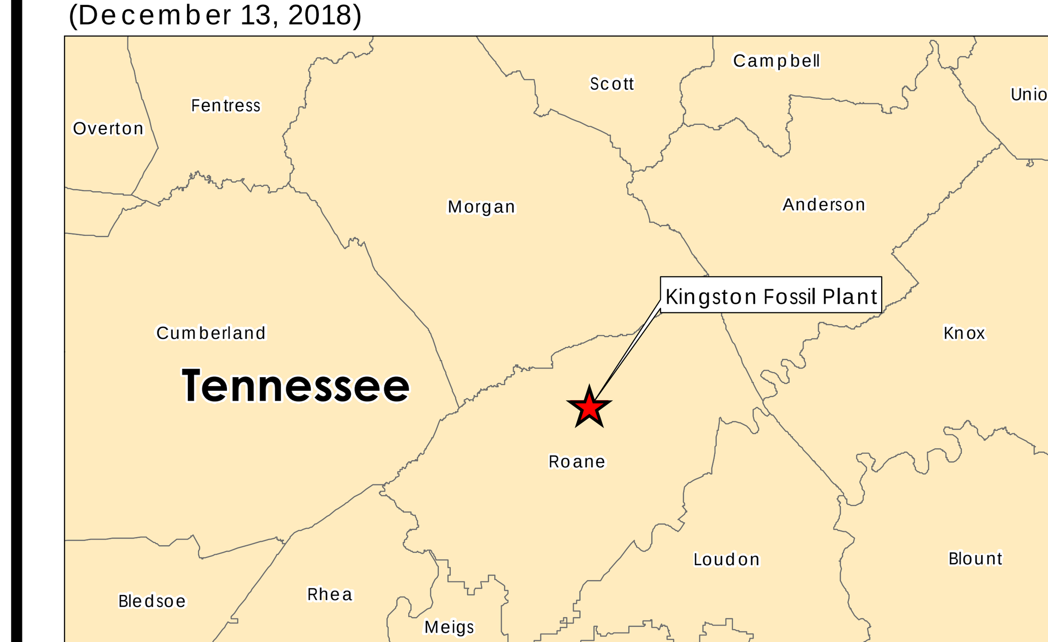
CCR: Coal combustion residuals

*Groundwater and pore water elevation displayed but not used as input for contouring due to factors such as well construction or being screened in a different hydrogeologic unit.

NM: Not measured; data not available

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery
3. Groundwater contours were created using Surfer Version 16.1.350 (December 13, 2018)



Stantec TVA

V:\1TVA-EP\175668043_KIF_Phase2\gis\mxd\EAR15-1_GroundwaterContour_wPZ_porewaterEvent3.mxd Revised: 2023-10-12 By: mbough

Exhibit No.
6-1

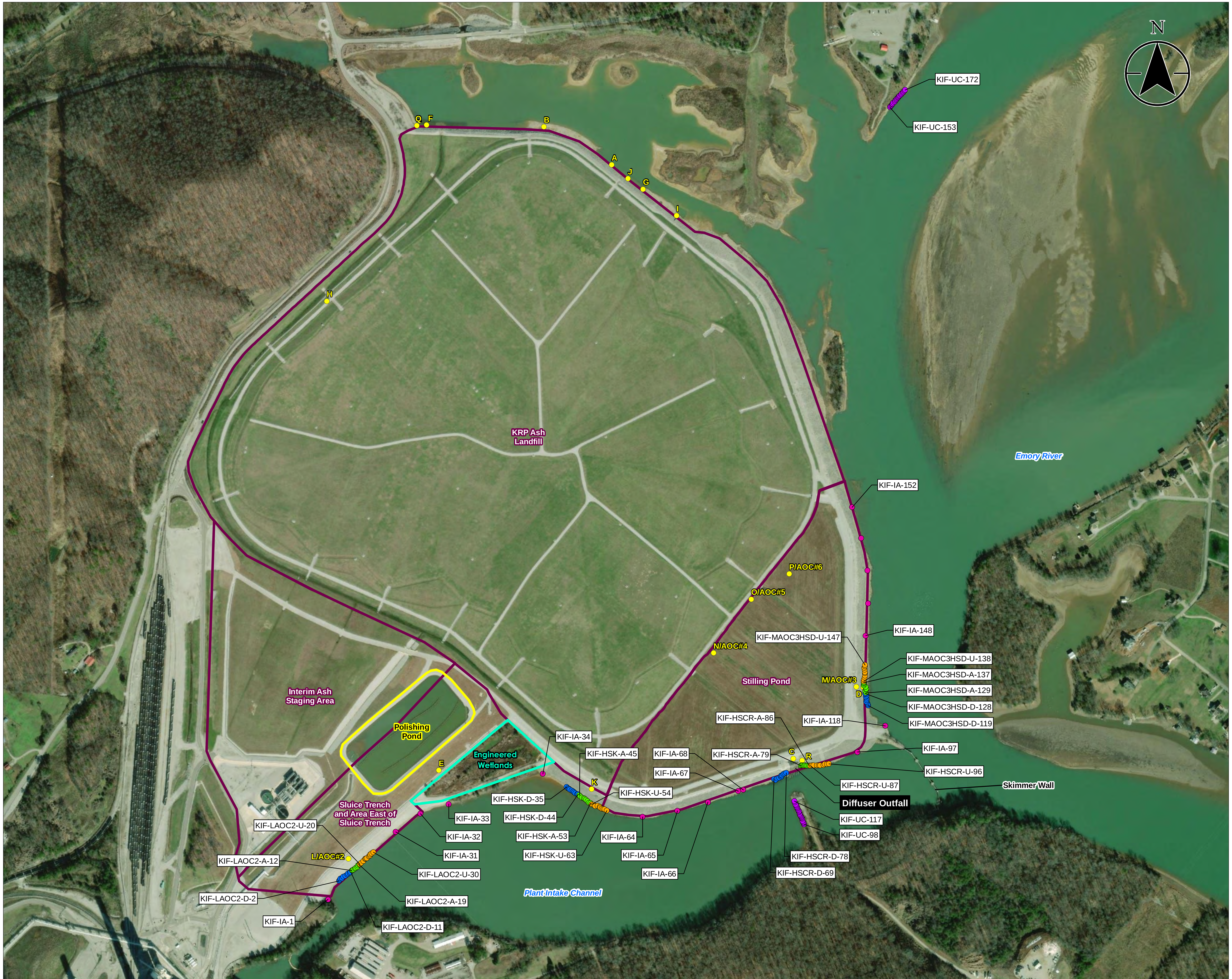
Title
Water Quality Parameter Measurement Locations Overview

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2022-07-01
Technical Review by HW on 2022-07-01

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)



Legend

Measurement Locations

- Adjacent (A)
- Downstream (D)
- Upstream (U)
- Upstream Control (UC)
- Intermediate Area (IA)
- Historic Seep (HS)/Area of Concern (AOC)
- CCR Unit Area (Approximate)
- Engineered Wetlands Area (Approximate)
- Polishing Pond (Approximate)

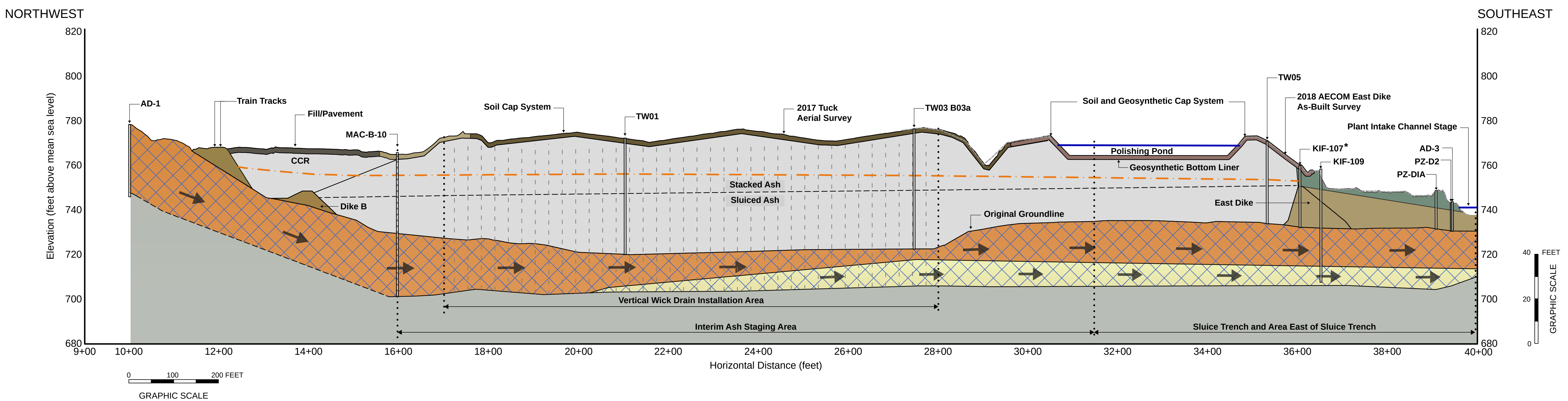
Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by Esri World Imagery

Stantec

TVA

INTERIM ASH STAGING AREA / SLUICE TRENCH AND AREA EAST OF SLUICE TRENCH



1 CCR Material

- CCR material is stacked ash over sluiced ash, and the estimated total volume of CCR based on the EI is about 3.9 million cubic yards.
- For the Interim Ash Staging Area, global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.
- For the Sluice Trench and Area East of Sluice Trench, global and veneer slope stability meet the established factor of safety criteria for the static load cases. For the seismic load cases, the veneer slope stability meets the established factor of safety criteria, but the pseudostatic global and post-earthquake global load cases do not meet the criteria. TVA is currently evaluating mitigation alternatives and it is anticipated that the mitigation design process will commence in parallel with the CARA phase of the TDEC Order program.
- The structural integrity of the CCR management unit is adequate and there is no evidence of voids/cavities in bedrock that could lead to loss of structural support and potential release of overlying CCR material.

2 Groundwater Quality

- The inferred groundwater and pore water elevations in the vicinity of the CCR management units were similar. Pore water level fluctuations at most locations within the CCR management units showed a similar, but subdued, correlation with the fluctuation pattern of the Emory River stage. Pore water level fluctuations were more subdued in comparison to groundwater level fluctuations, suggesting that foundation soils are impeding the flow of pore water.
- Most TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below GSLs. Cobalt in wells AD-2 and KIF-105 was detected above the GSL. This constituent will be further evaluated and addressed in the CARA Plan to determine if corrective actions are needed.

3 Potential Seep

- No seeps were identified during the EI**.

4 Surface Stream, Sediment and Ecology

- Based on the previous and ongoing extensive investigations conducted for the KRP, surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health.

Legend

- CCR / Stacked Ash / Sluiced Ash
- Primarily Silts and Clay
- Engineered Wetlands
- Fill
- Fill / Pavement
- Soil Cover
- Primarily Sand and Silty Sand
- Bedrock
- Phreatic Surface Groundwater / Pore Water Gauging (August 19, 2019)
- Generalized groundwater flow direction within the uppermost aquifer
- Uppermost aquifer
- Vertical Wick Drain Installation Area

Notes:

* The results of the polarized light microscopy analysis indicated that a 3-foot-thick interval consisting of 30% to 38% CCR material existed within the screened interval from approximately 9.0 to 12.0 feet below ground surface. The analytical results of water samples collected from well KIF-107 are thus found to be representative of pore water, not groundwater. See Chapter 5.1.3.1 of the EAR for additional details.

** Previously identified seepage is mitigated by a seepage collection system that discharges seep water to the Water Quality Channel and Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001.

Cross-section transect line is shown on Exhibit D-1.

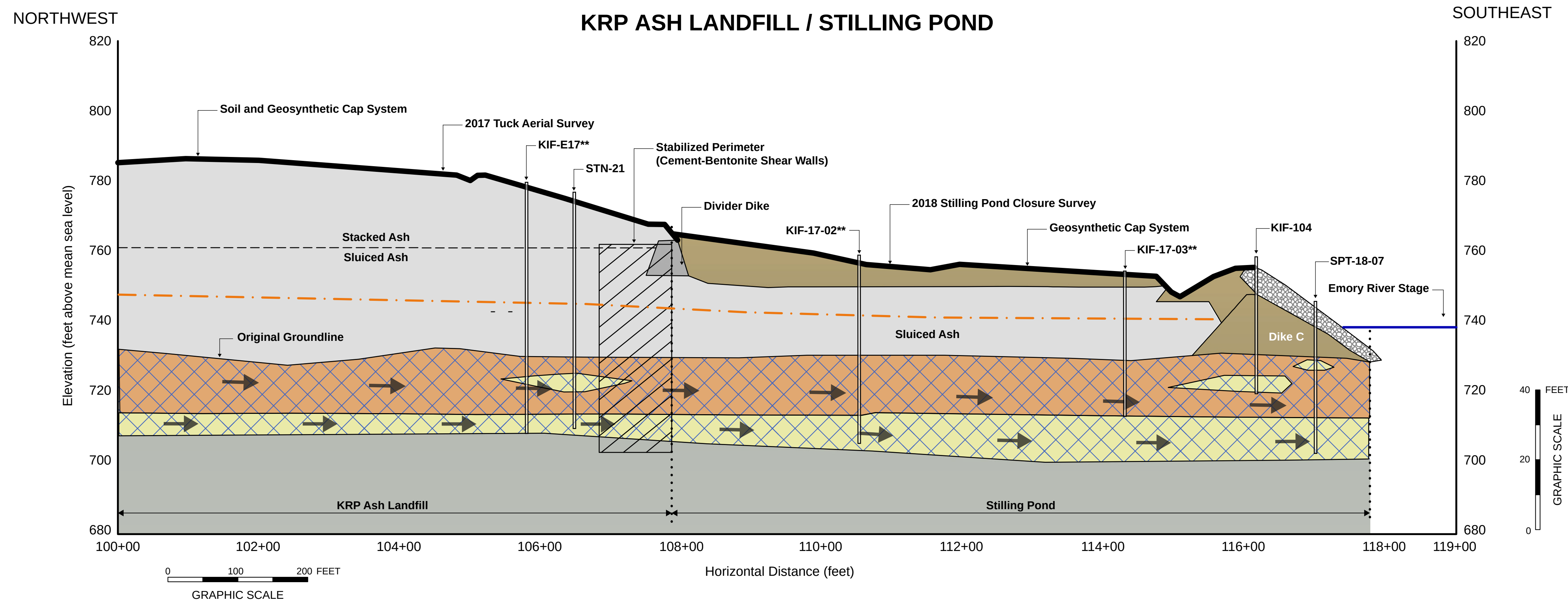
Exhibit No.
8-1

Title
INTERIM ASH STAGING AREA / SLUICE TRENCH AND AREA EAST OF SLUICE TRENCH CROSS-SECTION A–A' CONCEPTUAL SITE MODEL

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee
175568043
Prepared by KB on 2023-05-17

\\us0243-ppfs01\workgroup\1756\active\175668299\technical_production\collateral_materials\exhibits_kif_ear



1 CCR Material

- CCR material in the Stilling Pond is sluiced ash and the estimated total volume of CCR based on the EI is about 804,000 cubic yards.
- Global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.
- The structural integrity of the CCR management unit is adequate and there is no evidence of voids/cavities in bedrock that could lead to loss of structural support and potential release of overlying CCR material.

2 Groundwater Quality

- The inferred groundwater and pore water elevations in the vicinity of the CCR management units were similar. The elevations of pore water levels within and groundwater levels in the vicinity of the Stilling Pond were generally within five feet of the Emory River stage. Pore water level fluctuations at most locations within the CCR management units showed a similar, but subdued, correlation with the fluctuation pattern of the Emory River stage. Pore water level fluctuations were more subdued in comparison to groundwater level fluctuations, suggesting that foundation soils are impeding the flow of pore water.
- Most TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below GSLs. Cobalt in wells 6AR, KIF-103 and KIF-104 was detected above the GSL. This constituent will be further evaluated and addressed in the CARA Plan to determine if corrective actions are needed.

3 Potential Seep

- No seeps were identified during the EI*.

4 Surface Stream, Sediment and Ecology

- Based on the previous and ongoing extensive investigations conducted for the KRP, surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health.

Legend

- Stacked Ash / Sluiced Ash
- Compacted Ash
- Fill
- Rock Buttress
- Primarily Silts and Clay
- Primarily Sand and Silty Sand
- Bedrock
- Phreatic Surface Groundwater / Pore Water Gauging (April 2, 2019)
- Generalized groundwater flow direction within the uppermost aquifer
- Uppermost aquifer

Notes:

* Previously identified seepage is mitigated by a seepage collection system that discharges seep water to the Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001.

**KIF-17-02, KIF-17-03, and KIF-E17 are projected laterally onto the cross section.

Cross-section transect line is shown on Exhibit D-1.

The KRP Ash Landfill is not included in the TDEC Order; it is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM) - Class II Landfill Permit No. IDL 73-000-0094 (see Chapter 1.1 for more information).

Stantec TVA

Exhibit No.
8-2

Title
KRP ASH LANDFILL AND STILLING POND
CROSS-SECTION B-B' CONCEPTUAL SITE MODEL

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee
175568043
Prepared by KB on 2023-09-12

Common EI Findings for CCR Management Units

Overall:

- More than 96% of the groundwater sample results from over 300 samples were below the approved levels.

CCR Material:

- The CCR management units have adequate stability and slopes are stable under current static conditions. There is no evidence of void/cavities in bedrock that could lead to a loss of structural support and release of overlying CCR material.

Groundwater Quality:

- Groundwater concentrations for most CCR Parameters are below groundwater screening levels for each of the CCR management units.
- Groundwater quality is affected by geochemical processes during flow of the groundwater through geological materials. Concentrations of CCR constituents in groundwater are generally lower, and in many cases much lower, than in pore water.

Seeps:

- No seeps were identified during the EI*.

Surface Stream, Sediment and Ecology:

- Based on the previous and ongoing extensive investigations conducted for the Kingston Recovery Project, surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health. TVA is continuing long-term monitoring activities to confirm these findings.

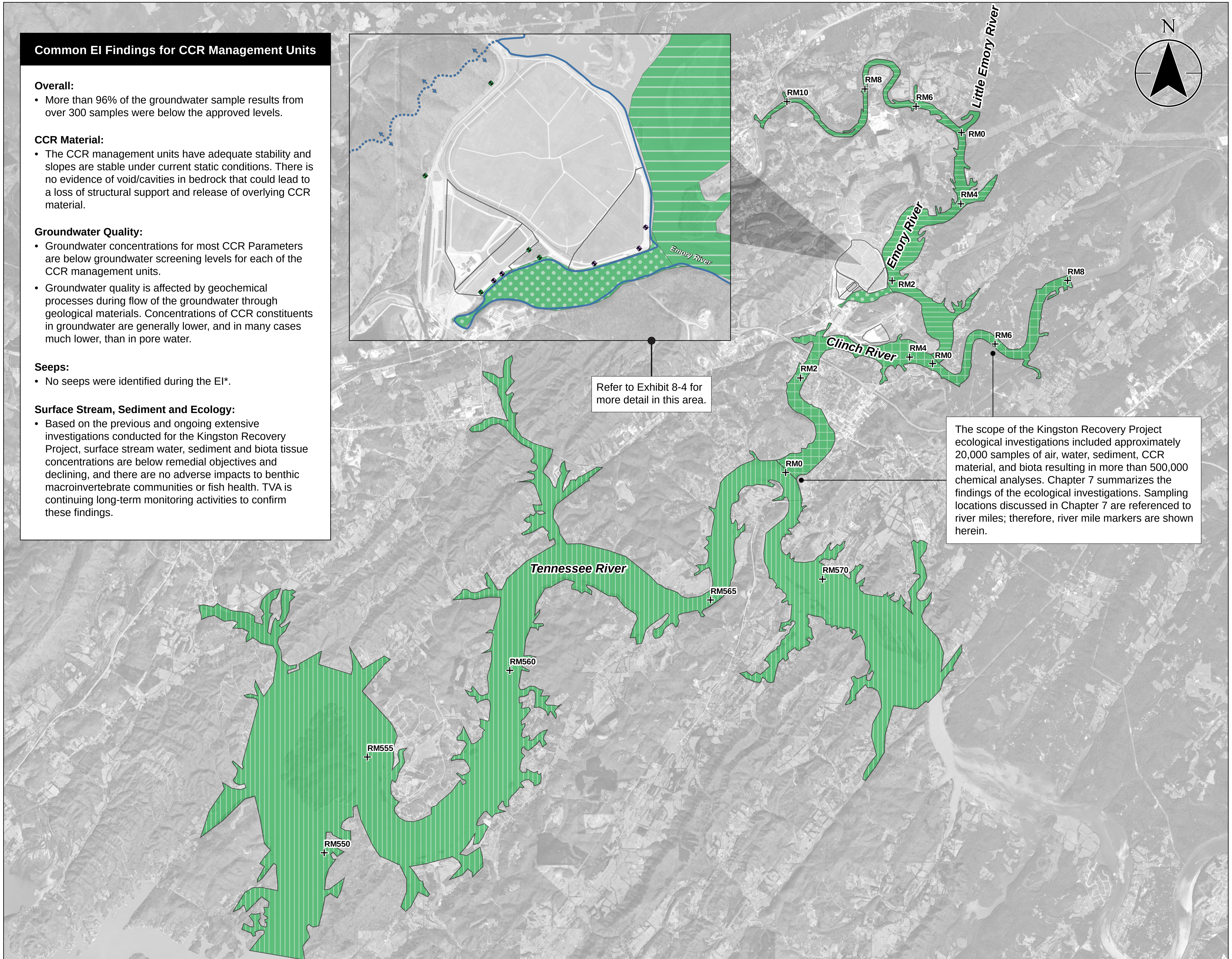


Exhibit No.
8-3

Title
Overall Investigation Area Findings

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location: Roane County, Tennessee
175668043
Prepared by KB on 2023-03-30

0 4,000 8,000 12,000 16,000 Feet

Legend

- Groundwater results below Groundwater Screening Levels
- Groundwater results above Groundwater Screening Levels

Surface Stream, Sediment, and Ecology Sampling Reach Location

- Clinch River
- Emory River
- Intake Channel/Impoundment
- Tennessee River
- Little Emory River
- RM River Mile
- Surface stream that bounds groundwater flow
- Hydrogeological Divide
- Generalized groundwater flow direction
- TDEC Order Study Area CCR Management Units (Approximate)

Abbreviations:

CCR: Coal combustion residuals

EI: Environmental Investigation

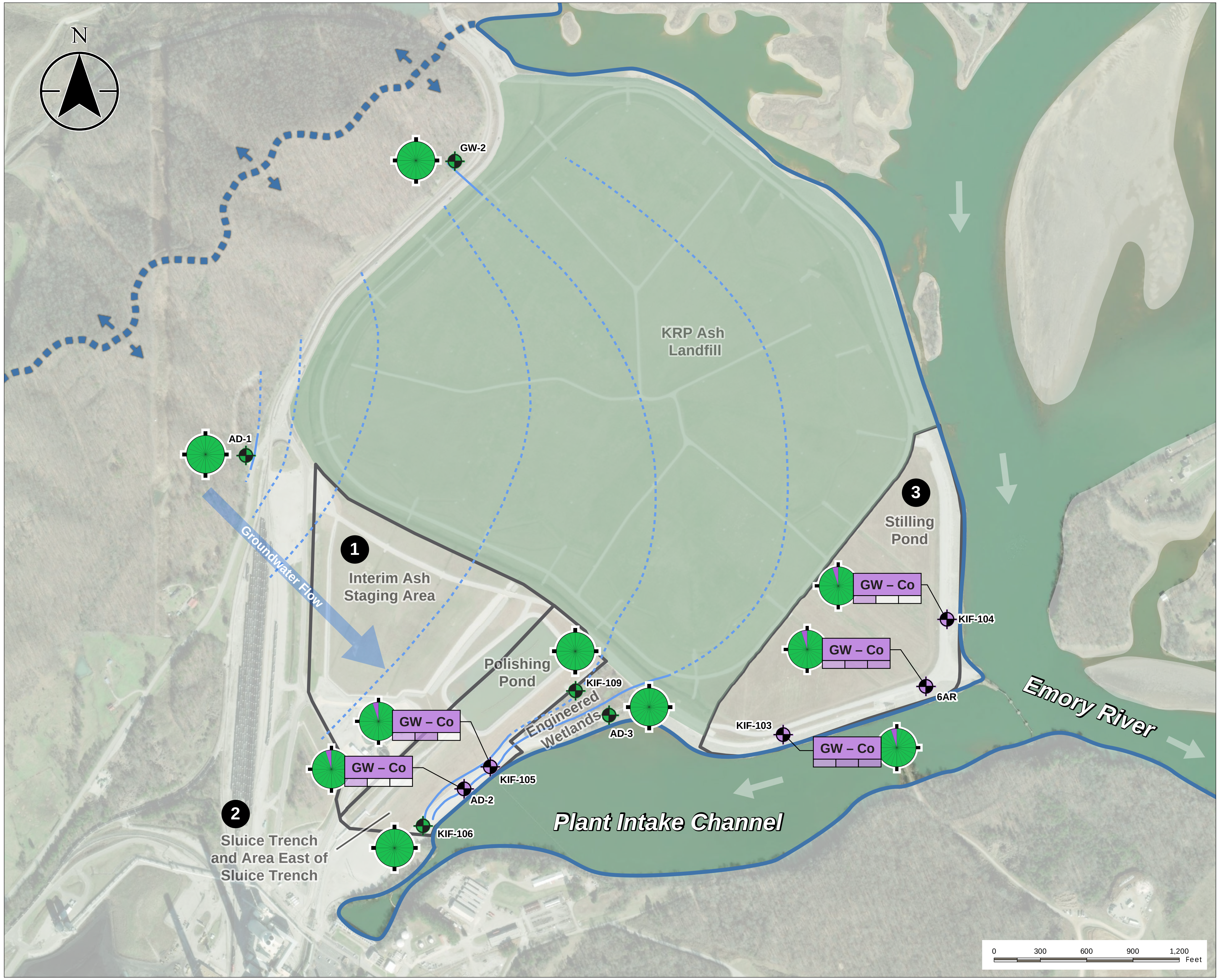
Notes:

* Previously identified seepage is mitigated by a seepage collection system that discharges seep water to the Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001.

The KRP Ash Landfill is not included in the TDEC Order; it is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM) - Class II Landfill Permit No. IDL 73-000-0094 (see Chapter 1.1 for more information).

Imagery provided by ESRI.

Stantec TVA



Potential groundwater impacts described below will be further evaluated in the CARA Plan.

1 Interim Ash Staging Area

CCR Material:

- CCR material in this unit is stacked ash over sluiced ash, and the estimated total volume of CCR material is ~ 3.9 million cubic yards, which also includes the volume for the Sluice Trench and Area East of Sluice Trench.
- The global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.

Groundwater Quality:

- Cobalt in wells AD-2 and KIF-105 was detected above the GSL.

2 Sluice Trench and Area East of Sluice Trench

CCR Material:

- CCR material in this unit is stacked ash over sluiced ash, the volume of CCR material is included in the estimated total volume for the Interim Ash Staging Area.
- The global and veneer slope stability meet the established factor of safety criteria for the static load cases. For the seismic load cases, the evaluation indicates that veneer slope stability meets the established factor of safety criteria, but that the pseudostatic global and post-earthquake global load cases do not meet the criteria; TVA is currently evaluating mitigation alternatives to address these conditions.

Groundwater Quality:

- Cobalt in wells AD-2 and KIF-105 was detected above the GSL.

3 Stilling Pond

CCR Material:

- CCR material is sluiced ash, with an estimated total volume of CCR of ~804,000 cubic yards.
- The global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.

Groundwater Quality:

- Cobalt in wells 6AR, KIF-103 and KIF-104 was detected above the GSL.

Overall

Surface Stream, Sediment and Ecology:

- As summarized on Exhibit 8-3, based on the previous and ongoing extensive investigations conducted for the Kingston Recovery Project, surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health. TVA is continuing long-term monitoring activities to confirm these findings.

Legend

Groundwater results below Groundwater Screening Levels

Groundwater results above Groundwater Screening Levels

Co – Cobalt

Sections colored in the chart indicate the number of constituents at a sampling location above screening levels

Number of constituents compared:

Groundwater: 20

Count represents TDEC Appendix I and CCR Rule Appendix IV constituents.

Surface stream flow direction

Interpolated Groundwater Contour

Groundwater Contour (5 ft interval; elevations are in ft amsl)

Surface stream that bounds groundwater flow

Hydrogeological Divide

Generalized groundwater flow direction

TDEC Order Study Area CCR Management Units (Approximate)

CCR: Coal combustion residuals

1–4 X above screening levels

5–9 X above screening levels

>10 X above screening levels

Notes:

Groundwater contours included to illustrate general groundwater flow directions. See Exhibit 5-1, Groundwater Elevation Contour Map Event #3 (August 19, 2019), for actual groundwater elevations and groundwater contours.

The KRP Ash Landfill is not included in the TDEC Order; it is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM) - Class II Landfill Permit No. IDL 73-000-0094 (see Chapter 1.1 for more information).

Imagery provided by Esri World Imagery

Exhibit No.
8-4

Title
Overall Findings Near KIF Plant TDEC Order CCR Management Units

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043

Prepared by KB on 2023-09-13

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