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November 13, 2015

Mr. David Wilson
Chief, Bureau of Water
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201

Subject: Revised Conceptual Closure Plan for Unit 1 Ash Pond
H.B. Robinson Steam Electric Plant
NPDES Permit #SC0002925

Dear Mr. Wilson:

Attached is the revised Conceptual Closure Planning (Revised CCP) document which includes information specific to closure of the Unit 1 Ash Pond per R.61-82 as well as an update of Duke Energy's progress to date on the Robinson Ash Basin Closure project.

Following submittal of the Conceptual Closure Planning Update in December 2014, Duke Energy, through its contractors HDR and the University of North Carolina at Charlotte (UNCC), completed a conceptual (two-dimensional) groundwater flow and transport model for the ash basin to evaluate the viability of a hybrid cover closure scenario. The modeling results indicated that limiting infiltration through the ash (via an engineered cap) would have minimal effect on the post-closure, long-term groundwater levels in the ash basin.

Based on the modeling results, Duke Energy elected to excavate ash from within the basin and move it to a new lined ash landfill to be constructed on Duke Energy Progress property northwest of the Darlington Electric Power Plant. This decision was conveyed to SCDHEC in correspondence from Duke Energy dated April 30, 2015.

The attached Revised CCP document presents the results of groundwater modeling and a preliminary design for the proposed Class 3 landfill (data presented in the initial Conceptual Closure Planning Update (HDR 2014) is also included). The Revised CCP document satisfies Duke Energy's commitment (made in the April 30, 2015 correspondence to SCDHEC) to provide additional details regarding our plans to permanently close the Robinson ash basin. The Revised CCP will be expanded in October 2016 to become compliant with the United States Environmental Protection Agency's Hazardous and Solid Waste Management System Disposal of Coal Combustion Residuals from Electric Utilities Rule. As you are aware, Duke Energy is currently evaluating the proposed site for suitability to construct a Class 3 landfill, including associated design and permitting activities.

Duke Energy appreciates your feedback on our ash basin closure planning and your continued regulatory oversight of the Robinson Plant. If you have comments, questions, or desire additional information, please contact us.

Sincerely,

John Elnitsky
Senior Vice President

Enclosure:
"Robinson Ash Basin Closure Investigation: Revised Conceptual Closure Planning Update" (HDR 2015)

Robinson Ash Basin Closure Investigation

Revised Conceptual Closure Planning Update

H.B Robinson Steam Electric Plant, Darlington County, SC

November 20, 2015

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Executive Summary

The purpose of this Revised Conceptual Closure Planning Update is to present South Carolina Department of Health and Environmental Control (SCDHEC) with an update of Duke Energy Progress' advancement of the Robinson Ash Basin Closure project since submittal of the Conceptual Closure Planning Update in December 2014.

Duke Energy Progress conducted a geotechnical and environmental exploration program in and around the H.B. Robinson Steam Electric Plant (Robinson Plant) Unit 1 ash basin and 1960 Fill Area (collectively referred to as the ash management areas) between July and November 2014. The program consisted of soil borings, groundwater monitoring well installation, testing of soil, ash, groundwater and free water, and in-situ hydraulic conductivity testing. A summary of data and information collected as part of the geotechnical and environmental exploration program, along with a summary of results, is provided in this update report. A more detailed description of data collected, methodologies used, and testing results is provided in the companion Robinson Ash Basin Closure Investigation Data Report (Data Report; HDR 2014).

Subsequent to submittal of the Data Report, Duke Energy Progress evaluated three potential options for permanent closure of the ash basin:

- **Hybrid Cap-in-Place** whereby coal ash residue from the 1960 Fill Area would be excavated and placed into the ash basin, ash immediately behind the ash basin embankment would be moved farther west within the basin to allow breaching or removal of the embankment, and consolidated ash within the basin would be capped with an engineered cover system.
- **On-Site Landfill** whereby coal ash residue from the 1960 Fill Area and ash basin would be excavated and moved to a lined landfill designed to contain coal ash residue.
- **Off-Site Landfill** whereby coal ash residue from the 1960 Fill Area and ash basin would be excavated and hauled to a lined landfill designed and permitted to receive coal ash residue.

In April 2015, the University of North Carolina at Charlotte (UNCC) completed conceptual groundwater flow and fate and transport modeling of the ash basin to evaluate the viability of a hybrid cover closure scenario. The model was conducted using a simplified two-dimensional flow system. The modeling results indicate that limiting infiltration through the ash (via an engineered cap) will have minimal effect on the post-closure long-term groundwater level in the ash basin.

The modeling results were presented to SCDHEC in a meeting on April 27, 2015. During this meeting Duke Energy Progress conveyed its plans to excavate ash from within the basin and move it to a new lined ash landfill to be constructed on Duke Energy Progress property northwest of the Darlington Electric Power Plant. In correspondence from Duke Energy Progress to SCDHEC dated April 30, 2015, Duke Energy Progress further identified that the new ash landfill will be constructed with a leachate collection system, bottom liner, and final cover compliant with requirements for a SCDHEC Class 3 landfill and consistent with the U.S.

Environmental Protection Agency's (USEPA) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule).

Since confirming plans to construct an on-site landfill in April 2015, Duke Energy Progress has been working with SCDHEC to evaluate the suitability of the proposed landfill site including a review of location restrictions and submittal of a Preliminary Hydrogeologic Characterization Report. A field hydrogeologic investigation consisting of the installation of 24 shallow and up to four deep groundwater piezometers within and around the proposed landfill footprint is ongoing and scheduled for completion in mid-October 2015. Data obtained from this investigation will be used to characterize the subsurface lithology (including evaluation of the presence or absence of a continuous confining layer), monitor seasonal variations in water table position, and evaluate geotechnical properties of underlying soil materials. These data will be incorporated into a Site Hydrogeologic Characterization Report and a Permit Application to construct an Industrial Solid Waste Class 3 Landfill, in accordance with South Carolina Regulation 61-107.19. The Permit Application will be submitted to SCDHEC on or before April 1, 2016.

1.0 Introduction

1.1 Project Overview

Duke Energy Progress owns and operated the H.B. Robinson Steam Electric Plant (Robinson Plant) located near Hartsville in Darlington County, South Carolina (**Figure 1**). The Robinson Plant coal ash management facilities include a former 177-megawatt (MW) coal-fired unit (Unit 1), one ash basin located north of the Robinson Plant and west of Lake Robinson, and an older ash storage area (1960 Fill Area) located west of Unit 1 (**Figure 2**). Coal ash residue generated during the coal combustion process at Unit 1 was stored in the 1960 Fill Area from 1960 until the mid-1970s when the approximate 72-acre ash basin was constructed. The ash basin continued to receive coal ash residue until October 2012 when Unit 1 was retired.

Duke Energy Progress retained HDR to develop a Conceptual Closure Plan (Plan) for the Robinson Plant ash basin. To do so, HDR implemented a geotechnical and environmental exploration program between July and November 2014 that consisted of soil boring completion; monitoring well installation; index property testing of soil and ash; constituent testing of soil, ash, groundwater, and free water; and in-situ hydraulic conductivity testing. The data derived from the field program were evaluated to achieve the following project objectives:

- Determine the amount of coal ash residue in the ash basin and 1960 Fill Area;
- Characterize subsurface materials within the ash management areas, down-gradient of the ash basin, and in background areas of the site;
- Develop a Site Conceptual Model (SCM) to serve as the basis for understanding the hydrogeologic characteristics of the site and ash basin (both existing and under the preferred closure option); and
- Use the SCM to develop a conceptual plan for closure of the ash basin that is protective of human health and the environment and acceptable to the South Carolina Department of Health and Environmental Control's (SCDHEC) Bureau of Water per their guidance, "Proper Closeout of Wastewater Treatment Facilities, Regulation 61-82" dated April 11, 1980.

The subsurface investigation included completion of 22 environmental soil borings and 11 geotechnical soil borings; installation of 30 groundwater monitoring wells; and subsequent soil, ash, groundwater, and free water sample collection and testing. Soil boring and monitoring well locations are shown on **Figures 3** and **4**. Specific details regarding the field exploration program are provided in **Section 3.0** of this report.

Closure of the 1960 Fill Area is regulated under Consent Agreement 15-23-HW (Consent Agreement) between Duke Energy Progress and the SCDHEC, signed on July 17, 2015. The final disposition of ash within the 1960 Fill Area will be incorporated into closure of the ash basin and is therefore discussed herein.

1.2 Purpose

The purpose of this Revised Conceptual Closure Planning Update is to present SCDHEC with Duke Energy Progress' advancement of the Robinson Ash Basin Closure Investigation and summarize the closure options and selected option for the ash basin and 1960 Fill Area. A summary of data and information collected as part of the Robinson Ash Basin Closure Investigation, along with a summary of results, is provided in this document. A more detailed description of data collected, methodologies used, and testing results is provided in the companion Robinson Ash Basin Closure Investigation Data Report (Data Report; HDR 2014).

1.3 Report Organization

The report is organized into the following sections:

- Site background, geology, and hydrogeology are provided in **Section 2.0**
- A summary of the geotechnical and environmental exploration programs is provided in **Section 3.0**
- Results obtained from the exploration program are provided in **Section 4.0**
- A review of the groundwater modeling is provided in **Section 5.0**
- Potential closure options are summarized in **Section 6.0**
- A description of the selected closure option is provided in **Section 7.0**
- A schedule for refinement of the Plan is provided in **Section 8.0**
- References are provided in **Section 9.0**

2.0 Site Background

2.1 Plant Description

The Robinson Plant (Unit 1) is a former coal-fired electricity generating facility located approximately 4.5 miles north of Hartsville, in Darlington County, South Carolina. The site is bounded by Icy Street to the north, West Old Camden Road to the south, Lake Robinson to the east, and South Carolina Highway 151/West Bobo Newsome Highway to the west.

Development of the Robinson Plant (Unit 1) facility began in the late 1950s when Black Creek was impounded to create Lake Robinson. Shortly thereafter, the coal-fired unit (Unit 1) began commercial operation in 1960 until it was retired in October 2012. The 724 MW nuclear unit (Unit 2) was brought online in 1971. Duke Energy Progress also owns and operates the H.B. Robinson/Darlington Electric Power Plant (Darlington County Plant), which is located just north of the Robinson Plant and along the western shore of Lake Robinson. The 790 MW Darlington County Plant consists of 13 combustion-turbine units fueled by natural gas and oil.

2.2 Ash Management Facilities

The Robinson Plant coal ash management facilities include the coal-fired unit (Unit 1), one ash basin located north of the fossil and nuclear units, and the 1960 Fill Area located west of Units 1 and 2 (**Figure 2**).

The 1960 Fill Area was created in 1960 and received ash from Unit 1 until the ash basin was constructed in the mid-1970s. Between May 2013 and August 2014, Duke Energy Progress contracted AMEC Environment & Infrastructure, Inc. (AMEC) to evaluate the extent and volume of ash stored in this area. Based on data obtained during this assessment, ash was found to cover a surficial area of approximately 25 acres with a maximum ash thickness of 16.3 feet. The calculated volume of ash within the 1960 Fill Area is 275,800 cubic yards (cy) (AMEC 2014).

The 72-acre ash basin is comprised of a 49-acre basin and a 23-acre dry ash storage area near the upstream (e.g., western) end of the ash basin. The basin was formed via construction of a dam across an unnamed tributary to Black Creek. The basin began receiving sluiced ash from Unit 1 in the mid-1970s, and continued to receive sluiced ash until Unit 1 was retired in October 2012. Based on data obtained during the current exploration program, ash thickness within the basin ranges from 11 feet along the northern flank of the basin to 53 feet in the middle of the basin. Ash thickness is expected to be greatest within the thalweg (i.e., deepest portion of the channel) of the former tributary to Black Creek.

There are no permitted National Pollutant Discharge Elimination System (NPDES) outfalls from the basin to Lake Robinson. However, the ash basin does have a permitted NPDES outfall to the discharge canal located northeast of the ash basin, which ultimately feeds discharges to Lake Robinson. In 2014, Duke Energy Progress submitted an NPDES permit application update to re-route stormwater from the ash basin to the discharge canal. The ash basin historically received discharge from the Darlington County Plant oil/water separator; however, this waste stream has also been re-routed to the discharge canal. There is currently no standing water in

the 1960 Fill Area or the ash basin, except for the northeastern most corner of the ash basin near the discharge from the Darlington County Plant.

2.3 Regional Geology/Hydrogeology

South Carolina is divided into distinct regions by portions of three physiographic provinces: the Atlantic Coastal Plain, Piedmont, and Blue Ridge (Fenneman 1938). The Coastal Plain is a region of broad, relatively flat terraces of primarily unconsolidated sediments and carbonate rocks. These materials, ranging in age from Cretaceous to Quaternary, were deposited in shallow seas by rivers draining the Blue Ridge and Piedmont provinces.

Within the upper Coastal Plain and extending across the middle of South Carolina is a narrow, irregular band of rolling hills known as the Carolina Sandhills. These rounded, gently sloping hills range in elevation from 250 to 450 feet above sea level and are generally higher than either the adjacent Piedmont or Coastal Plain regions. The Sandhills region varies in width from 5 to 30 miles, although it is absent along some large river systems such as the Congaree River near Columbia, South Carolina, where it has cut completely through the Sandhills deposits to expose the underlying Piedmont rocks.

The Robinson Plant is located within the Pee Dee Region of South Carolina. According to the “Preliminary Assessment of the Groundwater in Part of the Pee Dee Region, South Carolina” (SCDHEC 2003), aquifer systems beneath the Pee Dee Region are primarily Late Cretaceous in age and include the Black Creek, Middendorf, and Cape Fear systems. Groundwater is the principal source of potable water in the Pee Dee region and the Middendorf and Middendorf/ Cape Fear systems together are the primary source of groundwater for Darlington County, South Carolina. Groundwater is also obtainable from the unconfined surficial aquifer that typically extends from land surface to a depth of approximately 30 to 50 feet below land surface. Groundwater in the surficial aquifer is generally unconfined and recharged primarily from precipitation, losing streams and rivers, and up-flow from underlying aquifers. The surficial aquifer is underlain in the region by fine- to coarse-grained sands with discontinuous layers of sandy clays, kaolins, and gravel. The base of the surficial aquifer typically displays an increase in clay and kaolin, and is considered to be the upper confining unit of the Middendorf aquifer. The weathered nature of the sediments in addition to similar parent material makes the exact transition between the surficial aquifer and underlying aquifers very difficult to identify.

The Middendorf aquifer overlies crystalline bedrock and extends from the Fall Line in the upper coastal plain to the Atlantic coast. Sediment within the aquifer is described as sand to gravelly sand with varying degrees of induration. Transmissivity values in the Middendorf aquifer are relatively high with individual supply wells obtaining groundwater from the aquifer producing yields of up to 2,000 gallons per minute. Groundwater in the Middendorf aquifer is under artesian conditions with primary recharge along the outcrop of the aquifer along the Fall Line and minor recharge controlled by differences in hydraulic head with neighboring aquifers. The Middendorf aquifer has reportedly experienced a potentiometric head loss of greater than 195 feet since "predevelopment" in 1927 to current levels. The primary reason for this substantial head loss has been attributed to an increase in groundwater demand in the region (Catlin 2008).

2.4 Site Geology/Hydrogeology

2.4.1 Site Geology

Based on HDR's review of soil boring and monitoring well installation logs provided by Duke Energy Progress for previous work completed on site as well as observations made during the 2014 subsurface investigation, stratigraphy in the vicinity of the ash basin consists of the following material types: fill, ash, alluvium, Coastal Plain sediments, and bedrock. In general, fill was restricted to borings advanced through the ash basin dam while ash is restricted to the confines of the basin. Alluvium was present beneath ash in several borings advanced into the historic drainage feature that was dammed to create the ash basin. Coastal Plain sediments consisting predominantly of sand with some silt and clay were encountered across the site. Bedrock was reportedly encountered at 398 feet below ground surface during installation of supply Well D in December 2004. Well D is located adjacent to the Unit 2 facility, approximately 4,900 feet south of the ash basin. The general stratigraphic units, in sequence from the ground surface down to boring termination, are defined as follows:

- **Fill** – Fill material generally consisted of re-worked sand and silt that were borrowed from one area of the site and re-distributed to other areas.
- **Ash** – Ash is present within the ash basin and 1960 Fill Area. Ash has been characterized in the field as gray to dark gray fine- to coarse-grained material.
- **Alluvium** – Alluvium is unconsolidated soil and sediment that has been eroded and re-deposited by streams and rivers. Alluvium may consist of a variety of materials ranging from silts and clays to sands and gravels. Alluvium was present beneath ash in several borings advanced into the historic drainage feature that was dammed to create the ash basin.
- **Coastal Plain Sediments** – Coastal Plain sediments representing fluvial or upper delta-plain depositional environments are found across the site. Based on boring logs reviewed, sediments were characterized as yellow, reddish yellow, pink, pale brown, or brown coarse- to fine-grained sand with gray to white to pink clay lenses and extend to an average depth of greater than 300 feet below ground surface (bgs).
- **Bedrock** – Bedrock was encountered in several historic well borings in the vicinity of the Unit 2 facility. Bedrock was described as "greenish rock" in the associated boring logs and presumed to represent glauconitic basement rock of the Piedmont. Bedrock was not encountered during the current conceptual closure assessment activities.

Boring logs and laboratory reports providing detailed geologic information are provided in the Data Report (HDR 2014). Based on the results of exploration activities as well as review of historical boring logs, well data, and drawings provided by Duke Energy Progress, HDR developed four cross-sections (A-A' through D-D') to illustrate the site hydrostratigraphy interpretation. General section descriptions are:

- Section A-A' extends approximately west to east (i.e., longitudinally) through the ash basin.
- Section B-B' extends north to south across the ash basin and dry stack area in the western extent of the basin.

- Section C-C' extends north to south across the central part of the ash basin.
- Section D-D' extends north to south across the eastern extent of the ash basin.

The locations of cross-section lines are shown on **Figure 3**. Cross-section A-A' is shown on **Figure 5**. Cross-sections B-B', C-C', and D-D' are shown on **Figure 6**. Note that cross-sections are interpretations and conditions between borings are estimated and/or inferred and were developed in part from historic drawings.

2.4.2 Site Hydrogeology

Groundwater occurrence within and around the ash basin was relatively uniform and generally follows topography across the site. Groundwater was encountered under unconfined conditions in the surficial aquifer at depths ranging from 28.44 to 44.69 feet below the top of well casings in shallow wells in the vicinity of the ash basin (excluding well MW-108S, which is located on top of the dry ash stack). The exploration program was developed to include installation of paired monitoring wells in many locations to evaluate groundwater characteristics in the upper and lower portions of the unconfined aquifer. Note that groundwater elevations between paired wells seldom varied by more than 1 foot. This confirms that the portion of unconfined aquifer that was the subject of this investigation (shallower than 100 feet) is composed of relatively homogenous material with little or no significant confining layers present.

Subsequent to completion of the well installation program, groundwater elevations in the monitoring wells were measured during a comprehensive gauging event on November 17, 2014. Groundwater elevations measured in shallow monitoring wells installed within the ash basin footprint ranged from 227.82 feet in well MW-110S to 235.53 feet in well MW-108S. Corresponding ground surface elevations at wells MW-110S and MW-108S were 270.17 feet and 283.97 feet, respectively. Groundwater elevations measured in wells located beyond the ash basin waste boundary ranged from 222.67 feet in well MW-112S to 236.44 feet in well MW-107S. Groundwater elevations measured in shallow wells installed within the 1960 Fill Area ranged from 226.30 feet in well MW-118S to 229.25 feet in well MW-117S.

Based on groundwater elevation data collected on November 17, 2014, approximately 18 feet of ash was located below the groundwater table in the vicinity of well pair MW-109S/D. Additional groundwater data collection and post-closure groundwater modeling is necessary to precisely predict the post-closure long-term groundwater level in the ash and whether additional mitigation measures are necessary to protect groundwater. Groundwater elevations for monitoring wells installed during the current investigation are presented in **Table 1**. Potentiometric surface maps for shallow and deeper wells, based on groundwater elevations obtained on November 17, 2014, are shown on **Figures 7** and **8**. Groundwater elevations are shown in each of the four previously referenced cross-sections (**Figures 5** and **6**).

2.5 Surface Water

The Robinson Plant site is located along the western extent of Lake Robinson. The ash basin was formed via construction of a dam across an unnamed tributary to Black Creek in the mid-1970s. Modifications to the ash basin and ash basin riser barrel in the early 1980s and early 2000s are shown on Carolina Power and Light Drawing D-1777 (May 1982) and Law

Engineering and Environmental Services, Stormwater Drainage Improvements, Modifications to Ash Pond (December 2002). The inlet elevation for the upstream riser barrel (Skimmer-005) is 263.87 feet. The 36-inch reinforced concrete pipe (RCP) exiting the riser barrel and embedded in the ash basin embankment enters Catch Basin No. 2, having an inlet elevation of 256.04 feet. The outlet from Catch Basin No. 2 enters new Catch Basin A with an inlet elevation of 243.5 feet. The outlet pipe (36-inch high density polyethylene [HDPE]) from Catch Basin A exits into the discharge canal with an invert elevation of 234.12 feet.

Based on review of the Site Information drawing prepared by AMEC including the 100-year flood boundary (Federal Emergency Management Agency, Flood Insurance Study, Darlington County, South Carolina, effective February 6, 2013), the ash basin is located within the 100-year flood zone. The 100-year flood level for Lake Robinson adjacent to the ash embankment is shown as 220.96 feet. The crest of the ash basin embankment is 270 feet, which is 49.04 feet higher than the flood level. In addition, the inlet elevation for Catch Basin A located at the downstream toe of the ash basin embankment is 22.54 feet higher than the 100-year floodplain elevation. Historic design drawings provided by Duke Energy Progress (D-1777 2002 and LAW 2002) indicate the ash basin will not flood due to riser barrel and catch basin inlet elevations depicted in the figures. It appears that the AMEC Site Information drawing shows the intrusion of Lake Robinson's 100-year flood boundary into the ash basin.

Based on a review of AMEC's and Duke Energy Progress' drawings, HDR observed that the floodplain mapping did not consider the presence of the riser barrel and catch basin configuration. As such, the ash basin should not be considered to lie within the 100-year floodplain of Lake Robinson. That said, the preferred ash basin closure option will evaluate and mitigate for any potential impacts resulting from the 100-year flood level (i.e., 220.96 feet).

3.0 Field Exploration

The field exploration program was implemented between July and November 2014 to characterize the geotechnical and environmental conditions of the ash basin and 1960 Fill Area. The subsurface investigation included completion of 22 environmental soil borings and 11 geotechnical soil borings; installation of 30 groundwater monitoring wells; and subsequent soil, ash, groundwater, and free water sample collection and testing.

Drilling was conducted by SAEDACCO under the supervision of HDR personnel. Data obtained from the subsurface investigation included boring logs, monitoring well logs, and well construction records. Boring and well survey information are included in the Data Report (HDR 2014). As-built boring and well locations are shown on **Figures 3** and **4**.

Field exploration also included a natural resources survey of the site to identify jurisdictional waters of the U.S. and the potential for threatened/endangered species whose presence may affect closure of the ash management facilities. A summary of field exploration methods is presented in the following sections.

3.1 Subsurface Exploration

Exploration was conducted by various methods selected for their ability to measure and collect the required data in the field. In general, the geotechnical and environmental exploration programs were implemented independent of one another, although the data collected from those investigations are frequently cross-referenced during evaluation.

3.1.1 Soil Borings

The subsurface investigation consisted of the completion of 22 environmental soil borings and 11 geotechnical soil borings. Of these borings, 10 were completed within the ash basin, 3 were completed within the 1960 Fill Area ash boundary, 4 were completed through the ash basin dike, 11 were completed down- or cross-gradient of the ash management areas, and 5 were completed in background locations as shown in the table below.

Boring Location	Geotechnical		Environmental	
	Quantity	Boring IDs	Quantity	Boring IDs
Ash Basin	4	AP-2, AP-5, AP-9, AP-10	6	AP-2, AP-5, AP-6, AP-7, AP-9, AP-10
Ash Basin Dike	2	DD-1, DD-2	2	DD-1, DD-2
Cross- or Down-Gradient of Ash Basin	4	AP-1, AP-3, AP-4, AP-8	7	AP-1, AP-3, AP-4, AP-8, CB-1, CB-2, CB-3
1960 Fill Area	0	NA	3	LOL-2, LOL-3, LOL-4
Background	1	AP-11	4	BG-1, BG-2, BG-3, BG-4

Note: NA = Not applicable.

In general, geotechnical soil test borings were completed via hollow stem auger (HSA), cased hole, tricone, and mud rotary drilling techniques using a Diedrich D-50 track rig. Environmental soil borings were completed via HSA using a Diedrich D-50 track rig or via continuous coring using a Geoprobe™ Direct Push Technology (DPT) track rig.

Split-spoon (SPT) and disturbed sampling were performed using a split-spoon sampler driven 18 inches into the ground with an automatic 140-pound hammer. SPT was conducted at 5-foot intervals (3 feet between samples) for ash fill materials and the underlying in-situ soils (e.g., 4–6, 9–11, 14–16, 19–21 feet) for dual-purpose environmental/geotechnical borings.

For borings advanced for geotechnical testing only, SPT was conducted at 2.5-foot intervals (1 foot between samples) to a depth of 20 feet and was then conducted at 5-foot intervals to the boring termination depth. Undisturbed Shelby tube samples were pushed with the hydraulic drill rig 24 inches into the ground to obtain samples at the desired interval. Piston sampler tubes were also taken in selected borings. For environmental soil borings completed with the DPT rig, continuous soil cores were collected using a macro-core sampler with new polyvinyl chloride (PVC) sample liners.

After collection, the sampler was opened and recovered material was described in the field in accordance with the Unified Soil Classification System (USCS). For geotechnical borings, a selected portion of the sample was transferred into a container, sealed, and transported to the on-site storage area to await laboratory testing assignment. For environmental borings, select samples were transferred to containers provided by a third-party analytical testing laboratory (Pace Analytical Services, Inc.), stored on ice in a laboratory-provided cooler, and shipped to the laboratory under chain-of-custody protocol. Soil samples were obtained from each boring and submitted to independent laboratories for geotechnical and environmental property testing as discussed in **Section 4.2.1**. Upon completion, all borings were backfilled with bentonite or grout unless a monitoring well was installed.

3.1.2 Monitoring Well Construction

The subsurface investigation also included installation of 30 groundwater monitoring wells. In general, wells were installed as paired “shallow” and “deep” wells with shallow wells screened across the water table surface and deep wells installed as cased wells screened at depth to evaluate vertical variations in water quality conditions. Of the 30 wells, 17 were installed within and around the ash basin, 8 were installed within and around the 1960 Fill Area, and 5 were installed in background locations up-gradient of the ash basin and 1960 Fill Area as shown in the table below.

Well Location	Quantity	Well IDs
Ash Basin	6	MW-108S, MW-108D, MW-109S, MW-109D, MW-110S, MW-110D
Toe of Ash Basin Dam	2	MW-102D, MW-7D
Cross- or Down-Gradient of Ash Basin	9	MW-107S, MW-107D, MW-111S, MW-111D, MW-112S, MW-113S, MW-113D, MW-114S, MW-114D
1960 Fill Area	4	MW-105S, MW-105D, MW-106S, MW-106D
Cross- or Down-Gradient of 1960 Fill Area	4	MW-117S, MW-117D, MW-118S, MW-118D
Background	5	MW-101D, MW-115S, MW-115D, MW-116S, MW-116D

In general, shallow wells (designated by an "S" qualifier) were installed as Type III wells with 2-inch-diameter Schedule 40 PVC casing and 10-foot well screens set to bracket the water table at the time of installation using HSA drilling techniques. Due to the presence of flowing sands encountered at depth, deep wells were installed using mud rotary drilling techniques. Deeper wells (designated by a "D" qualifier) were completed as cased Type III wells with a 6-inch-diameter Schedule 40 PVC outer casing generally set at least 15 feet below the bottom of the adjacent shallow well screen, and completed with a 2-inch-diameter Schedule 40 PVC casing and 5-foot well screen placed at least 10 feet below the bottom of the outer casing.

Subsequent to completion, all newly installed monitoring wells were developed to create an effective filter pack around the well screen and to remove fine particles within the well. Specific details regarding well development procedures and benchmarks were provided in the Data Report (HDR 2014).

3.1.3 Topographic and As-Built Well Surveys

Between July and November 2014, WSP USA Corp (WSP) completed topographic mapping of an approximate 800-acre area of the site and portions of adjacent properties via aerial and conventional ground run surveying methods. Horizontal and vertical control was tied to existing South Carolina Geodetic Survey NAD83 (2011) and NAVD88 datum. Topography was compiled at a 2-foot contour interval for areas within and adjacent to the ash basin and 1960 Fill Area and at a 4-foot interval for all other areas included in the mapping area. Subsequent to well completion, WSP also surveyed the locations, ground elevations, and top of casing elevations of the 30 newly installed monitoring wells at an accuracy of less than 0.1 foot. The topographic and well surveys were conducted to provide a basis for calculating ash volumes, landfill design, and groundwater position as it pertains to the conceptual closure plan proposed herein. Copies of the preliminary surveys prepared by WSP are included as **Appendix A**.

3.1.4 Water Sampling

Monitoring well sampling was performed by Pace Analytical Services, Inc. (Pace) personnel in August and November 2014. Groundwater samples were collected from 20 newly installed monitoring wells located within and near the ash basin and from 10 newly installed monitoring wells located within and near the 1960 Fill Area to assess groundwater quality. Samples were collected using low-flow sampling techniques in general accordance with USEPA Region 1 Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (revised January 19, 2010).

Free water sampling was performed by Pace personnel in August 2014. One free water sample was collected from the discharge canal using a telescoping cup sampler to assess water quality down-gradient of the ash basin.

3.1.5 Hydraulic Conductivity Testing

Following groundwater sampling, in-situ hydraulic conductivity tests (slug tests) were performed in each of the newly installed monitoring wells. Slug testing was conducted to evaluate the horizontal hydraulic conductivity (K) of aquifer materials relative to monitoring well screen position. Hydraulic conductivity is an important parameter needed to understand groundwater movement and how it impacts closure options and design. Raw data obtained during falling and

rising head tests were analyzed using the Bouwer and Rice method with the following assumptions:

- The groundwater zone is infinite in extent, homogeneous, and uniform in thickness.
- Groundwater flow can be described by Darcy's Law.
- The water table or piezometric surface is horizontal and extends infinitely in the radial direction.
- At time = 0, the change in head occurs instantly.
- The inertia of the water column in the well and linear/non-linear well losses are considered negligible.
- The well diameter is finite; hence storage in the well is not neglected.
- Groundwater density and viscosity are constant throughout the test.

3.2 Natural Resources Surveys

On November 13, 2014, HDR biologists conducted an on-site investigation consisting of a delineation of jurisdictional waters of the U.S. and surveys for federally protected species within an approximately 660-acre study area on property owned by Duke Energy Progress (**Figure 9**). The purpose of the Natural Resources Survey was to evaluate whether the presence of such features/habitats would potentially constrain the preferred closure option. The following sections provide a summary of HDR's methods employed during natural resources survey. Findings of the survey are presented in **Section 4.3**.

3.2.1 Data Review

HDR conducted a desktop survey of publically available data from federal and state agencies prior to engaging in field reconnaissance surveys. The following sources were reviewed as part of this analysis:

- ESRI ArcGIS online aerial imagery, streets, and basemap information
- National Hydrography Dataset (NHD), U.S. Geological Survey (USGS) (http://nhd.usgs.gov/)
- National Wetland Inventory (NWI), U.S. Fish and Wildlife Service (USFWS) (http://www.fws.gov/wetlands/)
- South Carolina List of At-Risk, Candidate, Endangered, and Threatened Species – Darlington County, USWFS (http://www.fws.gov/charleston/EndangeredSpecies_County.html)
- South Carolina Rare, Threatened and Endangered Species Inventory Quadrangle Search, South Carolina Department of Natural Resources (SCDNR) Heritage Trust Program (https://www.dnr.sc.gov/pls/heritage/species.select_quad_map?pcounty=darlington)
- Soil Survey for Darlington County, Natural Resources Conservation Service (NRCS) (http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/south_carolina/SC031/0/Darlington.pdf)
- USGS Lake Robinson 24K Quadrangle (**Figure 9**)

3.2.2 Jurisdictional Waters of the U.S.

HDR surveyed the defined study area for jurisdictional waters of the U.S. under Section 404 of the Clean Water Act. The study area was examined according to the methodology described in the U.S. Army Corps of Engineers (USACE) 1987 Wetland Delineation Manual, USACE Post-Rapanos guidance, and the USACE Atlantic and Gulf Coastal Plain Regional Supplement. The North Carolina Division of Water Resource's Methodology for Identification of Intermittent and Perennial Streams and Their Origins (Version 4.11) was used to determine the presence/absence of jurisdictional streams since no stream identification protocol has been established by SCDHEC. Jurisdictional waters were classified in accordance with the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979).

3.2.3 Vegetation Communities

Vegetation community types were documented and categorized based on the Natural Communities of South Carolina Initial Classification and Description developed by Nelson (1986). Dominant species in the canopy, shrub/subcanopy, herbaceous, and vine strata were identified and documented to the lowest taxonomic level based on Radford et al. 1960.

3.2.4 Federally Protected Species

HDR obtained and reviewed a list of federally protected species for Darlington County from the USFWS website, which was last updated on October 23, 2013. A summary of these species is provided in the following table.

Common Name	Scientific Name	Federal Status	Habitat Present
	Bird		
Bald eagle	*Haliaeetus leucocephalus*	BGPA	Yes
Red-cockaded woodpecker	*Picoides borealis*	E	Yes
	Fish		
Atlantic sturgeon	*Acipenser oxyrinchus*	E	No
Shortnose sturgeon	*Acipenser brevirostrum*	E	No
	Plant		
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	E	No

Notes:
1. BGPA = Federally protected under the Bald and Golden Eagle Protection Act
2. E = Federally Endangered

HDR also reviewed the South Carolina Department of Natural Resource (SCDNR) Heritage Trust Program's Rare, Threatened, and Endangered Species Inventory Quadrangle Search for protected species distribution and proximity to the study area.

4.0 Exploration Results

4.1 Geotechnical Testing

Geotechnical laboratory determination of soil index properties included particle size analysis by #200 wash only or #200 wash with hydrometer analysis, Atterberg limit determination, and specific gravity determination. Testing was performed on representative soil and ash samples. Material for testing was obtained from either split-spoon samples, relatively undisturbed Shelby tube samples, or bulk samples obtained at the surface. Additional geotechnical laboratory testing included soil strength determination such as consolidated undrained with pore pressure measurements (CU) testing. Additionally, the hydraulic conductivity of selected samples was also determined. All testing was performed in accordance with the most recently updated American Society for Testing Materials (ASTM) testing standards.

Subsurface exploration results indicate that the majority of on-site soil consists of unconsolidated, loose to medium dense sand with varying degrees of silt and/or clay. A summary of the geotechnical laboratory testing program is presented in the table below.

Boring	Depth of Boring	Depth of Fill	Depth of Ash	Depth of Unconsolidated Sediments	No. of Soil Samples[2, 3] Collected	No. of Disturbed Soil Samples Tested	No. of Undisturbed Soil Samples Tested
AP-1	50.0	-	-	50	D=12	1	0
AP-2	100.0	-	56	44	D=8: U=2	2	0
AP-3	50.0	-	-	50	D=12	1	0
AP-4	50.0	-	-	50	D=12	4	0
AP-5	88.8	-	59.5	29.3	D=6; U=1	2	0
AP-8	50.0	-	-	50	D=12	1	0
AP-9	50.0	-	35.5	14.5	D=9	1	0
AP-10	50.0	-	16.5	33.5	D=4; U=1	0	3
AP-11[1]	50.0	-	-	50	D=12; U=2	2	1
DD-1	65.0	22.5	-	42.5	D=15	2	0
DD-2	71.5	41	-	30.5	D=13; U=4	2	2

Notes:
1. Includes Boring AP-11A that was advanced at same location to collect undisturbed samples
2. D = Disturbed Samples
3. U = Undisturbed Samples

Data obtained during the geotechnical exploration program will be used to support the preferred ash basin closure option as feasibility of the option is further refined. Laboratory results of geotechnical testing are summarized in **Tables 2A** and **2B**.

4.2 Environmental Testing

Environmental laboratory testing was performed on soil, ash, ash pore water, groundwater, and free water samples collected from borings, monitoring wells, and the ash basin discharge canal. Samples were analyzed by Pace or their subcontract laboratories in accordance with USEPA methods or other applicable standards.

4.2.1 Soil and Ash

A total of 53 soil and ash samples were collected from borings completed within the ash basin, outside of the ash basin, in the 1960 Fill Area, and in background locations. Of the 53 samples, 12 were collected in ash within the ash basin and 4 were collected in ash within the 1960 Fill Area. The remaining samples were collected in soil either beneath ash or outside of ash management areas as presented in the table below.

Soil Boring Location	Soil Boring ID	Type and Quantity of Analyses		
		Soil	Ash	Ash - SPLP
Within Ash Basin	AP-2	--	2	2
	AP-5	--	2	2
	AP-6	1	2	1
	AP-7	1	2	2
	AP-9	1	2	--
	AP-10	1	2	1
Background of Ash Basin	BG-1	4	--	--
	BG-2	3	--	--
	BG-3	4	--	--
Cross-gradient of Ash Basin	AP-1	1	--	--
	AP-3	1	--	--
	AP-4	1	--	--
	AP-8	1	--	--
Down-gradient of Ash Basin	DD-1	3	--	--
	DD-2	3	--	--
	CB-1	2	--	--
	CB-2	2	--	--
	CB-3	2	--	--
Within 1960 Fill Area	LOL-2	1	1	1
	LOL-3	1	2	1
	LOL-4	1	1	1
Background of 1960 Fill Area	BG-4	3	--	--

Note:

1. SPLP = Synthetic Precipitation Leaching Procedure

The 53 samples were submitted to Pace for analysis of total antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, thallium, and zinc using EPA Method 6010; chloride using EPA Method 9056; mercury using EPA Method 7471; and pH using EPA Method 9045. Eleven ash samples were also analyzed for leaching potential of inorganic constituents using the Synthetic Precipitation Leaching Procedure (SPLP) by USEPA Method 6020/1312.

Ash and soil samples collected from within and beneath the ash basin were also analyzed for cesium-137 using Method DOE HASL 300, 4.5.2.3/Ga-01-R, and cobalt-60 using Method DOE HASL 300, 4.5.2.3/Ga-01-R, due to the 1998 approved discharge of low-level radioactive boiler cleaning wastewater to the ash basin. This disposal involved boiler chemical metal cleaning wastes that were contaminated at very low levels with Cobalt-60 (Carolina Power & Light Company 1998).

Analytical results of the total concentration analyses were compared to Maximum Contaminant Level-based (MCL-based) USEPA Protection of Groundwater Soil Screening Levels (SSLs) and USEPA Industrial SSLs. The site is used for industrial purposes and is not anticipated to be rezoned to residential. Constituents that exceeded the USEPA Protection of Groundwater SSLs in the ash samples collected from within the ash basin and the 1960 Fill Area included antimony, arsenic, barium, beryllium, cadmium, copper, lead, mercury, and selenium. Arsenic was also reported above the USEPA Industrial SSL in the ash samples collected from within the ash basin and the 1960 Fill Area. Constituents that exceeded USEPA Protection of Groundwater SSLs in the soil samples include arsenic and selenium. Arsenic also exceeded the USEPA Industrial SSL in one soil sample. Radiological parameters were not detected above the laboratory method detection limit (10.0 pCi/L) in ash or soil samples collected within the ash basin. Laboratory results of soil and ash samples are presented in **Tables 3A, 3B, 3C, and 3D**.

Laboratory results of SPLP analyses were compared to the SCDHEC Primary and Secondary MCLs for drinking water last amended on August 28, 2009. Arsenic was detected at concentrations greater than the Primary and Secondary MCLs in ash samples collected from within the ash basin. Iron and manganese were measured at concentrations greater than the Primary and Secondary MCLs in ash samples collected from within the 1960 Fill Area. Leaching results of select samples of ash are presented in **Table 4**.

The results of environmental soil and ash analyses will be further evaluated to derive a list of site-specific constituents of concern (CoCs) and to assess the leaching potential of those CoCs from ash into underlying soils and/or groundwater.

4.2.2 Groundwater

Between August and November 2014, groundwater samples were collected from 20 newly installed monitoring wells located within and near the ash basin and from 10 newly installed monitoring wells located within and near the 1960 Fill Area to assess groundwater water quality.

Samples were collected for both total and dissolved concentration analyses. The samples collected for dissolved concentration analyses were filtered by Pace in a laboratory controlled environment. The samples were submitted to Pace for analysis as follows:

- Antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, sodium, and zinc using USEPA Method 200.7 (total and dissolved concentrations)
- Mercury using USEPA Method 245.1 (total and dissolved concentrations)
- Thallium using USEPA Method 200.8 (total and dissolved concentrations)
- Alkalinity using SM 2320B
- Bromide, chloride, and sulfate using USEPA Method 300.0
- Ferrous iron using SM 3500-Fe B
- Methane using RSK 175
- Nitrate as nitrogen using USEPA Method 353.2
- Sulfide using SM 4500-S2D
- Total dissolved solids using SM 2540C

Ash pore water and groundwater samples collected from wells screened below ash were also analyzed for cesium-137 using Method DOE HASL 300, 4.5.2.3/Ga-01-R, and cobalt-60 using Method DOE HASL 300, 4.5.2.3/Ga-01-R, to evaluate potential impacts from the 1998 approved discharge of low-level radioactive boiler cleaning wastewater to the ash basin.

Constituents detected at concentrations that meet or exceed the Primary and Secondary MCLs in the ash pore water samples include arsenic (samples MW-108S and MW-109S), iron (sample MW-108S), manganese (samples MW-108S and MW-109S), and pH (sample MW-108S). Constituents detected at concentrations that meet or exceed the Primary and Secondary MCLs in the groundwater samples include arsenic (sample MW-7), iron (11 samples), manganese (17 samples), and pH (22 samples). Radiological parameters were not detected above the laboratory reporting limit (10.0 pCi/L) in wells screened within or below ash in the ash basin.

Based on these results, the following CoCs were identified in groundwater in the vicinity of the ash basin and/or the 1960 Fill Area: arsenic, barium, boron, iron, manganese, and molybdenum.

Laboratory results of groundwater samples are summarized in **Table 5A** (total inorganics), **Table 5B** (major anions and cations), **Table 5C** (dissolved inorganics), and **Table 5D** (radiological isotopes).

4.2.3 Free Water

One free water sample was collected by Pace personnel in August 2014 from the discharge canal to assess water quality down-gradient from the ash basin. The free water sample was analyzed for total and dissolved concentrations of the same suite of constituents/parameters as the groundwater samples with the exception of radiological parameters. Total and dissolved concentrations of barium, iron, and manganese were detected above their respective laboratory reporting limits in the free water sample. No other constituents were detected above their reporting limits. Laboratory results of the free water sample are summarized in **Table 6**.

The results of free water analysis will be further evaluated to derive a list of site-specific CoCs, assess whether leaching of those CoCs from ash into groundwater has occurred, ascertain the position of groundwater relative to ash, and identify the potential for off-site migration of CoCs at concentrations that exceed applicable water standards. These efforts will support the preferred ash basin closure option as feasibility of the option is further refined.

4.3 Groundwater Flow

As discussed in **Section 2.4.2**, groundwater elevations in the monitoring wells were measured during a comprehensive gauging event on November 17, 2014. Based on these data, groundwater in the vicinity of the ash basin flows east toward Lake Robinson. Groundwater in the immediate vicinity of the 1960 Fill area flows southeast; however, groundwater is expected to ultimately discharge into Lake Robinson to the east.

Rising and falling head slug tests were performed on each newly installed well to evaluate hydraulic conductivity of the surficial aquifer between November 10 and 14, 2014. Prior to the tests an In-situ Level Troll pressure transducer and 2-foot-long stainless steel slug were placed into the well. The water level in the well was recorded as a “Background” test until the well

recharged to within 90% of the original measurement. Subsequent to normalization, the rising head test was started, the slug was removed and the change in head versus time was measured using a RuggedReader data logger. Slug test data were analyzed using Aqtesolv software to estimate hydraulic conductivity in each well.

Detailed slug test results for individual wells are provided in **Table 7.** A summary of these results is provided below.

Slug Test Type[1, 2]	K (ft/day)[3]	K (cm/sec)
Injection (S and D Wells)		
Average	8.1	2.9×10^{-3}
Median	5.8	2.1×10^{-3}
Withdrawal (D Wells)		
Average	8.1	2.9×10^{-3}
Median	5.1	1.8×10^{-3}
Withdrawal (S Wells)		
Average	2.4	8.5×10^{-4}
Median	1.7	6.1×10^{-4}

Notes:
1. Injection = Falling head slug test
2. Withdrawal = Rising head slug test
3. K = Hydraulic conductivity in feet per day (ft/day) and centimeters per second (cm/sec)

4.4 Natural Resources Survey

4.4.1 Jurisdictional Waters of the U.S.

Based on the Classification System of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979), identified waters can be described as: deep water Lacustrine; Limnetic; Unconsolidated Bottom; Permanently Flooded; Diked/Impounded (L1UBHh) with adjacent fringe Palustrine; Emergent; Seasonally Flooded; Diked/Impounded (PEMCh) and Palustrine; Scrub-Shrub; Broad-Leaved Deciduous; Seasonally Flooded; and Diked/Impounded (PSS1Ch). No jurisdictional streams were located within the study area. Jurisdictional waters identified are shown on **Figure 10**. USACE Wetland Determination Data forms are provided in **Appendix B**. A summary of the delineated feature is provided in the table below.

Site Number or Name	Latitude	Longitude	Cowardin Classification	Estimated Amount of Aquatic Resources in Study Area	Class of Aquatic Resources
Open Water	34.41778	-80.15945	L1UBHh	2.81	Section 10 – Non-Tidal

4.4.2 Vegetation Communities

Maintained/Disturbed

Maintained/disturbed areas are scattered throughout the study area and include land north of Icy Street, maintained rights-of-way (ROWs), and the 1960 Fill Area. These areas are dominated by immature pines (*Pinus* sp.), asters (*Aster* sp.), black cherry (*Prunus serotina*), blackberry (*Rubus* sp.), big bluestem (*Andropogon gerardii*), Chinese privet (*Ligustrum*

sinense), dogfennel (*Eupatorium capillifolium*), fescue (*Fescue* sp.), goldenrods (*Solidago* sp.), Japanese honeysuckle (*Lonicera japonica*), Johnson grass (*Sorghum halepense*), sumac (*Rhus* sp.), and other early successional species.

Pine-Scrub Oak Sandhill

The pine-scrub oak sandhills are located primarily in the western portion of the study area. The canopy is dominated by longleaf pine (*Pinus palustris*) and understory species consist of a high percentage of scrub oaks including bluejack oak (*Quercus incana*), blackjack oak (*Quercus marilandica*), and turkey oak (*Quercus laevis*). Additional understory and shrub species include black cherry, dwarf huckleberry (*Gaylussacia dumosa*), flowering dogwood (*Cornus florida*), highbush blueberry (*Vaccinium stamineum*), mockernut hickory (*Carya tomentosa*), sassafras (*Sassafras albidum*), and sweetgum (*Liquidambar styraciflua*). Herbaceous species included bluestem (*Andropogon* sp.) and bracken fern (*Pteridium aquilinum*).

Mixed Pine/Hardwood Forest

The community located north of the backwater cove below the ash basin does not fall into a distinct natural community type as described by Nelson. The canopy is dominated by loblolly pine (*Pinus taeda*), hickories (*Carya* sp.), and sweetgum. Understory and shrub species consist of American holly (*Ilex opaca*), black cherry, flowering dogwood, highbush blueberry, and wax myrtle. Vine species include Japanese honeysuckle, poison ivy (*Rhus radicans*), and yellow jasmine (*Gelsemium sempervirens*).

4.4.3 Federally Protected Species

The following is a summary of biological conclusions for species that are protected under provisions of Section 7 and Section 9 of the Endangered Species Act of 1973 and the Bald and Golden Eagle Protection Act. In addition, the SCDNR Lake Robinson Quadrangle search revealed several known occurrences of Red-Cockaded Woodpecker (*Picoides borealis*) in the Sandhills State Forest approximately 5 miles north of the study area.

Bald Eagle (*Haliaeetus leucocephalus*)

The study area is located near open water (Lake Robinson). Although this is considered suitable Bald Eagle habitat, no known occurrences of the species have been documented nearby. No Bald Eagle individuals or nests were observed within the study area during the on-site investigation. A follow-up survey is recommended should any future on-site activities require Section 7 consultation with the United States Fish and Wildlife Service (USFWS).

Red-Cockaded Woodpecker (*Picoides borealis*)

Minimal areas of suitable habitat for the Red-Cockaded Woodpecker exist within the study area. There are a few stands of 20- to 30-year-old (estimated) longleaf pines within the study area, which would be suitable for foraging habitat; however, the pine stands are not fire maintained and have a thick understory consisting of scrub oaks and other hardwoods, which are limiting factors. No individuals, cavity trees, or mature nesting trees were observed during the on-site investigation. Potential foraging habitat for the Red-Cockaded Woodpecker would be restricted to a few areas with mature pines, little or no understory, and abundant herbaceous ground

cover within the study area. A follow-up survey is recommended should any future on-site activities require Section 7 consultation with the USFWS.

Atlantic Sturgeon (*Acipenser oxyrinchus*)
No suitable habitats are located within the study area. No known occurrences or historic populations of Atlantic Sturgeon have been recorded in Lake Robinson.

Shortnose Sturgeon (*Acipenser brevirostrum*)
No suitable habitats are located within the study area. No know occurrences or historic populations of Shortnose Sturgeon have been recording in Lake Robinson.

Rough-Leaved Loosestrife (*Lysimachia asperulaefolia*)
The study area does not have suitable ecotone habitat between existing longleaf pine stands and wetter areas that may include pocosins, wet pine savannas, or streamhead seeps. No known occurrences of Rough-Leaved Loosestrife have been documented nearby and this species in now considered to be extirpated in Darlington County (NatureServe 2014).

4.4.4 Natural Resources Survey Conclusions

Based on the data reviewed and observations made during the on-site natural resources survey, HDR did not identify Jurisdictional Waters of the U.S., wetlands, vegetation communities, or threatened and endangered species in the study area that would likely be impacted by closure of the ash basin or movement of ash from the 1960 Fill Area.

5.0 Groundwater Modeling

Between July and November 2014, Duke Energy Progress completed a field exploration and laboratory analysis program consisting of the following:

- Completion of 22 environmental soil borings and 11 geotechnical soil borings;
- Installation, development, and sampling of 30 shallow and deep groundwater monitoring wells;
- Hydraulic conductivity testing of 29 newly installed monitoring wells;
- Laboratory testing of 18 disturbed and 6 undisturbed soil and ash samples for geotechnical parameters; and
- Laboratory analysis of 53 soil and ash samples, 30 groundwater samples, and one free water (or surface water) sample for dissolved arsenic, barium, boron, iron, manganese, and molybdenum (all CoCs) and natural attenuation indicator parameters

These data were used, in part, to support development of a two-dimensional (2-D) cross-sectional groundwater flow and contaminant transport model to evaluate the viability of a hybrid cap-in-place closure scenario. The 2-D cross-sectional model was used to predict resultant contaminant concentrations in groundwater considering the following preliminary ash basin closure options:

- **Hybrid Cap-in-Place** whereby coal ash residue from the 1960 Fill Area is excavated and placed into the ash basin, ash immediately behind the ash basin embankment is moved farther west within the basin to allow breaching or removal of the dam, and consolidated ash within the basin and capped with an engineered cover system. Potential areas of saturated ash within the basin post-closure (based on modeling) would be reduced or eliminated using appropriate engineering measures (e.g., removal of ash from saturated areas, fixing ash in place via soil mixing and/or injection of stabilizing materials, installation of infiltration cut-off walls on the upstream side of the ash basin) to prevent or minimize leaching of coal ash constituents to down-gradient areas.
- **On-Site Landfill** whereby coal ash residue from the 1960 Fill Area and ash basin is excavated and moved to a lined landfill designed to contain coal ash residue. While not thoroughly investigated at this time, an on-site landfill could potentially be located on the northwest side of the Darlington County Plant.
- **Off-Site Landfill** whereby coal ash residue from the 1960 Fill Area and ash basin is excavated and hauled to a lined landfill designed and permitted to receive coal ash residue. This could either be an existing lined landfill with capacity and ability to accept the coal ash residue or a newly constructed landfill permitted to accept coal ash residue.

5.1 Soil Sorption Study

Site-specific sorption terms for CoCs were derived for the transport model in the form of soil-water partition coefficients (K_d terms) using native soil samples collected at the site. The soil samples were collected beneath the ash basin and areas down-gradient of the ash basin (sample depth range was 33 feet to 65 feet). The soil sorption study was performed at the University of North Carolina Charlotte's (UNCC) Civil & Environmental Engineering Laboratory. Soil samples were collected at the site between July and November 2014 and submitted to UNCC for testing. The site-specific K_d terms were used in the model to evaluate the preliminary ash basin closure options. Details regarding the sorption study, test methods and study findings are presented in the UNCC report titled, "Sorption Evaluation for Ash Basin Closure – H.B. Robinson Steam Station" (Sorption Report), dated March 13, 2015. The report is included in **Appendix C** and an overview of the study is presented below.

Of the 17 soil samples submitted to UNCC, 13 samples were used for the soil sorption study. To prepare the samples for testing, the soils were disaggregated, homogenized, dried, and sieved to a particle diameter of less than 2 millimeters (mm).

Both batch and column testing methods were utilized to evaluate the sorption characteristics of the soil samples. Batch testing consisted of preparing an aqueous "background" solution similar to site groundwater chemistry of major cations and anions, and adding CoCs to the background solution to produce separate CoC-amended solutions (target concentration = 0.5 mg/L for each CoC). Iron and manganese were not tested due to the natural high concentrations in the soil. The target pH for arsenic, barium, boron, and molybdenum in amended-solutions solutions was 7 standard units. The following soil mass/solution ratios were tested in the batch tests; 50, 125, 250, 375 and 500. The solution and soil mixtures were rotated for 24 hours at which time it was assumed that chemical equilibrium was achieved between dissolved and adsorbed phases. A sample was collected and analyzed from each test bottle to determine the aqueous-phase concentration. The data were used to produce plots of measured solution concentration versus calculated adsorbed soil concentration to create an isotherm for each of the tests performed. The K_d of the constituent was calculated by computing the slope of the linear isotherm.

Column testing consisted of passing the separate CoC-amended solutions through cylindrical columns packed with the soil samples. A flow rate of 12 pore volumes per day was maintained and effluent samples were collected from the column during the test. The concentrations of constituents measured in the column effluent versus time were plotted to develop breakthrough curves for the CoCs tested. The breakthrough curves were matched to curves generated by the Ogata and Banks Solution to the 1-D Advection-Dispersion Equation to arrive at a reasonable K_d ranges for each constituent.

The batch test procedure yielded higher K_d values than column test derived K_d terms, as the batch test provided more effective contact between the solution and soil. However, column test results better represented actual in-situ groundwater flow conditions as natural solution-soil contact is non-uniform and chemical equilibrium is not usually achieved in the aquifer. Both iron and manganese are present in site soil at high concentrations. As a result, it was not possible to determine site-specific K_d terms for iron and manganese using these test methods.

5.2 Groundwater Flow and Contaminant Transport Modeling

Conceptual 2-D cross-sectional groundwater flow and contaminant transport models were created to assess and compare the effects of preliminary ash basin closure options. The model results are considered conceptual because they rely upon a simplified flow system to simulate ash basin groundwater conditions and the potential closure options were modeled in limited detail.

A description of the methods used to conduct the conceptual groundwater modeling work, along with a discussion of the model findings, are presented in the UNCC report titled, “Conceptual Groundwater Modeling for Ash Basin Closure – H.B. Robinson Steam Station” (Modeling Report), dated November 12, 2015. The report is included as **Appendix D** in this report and an overview of the modeling approach as well as groundwater flow and contaminant transport modeling results are presented below.

5.2.1 Conceptual Model and Modeling Approach

The 2-D cross-sectional groundwater flow model follows the original thalweg of the tributary to Black Creek from which the ash basin was formed from approximately 500 feet west of the ash basin to the discharge canal located at the toe of the ash basin dam. Both the eastern and western vertical boundaries of the model domain were treated as constant head boundaries in the numerical model, as shallow groundwater primarily enters from the west and discharges to the east in the discharge canal and Lake Robinson. The lower limit of the model domain was treated as a no flow boundary, which is consistent with low permeability bedrock at the site. Unconfined (water table) conditions were applied throughout the domain. The modeling was performed under transient conditions, as recharge and contaminant concentrations applied at the surface were varied over time to be consistent with historical conditions.

Work to develop the model relied upon analytical test results and water-level measurements obtained during the Fall 2014 and Winter 2015 ash basin monitoring events, geologic and hydrostratigraphic data from ash basin environmental and geotechnical borings, permeability test results for an undisturbed sample from boring AP-10, hydraulic conductivity data obtained from monitoring wells in November 2014, and published information on area precipitation rates. Initial head values are from water level measurements were applied and the recharge rates from precipitation applied at the surface were determined during flow model calibration and vary from 10 inches/year at the ash basin with 4 inches/year in other locations (1975-2012), to 4 inches/year throughout the model domain (2012 forward). The CoC concentrations are applied at the surface and a first-order degradation rate constant was applied to simulate a decreasing ash basin source. The hydraulic conductivity values used for modeling are based on laboratory permeability data, and a single value was applied for all materials in the calibrated model (K_x=K_y=0.1K_z). The site-specific K_d’s from the UNCC Sorption Study were used for contaminant transport modeling. Model simulations were conducted using Visual MODFLOW (version 2011.1), the MODFLOW-2005 groundwater flow numeric engine, and the MT3D150 transport model with linear isotherm adsorption.

5.2.2 Groundwater Flow Model Calibration and Results

The groundwater flow model was calibrated by adjusting model parameters including hydraulic conductivity of each flow zone within the basin (e.g., sediments/ash and dam fill material), the net infiltration rate due to precipitation, and the depth or thickness of the model domain. An average hydraulic conductivity was derived from lab permeability test results of an undisturbed soil sample obtained during the field investigation portion of work. The documented net recharge rates are between 6 and 8 inches per year for nearby Chesterfield County, South Carolina and are considered representative of the site in Darlington County, South Carolina.

The calibration results indicate the model adequately represents groundwater flow conditions for cross-section A-A' and advective travel times are reasonable for pre-closure conditions (no discharge to the ash basin). Groundwater particle tracking predicts that the groundwater travel time from the western edge of the dry ash stack (Station 1000' on Cross Section A-A') to the discharge canal (Station 4400') ranges from 20 to 120 years. Also, residual error statistics are within reasonable ranges, indicating that the model is adequately calibrated to site conditions.

Assumptions used in the conceptual groundwater flow model calibration are summarized as follows:

- The effective hydraulic conductivities of each soil type in Cross Section A-A' are of similar magnitude.
- Recharge to groundwater due to precipitation across the surface of Cross Section A-A' is approximately 4" per year.
- The approximate lower limit of the shallow groundwater flow zone is at elevation 100'

Results of the groundwater flow model indicate that limiting infiltration through the ash (e.g., installing an engineered soil cap) has a minimal impact on lowering the water level within the ash basin.

5.2.3 Contaminant Transport Model Calibration and Results

The primary goal of contaminant transport model calibration was to match CoC concentrations detected in MW-108S, MW-109S, and MW-7 during the Fall 2014 and/or Winter 2015 sampling events. The contaminant transport model calibration parameters adjusted during calibration include initial CoC recharge concentrations, first-order degradation rate constant and distribution of the dissolved-phase CoCs along the cross sectional line. After initial adjustments, the calibration results were determined to be acceptable and the contaminant transport model was used to evaluate the ash basin closure options.

Assumptions used in the fate and transport model are summarized as follows:

- The relative rates at which chemical constituents move through Cross Section A-A' are dependent on their respective sorption coefficients.
- Residual dissolved and adsorbed chemical constituents in native soils beneath the ash basin may be mobilized over time until they are depleted.
- An effective sorption coefficient for arsenic which is less than the measured values is appropriate for the zone downgradient of the dam and overlying the former thalweg.

- Soil and groundwater below the original thalweg in the ash basin are not Impacted above MCLs, based on review of SPLP and groundwater sampling results from monitoring wells screened in natural soils in these areas.

Results of the 2-D cross-sectional contaminant transport model simulations indicate that limiting infiltration through the ash, either with or without moving ash over about two-thirds of the downgradient ash basin footprint to the remaining upgradient footprint, may have limited benefit in reducing downgradient constituent concentrations.

The two-dimensional model likely represents a conservative assessment of the critical volume of the ash basin that must be considered for closure. Delineation of the exact lateral and vertical extent of that critical volume is not possible with the data currently available. As noted in the "Robinson Ash Basin Groundwater Assessment for the MW-7 Area, H.B. Robinson Steam Electric Plant, Darlington County, South Carolina" (HDR, February 26, 2015), arsenic was not detected in MW-7D, indicating the vertical extent of contamination in the vicinity of MW-7 is delineated and, laterally, arsenic was not detected above the laboratory reporting limit in MW-120S and MW-120D nor the free water in the discharge canal or Lake Robinson. Further, it is noted that none of the deep wells (including those installed within the boundary of the basin itself) detected arsenic. Based on these data, further refinement of the fate and transport modeling would be prudent following collection of additional sampling data within the basin that could better define the extent of arsenic within the thalweg.

6.0 Potential Ash Basin Closure Options

As described in **Section 5.0**, Duke Energy Progress has evaluated the following three permanent ash basin closure options for the ash management areas (i.e., ash basin and 1960 Fill Area) at the Robinson Plant site:

- Hybrid Cap-in-Place
- On-Site Landfill
- Off-Site Landfill

Physical and environmental closure approaches for each closure option, as well as viability of each option, are discussed in the sections below.

6.1 Ash and Earthwork Quantities

The quantities of ash and impacted soil within the ash basin were estimated by HDR during completion of the initial Conceptual Closure Planning Update in December 2014. Between December 2014 and August 2015, additional soil boring data and historical documentation were reviewed, prompting Duke Energy Progress to revise volume calculations for ash within the ash basin as referenced in **Section 2.2**. These revisions indicate that approximately 2,923,000 cy of ash are stored within the ash basin and 1960 Fill Area. A detailed description of the approach and assumptions used during recalculation of ash volume within the basin are presented in the "Estimate of Coal Combustion Residuals Quantity" memo prepared by AMEC Foster Wheeler (AMECFW) in October 2015 (**Appendix E**).

6.1.1 1960 Fill Area

In accordance with the Consent Agreement, ash removed from the 1960 Fill Area will be handled in conjunction with closure of the ash basin.

The quantity of ash currently within the 1960 Fill Area was previously estimated to be approximately 276,000 cy (AMEC 2014). The same reference estimated that approximately 19,600 cy of cover soil had been placed over the ash in the 1960 Fill Area. Due to the relatively thin layer of cover present (typically less than 1 foot) and the length of time the cover has been in place (since the 1970s), it is assumed that removal and reuse of the cover soil without intermixing with ash will be impractical.

6.1.2 Ash Basin Area

HDR estimated the quantity of ash within the ash basin by digitizing pre-basin contours obtained from a topographic map of the site (Carolina Power & Light Company 1981) into CAD format and comparing that surface to a surface generated from a recently developed topographic map of the Robinson site (WSP Transportation and Infrastructure 2014). This work resulted in an ash volume estimate of between 3,000,000 and 3,500,000 cy which included the existing Dry Ash Storage Area located west of the transmission lines that extend over the basin. As a result of this estimate, AMECFW, in coordination with Duke Energy Progress and HDR, refined the estimated volume of ash in the ash basin, resulting in a calculated volume of 2,547,000 cy.

This estimate should not be considered representative of actual volume, however, since it is possible that the ash basin area may have been altered (e.g., by borrow operations to build the ash basin dam or other earthen structures) between the date of the pre-basin topography and when ash began being placed within the basin. (Note these earthwork activities are not depicted on historical topographic drawings reviewed during the preparation of this report.) Borings conducted within the ash basin as part of the closure investigation appear to support the premise that the grades within the basin were reworked prior to ash disposal since ash was encountered below the aforementioned pre-basin contours. The accuracy of the pre-basin topography is also questionable since information on the original source of the topography is not available and the vertical and horizontal datum is not known. Furthermore, the topographic contours outside of the basin limits deviate between the two surveys. The limits of ash were also estimated based on topographic features and aerial photographs, but cannot be determined with a high degree of confidence without field verification. Discrepancies within the limits of ash could also introduce inaccuracy with respect to the total calculated ash volume.

6.1.3 Ash Basin Embankment

The ash basin embankment, located on the east side of the ash basin, was constructed from general fill materials surrounding a 12-foot-wide compacted impervious core. If the main dam is lowered or removed as part of the overall ash basin closure process, the earthen material could likely be reused as a source of cover soil. The quantity of soil within the dam was estimated by comparing the digitized pre-basin contours to the recent topographic map of the Robinson site as previously described. The upstream profile of the dam, currently overlaid with ash, was estimated based on the original design sections (EBASCO Services Incorporated 1958). The estimated quantity of soil comprising the main dam is 309,400 cy.

6.2 Hybrid Cap-in-Place Closure Option

Under this option, ash and impacted soil from the 1960 Fill Area would be re-located to the footprint of the existing ash basin and closed in-place with an engineered cap system to reduce infiltration through the ash and underlying materials thereby limiting potential for future migration of CoC. Closure would require re-shaping of the basin area to shed stormwater and route to the existing stormwater outfall.

The Hybrid Cap-in-Place closure option would consist of the following activities:

- Consolidate ash and impacted soils from the 1960 Fill Area into the existing ash basin to reduce the closure footprint.
- Move ash and impacted soils from immediately behind the ash basin embankment to locations farther west within the basin to allow breaching or removal of the main dam.
- Cap consolidated portions of ash and impacted soils in place with an engineered cover system (soil-geosynthetic) designed to isolate and stabilize the ash while providing a physical barrier to the environment.
- Re-use embankment soils for closure construction.
- Decommission the ash basin and dam embankment from the SCDHEC Dams and Reservoirs Safety Program jurisdiction.

- Evaluate monitored natural attenuation (MNA) for environmental closure provided environmental investigation results facilitate MNA as a remedy.
- Maintain the current NPDES outfall location for stormwater discharge.

6.2.1 Physical Closure

The closure approach would consider the SCDHEC Regulation 61-82 for Proper Closeout of Wastewater Treatment Facilities, the USEPA CCR Rule, and established municipal solid waste landfill closure practices for engineered cover systems.

The Hybrid Cap-in-Place closure option has the benefits of reducing the closure footprint by approximately 30.5 acres and provides the opportunity to beneficially reuse the soil material in the main dam for engineered cover system construction. For this closure option, ash and impacted soils from the 1960 Fill Area and the upstream face of the ash basin embankment (to allow dam embankment decommissioning) would be consolidated with existing ash in the basin. The Hybrid Cap-in-Place closure option would require approximately 162,100 cy of soil to provide an 18-inch-thick soil cover as part of an engineered cover system. The amount of soil material in the main dam is more than sufficient for this purpose and excess soil could be used to construct stormwater berms and terraces required to promote surface runoff and/or to regrade the excavated 1960 Fill Area. As a result, the engineered cover system would be designed to effectively eliminate the vertical percolation of rainwater into the ash basin.

6.2.2 Environmental Closure

Environmental closure relates to the short- and long-term soil, groundwater, and surface water quality of the ash management areas. Environmental closure may take one of several pathways depending on the nature, extent, and characteristics of the CoCs. For the Hybrid Cap-in-Place closure option, ash and impacted soil beneath ash would largely be left in place. Therefore, the results of leaching analyses and groundwater modeling are critical to understanding whether leaving these materials in place would impact groundwater.

6.2.3 Viability

The effectiveness of this option is largely dependent on the ability of an engineered cover system to lower the groundwater potentiometric surface within the ash basin such that it is below the ash. As shown on the cross sections (**Figure 5** and **Figure 6**), the potentiometric surface measured during the field exploration extends up to 18 feet into the ash. Based on the results of modeling discussed in **Section 5.2.2**, limiting infiltration through the ash will have minimal effect on the water level within the basin post-closure. This scenario would not meet the requirements of the SCDHEC Solid Waste Management: Solid Waste Landfills and Structural Fill Regulations for a Class 3 Landfill R-61-107.19 Part V (Class 3 Regulations) or the CCR Rule. For this reason, the Hybrid Cap-in-Place closure option has been eliminated from further consideration.

6.3 On-Site Landfill Ash Basin Closure Option

Under this option, ash and impacted soil from the ash basin and the 1960 Fill Area would be relocated to a new, on-site lined ash landfill and closed with an engineered cap system to reduce infiltration through the ash and underlying materials, thereby limiting potential for future migration of CoCs. Regrading of the ash basin and 1960 Fill Area would be required after ash and impacted soil removal to ensure that positive drainage is maintained, to eliminate ponding, and to ensure the final surface can be maintained without excessive erosion. Soil from the decommissioned dam embankment could be used for final grading. Topsoil would also be placed over all regraded areas to encourage growth of vegetation. Fast-growing vegetation cover consisting of native grasses would initially be established to stabilize the excavated and regraded areas against erosion. Eventually, trees and/or shrubs would be planted or allowed to naturally populate these areas to reduce maintenance requirements.

The On-Site Landfill closure option would consist of the following:

- Construct a lined ash landfill with leachate collection system meeting the minimum bottom liner and final cover requirements for a SCDHEC Class 3 landfill within the area shown on **Drawing G-01.**
- Consolidate ash and impacted soils from the ash basin and 1960 Fill Area into the on-site landfill.
- Construct an engineered cover system (soil-geosynthetic) over the landfill.
- Re-use embankment soils from the ash basin dam for engineered cover system construction, if feasible.
- Establish a groundwater detection monitoring program for the ash landfill.
- Decommission the ash basin and dam embankment from the SCDHEC Dams and Reservoirs Safety Program jurisdiction.
- Establish vegetation within the post-closure ash basin area and 1960 Fill Area.
- Evaluate MNA for environmental closure of the ash basin area and 1960 Fill Area, provided environmental investigation results facilitate MNA as a remedy.

6.3.1 Physical Closure

Under this scenario, ash and soils mixed with ash from the ash basin and the 1960 Fill Area would be moved to an on-site lined ash landfill and capped with an engineered cover system designed to isolate and stabilize the ash within the landfill while providing a physical barrier to the environment.

The quantities of ash and impacted soil to be moved to the proposed on-site ash landfill and the quantity of clean cover soil required for cap construction were estimated and are provided in **Table 9**. Estimates of cut and fill required for landfill construction cannot be provided until a hydrogeological investigation is performed at the proposed ash landfill site. For cover soil estimation purposes, the footprint of the on-site landfill was estimated to be 56 acres. Unless specifically noted, the quantities are in-place (i.e., bank measure) quantities that do not include swell or shrinkage factors.

6.3.2 Environmental Closure

In this option, ash and soils mixed with ash will be moved to the lined on-site landfill. As such, the environmental closure then becomes more focused on long-term groundwater quality in the vicinity of the former ash basin. Based on the results of conceptual fate and transport modeling presented in **Section 5.2.2**, arsenic concentrations in groundwater will remain above the SCDHEC Primary MCL indefinitely. Based on modeling results, arsenic concentrations in groundwater entering the discharge canal may eventually exceed regulatory standards. More comprehensive modeling efforts are recommended to determine the need for and degree of active remediation required to restore arsenic levels in groundwater to acceptable levels.

6.3.3 Viability

The viability of this option is largely dependent upon the ability of the selected landfill site to support construction of a Class 3 landfill in accordance with Class 3 Regulations. Duke Energy Progress has identified a portion of the greater Robinson Plant property located northwest of the ash basin for on-site landfill suitability. Based on availability of land to construct a landfill and an initial evaluation of location restrictions (e.g., water well location survey, buffer restrictions), the On-Site Landfill closure option is deemed viable. Duke Energy Progress will further evaluate the suitability of the landfill site through the completion of a Preliminary Hydrogeologic Characterization Report and subsequent Hydrogeologic Characterization Report in accordance with the Class 3 Regulations.

6.4 Off-Site Landfill Ash Basin Closure Option

Under this option, ash and impacted soil from the ash basin and the 1960 Fill Area would be re-located to the off-site lined ash landfill, which would be closed with an engineered cap system to reduce infiltration through the ash and underlying materials thereby limiting potential for future migration of CoCs. Regrading of the ash basin and 1960 Fill Area would be required after ash and impacted soil removal to ensure that positive drainage is maintained to eliminate ponding and to ensure the final surface can be maintained without excessive erosion. Soil from the decommissioned dam embankment could be used for final grading. Topsoil would also be placed over all regraded areas to encourage the growth of vegetation. Fast-growing vegetation cover consisting of native grasses would initially be established to stabilize the excavated and regraded areas against erosion. Eventually, trees and/or shrubs would be planted or allowed to naturally populate these areas to reduce maintenance requirements.

Removal of ash and impacted soils from the ash basin and 1960 Fill Area and placement within a new off-site lined ash landfill was evaluated by AMECFW in their *Waste Strategy Analysis* report. During their work, AMECFW identified 11 potential properties between 7 and 14.2 miles from the Robinson Plant ash basin that meet the majority of landfill siting criteria, as identified in Section 1.5 of their report.

6.4.1 Physical Closure

Under this scenario, ash and impacted soils from the ash basin and the 1960 Fill Area would be moved to an off-site ash landfill and capped with an engineered cover system designed to isolate and stabilize the ash within the landfill while providing a physical barrier to the environment.

The quantities of ash and impacted soil to be moved to the proposed off-site ash landfill and the quantity of clean cover soil required for cap construction were estimated and are provided in **Table 9**. Estimates of cut and fill required for landfill construction cannot be provided until a hydrogeological investigation is performed at the proposed ash landfill site. For cover soil estimation purposes, the footprint of the off-site landfill was assumed to be 56 acres. Unless specifically noted, the quantities are in-place (i.e., bank measure) quantities that do not include swell or shrinkage factors.

6.4.2 Environmental Closure

Similar to the On-Site Landfill option, environmental closure for this option is focused on long-term groundwater quality in the vicinity of the former ash basin. Please refer to **Section 6.3.2** for a more detailed discussion of the environmental closure considerations.

6.4.3 Viability

Removal of ash from the Robinson Plant for off-site disposal has the potential to expose the public and environment due to transport of the ash along public roads. Given that Duke Energy Progress owns property of sufficient size to develop an on-site ash landfill and construct an on-site haul road, the Off-Site Landfill closure option has been eliminated from further consideration.

7.0 Selected Ash Basin Closure Option

In correspondence dated April 30, 2015, Duke Energy Progress informed SCDHEC of its decision to pursue further evaluation of the construction of an on-site lined ash landfill to permanently close the existing ash basin and 1960 Fill Area. The decision was based on the viability of this option to be most protective of groundwater, public heath, and environmental safety. The landfill is planned to be designed and constructed such that it is compliant with Class 3 Regulations and the USEPA's CCR Rule.

Since the date of notification, Duke Energy Progress has contracted HDR to provide engineering services associated with site suitability and design of the new landfill. As of the date of this report, Duke Energy Progress has submitted the Preliminary Hydrogeologic Characterization Report to SCDHEC and has begun the field investigation portion of work to evaluate the landfill site. Preliminary conceptual design drawings showing existing conditions, proposed grading in the 1960 Fill Area, and layout of the on-site Class 3 landfill are provided in **Appendix F**.

7.1 Preliminary Landfill Geometry

Preliminary design of the landfill estimates a 56-acre conceptual footprint with 4:1 side slopes and a top slope of 8% to an approximate top elevation of 75 feet above ground surface. Based on existing site conditions (e.g., buffer setbacks and utility corridors), stormwater management areas may be located on the northern and eastern sides of the containment unit. Leachate management may also be situated north of the containment unit.

7.2 Standard Design Details

Duke Energy Progress proposes to construct the new on-site lined landfill in accordance with Class 3 Regulations and the USEPA CCR Rule. Typical design details are provided below to provide a preliminary concept of the landfill design; however, it is important to note that the standard design details will be refined and amended as the landfill site exploration and design progresses.

7.2.1 Base Liner System

A composite base liner system has been selected that consists of three components: a geomembrane liner, geosynthetic clay liner, and a compacted clay liner. The geomembrane liner will be installed above and in uniform contact with a geosynthetic clay liner overlying a compacted clay liner. Currently, the compacted clay liner is specified as having a minimum thickness of 18 inches (0.46 meter) and a permeability of no more than 1.0×10^{-5} centimeters per second (or similar).

7.2.2 Leachate Management System

Liquid in the ash or stormwater that comes in contact with the ash is considered leachate. The general leachate management system for the proposed landfill includes the collection, storage, treatment, and disposal of the leachate generated. The collection of leachate will be facilitated within the landfill by use of a series of interconnected perforated and solid HDPE pipe laterals and headers designed to hydraulically convey leachate to a sump area along with a

geocomposite that covers the geomembrane barrier layer. A pump will be used to convey leachate from the sump to a leachate storage tank, proposed to be located north of the containment unit, or pumped directly to a sanitary sewer.

Clean-out riser pipes will be provided for each lateral and header to allow for periodic cleaning and maintenance. The leachate collection system will likely be designed to manage a 25-year, 24-hour storm event during an open subcell condition.

7.2.3 Cap System

The proposed components of the final soil and geomembrane cap system will be as follows from the top down.

- 6-inch thick topsoil layer
- 12-inch thick low permeable soil layer
- 18-inch thick unclassified soil layer
- 12-inch thick drainage soil layer
- 40-mil-thick polyethylene geomembrane

7.2.4 Stormwater Segregation Features

To minimize leachate generation during initial filling, stormwater will be segregated by using subcell divider berms, pipes, and a rain flap over the divider berms, if necessary. The subcell divider berms will be sized to manage a 25-year 24-hour storm. The stormwater that is collected in the subcells will be pumped out to the perimeter channel. Stormwater that is in contact with the ash will be collected and handled as leachate. As filling progresses, the areas where ash has reached final grade will be covered with intermediate cover soil to minimize leachate generation.

8.0 Schedule

The overall ash basin closure schedule is governed by the Consent Agreement and USEPA's CCR Rule. In accordance with the Consent Agreement, Duke Energy Progress will submit an application to construct a Class 3 solid waste disposal facility to the SCDHEC no later than April 1, 2016. Intermediate and post-application milestone dates are provided in the table below.

Task	Estimated Completion Date
Submit Preliminary Hydrogeologic Characterization Report to SCDHEC	August 25, 2015 (Complete)
Submit Piezometer Installation Work Plan to SCDHEC	August 25, 2015 (Complete)
Submit Determination of Need to SCDHEC	October 29, 2015 (Complete)
Piezometer Installation for Site Hydrogeologic Characterization	October 24, 2015 (Complete)
Submit Piezometer Installation Report to SCDHEC	November 20, 2015
Submit Revised Conceptual Closure Planning Update to SCDHEC	November 20, 2015
Submit Hydrogeologic Characterization Report to SCDHEC	December 24, 2015
Issue Notice of Filing of Permit Application	March 17, 2016
Submit Class 3 Landfill Permit Application to SCDHEC	March 21, 2016
Dam Decommissioning	Ongoing
Commence construction of Class 3 landfill, submit Ash Removal Plan and Health and Safety Plan to SCDHEC	Within 90 days of receiving final non-appealable permit to construct
Complete disposal of ash in Class 3 landfill	July 17, 2023
Submit Ash Removal Report to SCDHEC	Upon completion of ash removal work
Submit Assessment Plan to SCDHEC for delineation of extent of contamination	Within 30 days of submittal of Ash Removal Report
Submit Assessment Report to SCDHEC	Within 60 days of submittal of Assessment Plan
Submit Closure Plan and Remedial Plan (if necessary) to SCDHEC	Within 60 days of submittal of Assessment Report
Implement Closure Plan and Remedial Plan (if necessary) to SCDHEC	Within 45 days of SCDHEC approval of plans
Submit monthly progress reports to SCDHEC	Ongoing; within 30 days of execution of Consent Agreement

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25. U.S. Environmental Protection Agency. 1995. RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities. EPA/600/R-95/051.
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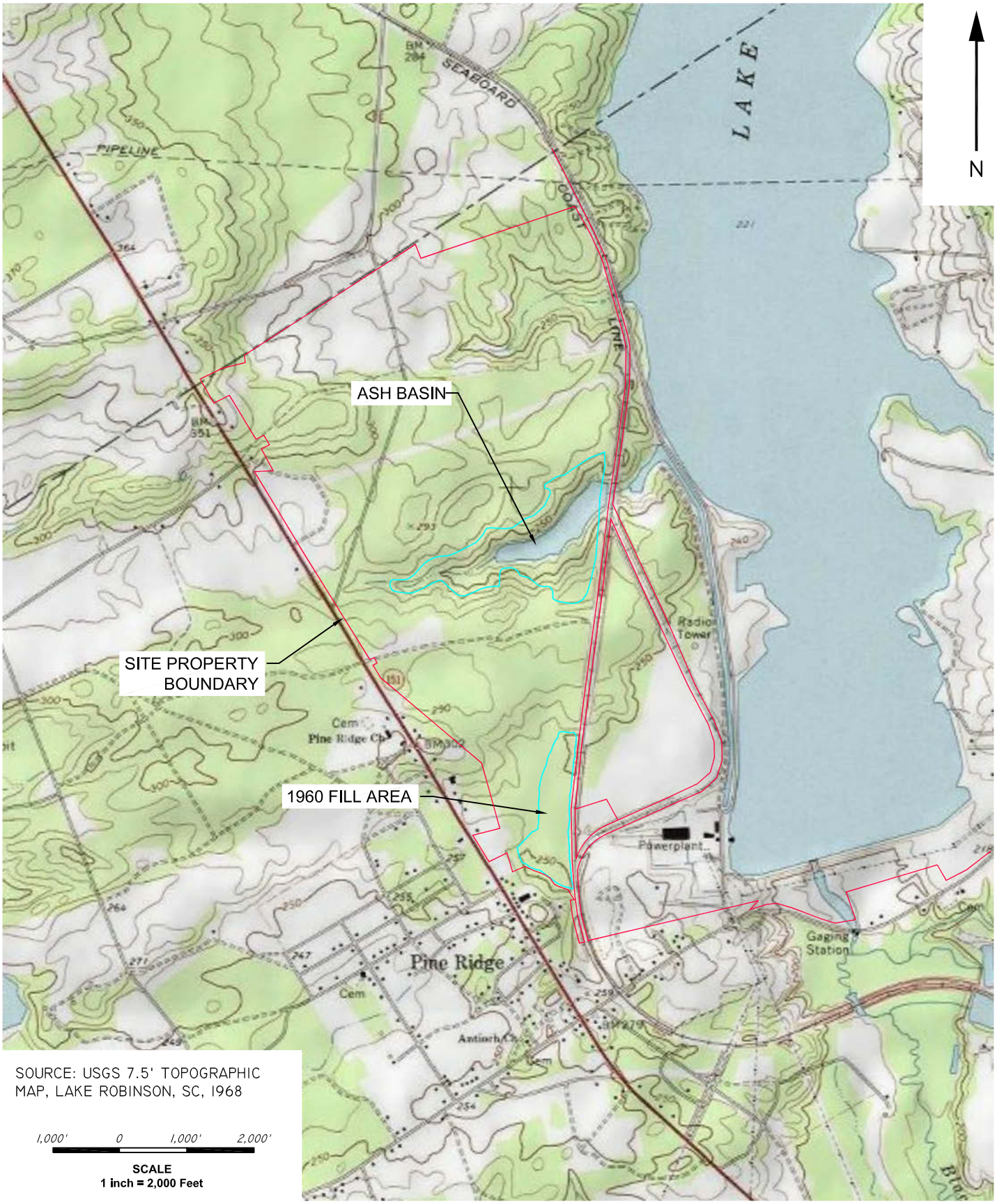
Figures



SITE LOCATION MAP
H.B. ROBINSON STEAM ELECTRIC PLANT
DUKE ENERGY PROGRESS
DARLINGTON COUNTY, SOUTH CAROLINA

DATE
DECEMBER 17, 2014

FIGURE
1

SCALE (FEET)
300' 0 300' 600'
1" = 600'

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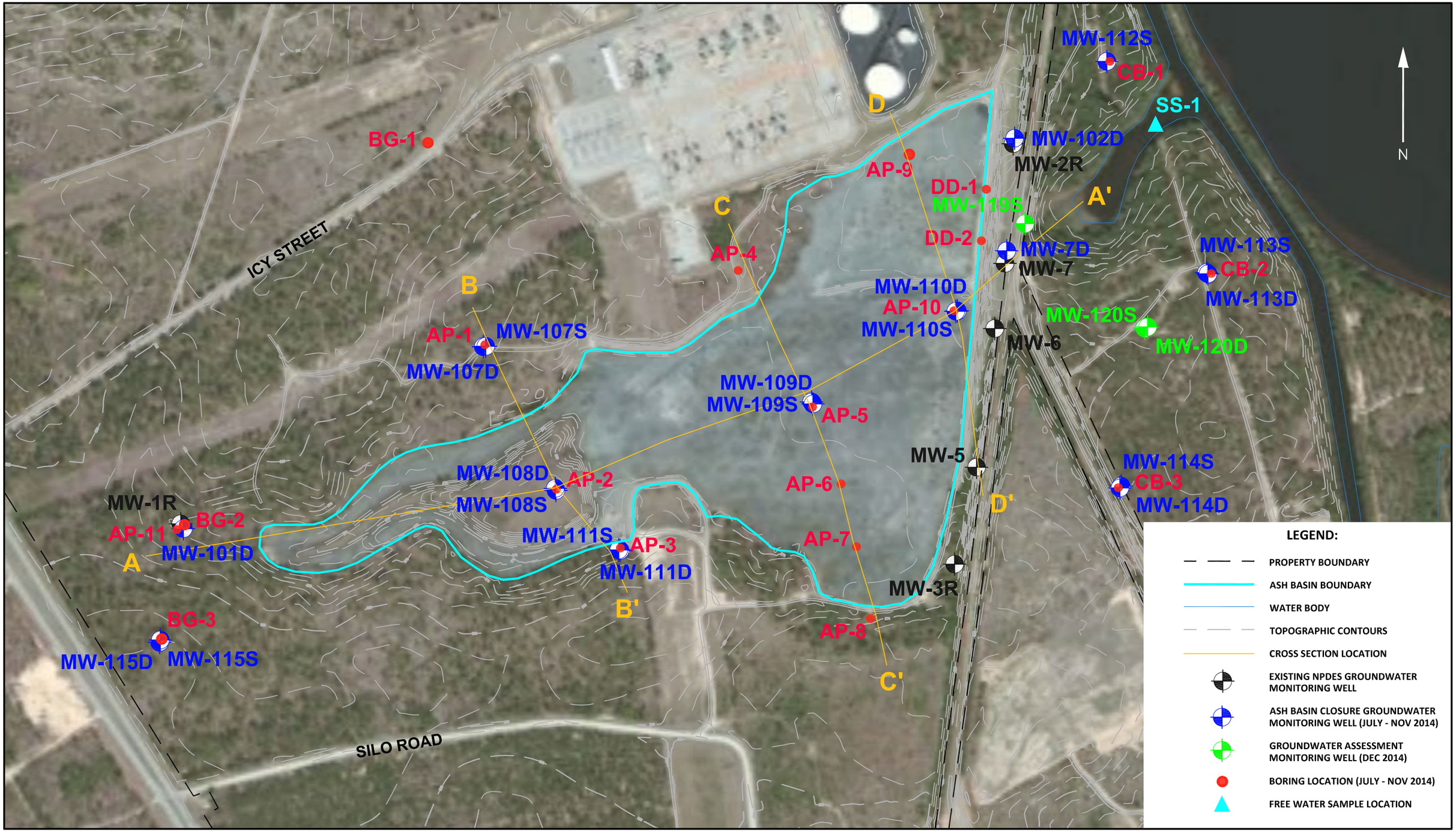
SITE LAYOUT MAP
ASH BASIN CLOSURE
DUKE ENERGY PROGRESS
ROBINSON PLANT - ASH BASIN CLOSURE PROJECT
DARLINGTON COUNTY, SOUTH CAROLINA

DATE
12/10/2014

FIGURE
2



SCALE (FEET)
200' 0 200' 400'
1" = 400'

HDR
North Carolina Engineering Firm Number: F-0116
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MONITORING WELL AND BORING LOCATION MAP
ASH BASIN CLOSURE (ASH BASIN)
DUKE ENERGY PROGRESS
ROBINSON PLANT - ASH BASIN CLOSURE PROJECT
DARLINGTON COUNTY, SOUTH CAROLINA

DATE
11/13/2015

FIGURE
3

SCALE (FEET)

200' 0 200' 400'

1" = 400'

HDR

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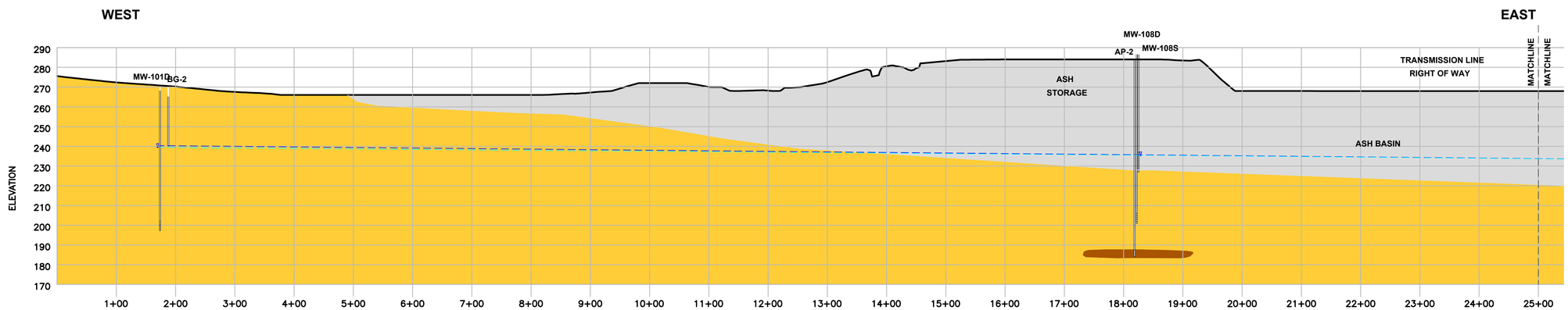
440 South Church Street Charlotte, NC 28202

WELL AND BORING LOCATION MAP
ASH BASIN CLOSURE (1960 FILL AREA)
DUKE ENERGY PROGRESS
ROBINSON PLANT - ASH BASIN CLOSURE PROJECT
DARLINGTON COUNTY, SOUTH CAROLINA

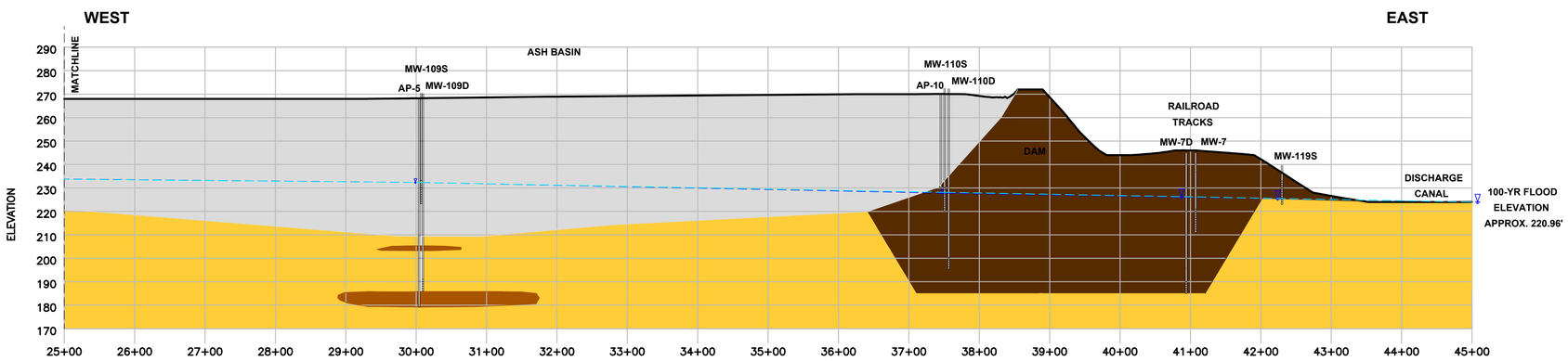
DATE
12/17/2014

FIGURE
4



SECTION A–A' (1 of 2)

HORIZONTAL: 1"=100'; VERTICAL: 1"=30'



SECTION A–A' (2 of 2)

HORIZONTAL: 1"=100'; VERTICAL: 1"=30'

LEGEND:

- EXISTING LAND SURFACE
- WATER TABLE SURFACE (FALL 2014)
- WATER TABLE SURFACE (WINTER 2015)
- ASH
- FILL
- UNCONSOLIDATED SEDIMENTS
- DISCONTINUOUS CLAY LENS

NOTES:

1. SEE FIGURE 3 FOR CROSS SECTION LOCATIONS.
2. EXISTING LAND SURFACE BASED ON TOPOGRAPHIC SURVEY PERFORMED BY WSP IN JULY 2014.
3. LITHOLOGY SHOWN IS ESTIMATED BASED ON BORING DATA OBTAINED DURING THE JULY AND AUGUST 2014 CLOSURE INVESTIGATION ACTIVITIES.

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STRUCTURAL	
PLUMBING	
ELECTRICAL	
DRAWN BY	C. HEARN, P.E.
PROJECT NUMBER	011237-243758-.012

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Duke Energy Progress

Robinson Plant
Ash Basin Closure Project

DARLINGTON COUNTY SOUTH CAROLINA

CROSS SECTION A-A'
EXISTING CONDITIONS

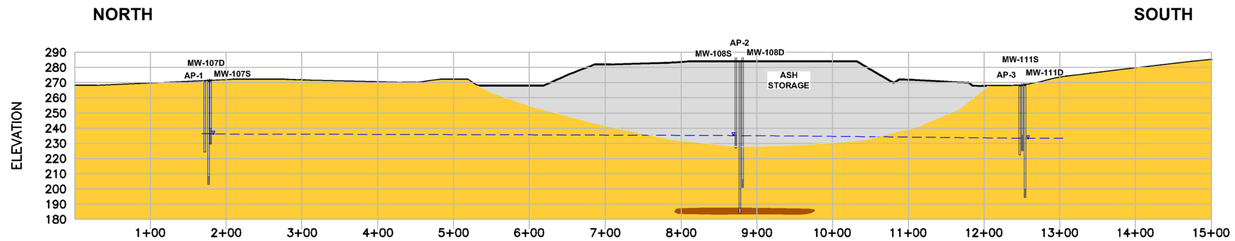
0 1" 2"

FILENAME 01C-04.DWG

SCALE AS SHOWN

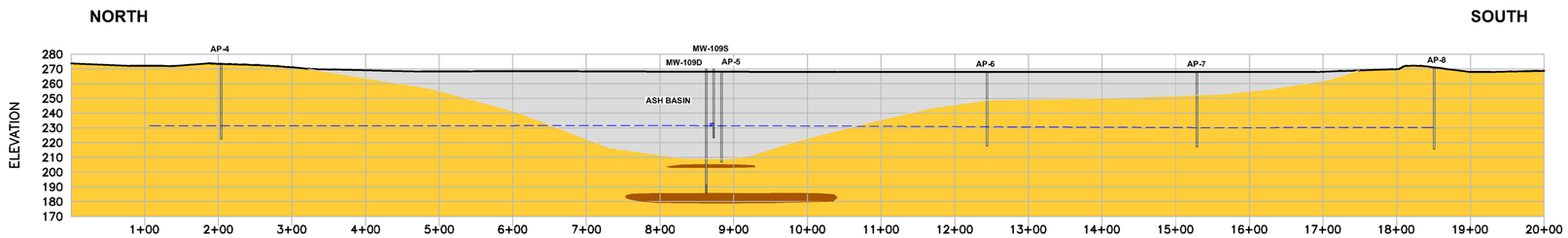
SHEET

FIGURE 5A



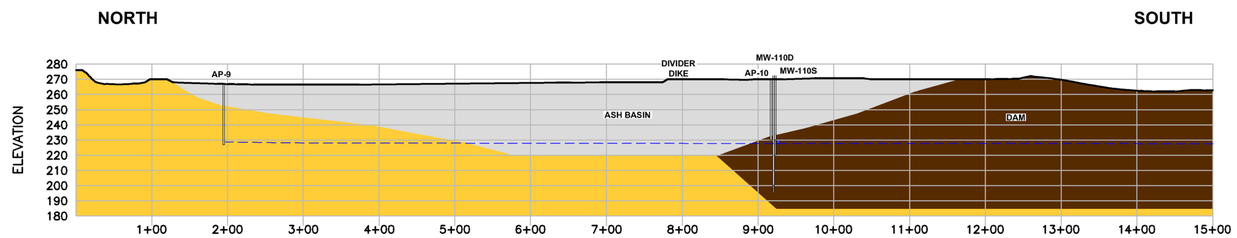
SECTION B–B'

HORIZONTAL: 1"=100'; VERTICAL: 1"=50'



SECTION C–C'

HORIZONTAL: 1"=100'; VERTICAL: 1"=50'



SECTION D–D'

HORIZONTAL: 1"=100'; VERTICAL: 1"=50'

LEGEND:

- EXISTING LAND SURFACE
- WATER TABLE SURFACE (ESTIMATED)
- ASH
- FILL
- UNCONSOLIDATED SEDIMENTS
- DISCONTINUOUS CLAY LENS

NOTES:

1. SEE FIGURE 3 FOR CROSS SECTION LOCATIONS.
2. EXISTING LAND SURFACE BASED ON TOPOGRAPHIC SURVEY PERFORMED BY WSP IN JULY 20 14.
3. LITHOLOGY SHOWN IS ESTIMATED BASED ON BORING DATA OBTAINED DURING THE JULY AND AUGUST 2014 CLOSURE INVESTIGATIO N ACTIVITIES.
4. WATER TABLE SURFACE SHOWN IS APPROXIMATE AND BASED ON MONITORING WELL WATER ELEVATIONS MEASURED ON NOVEMBER 17, 2014.

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Ash Basin Closure Project

DARLINGTON COUNTY SOUTH CAROLINA

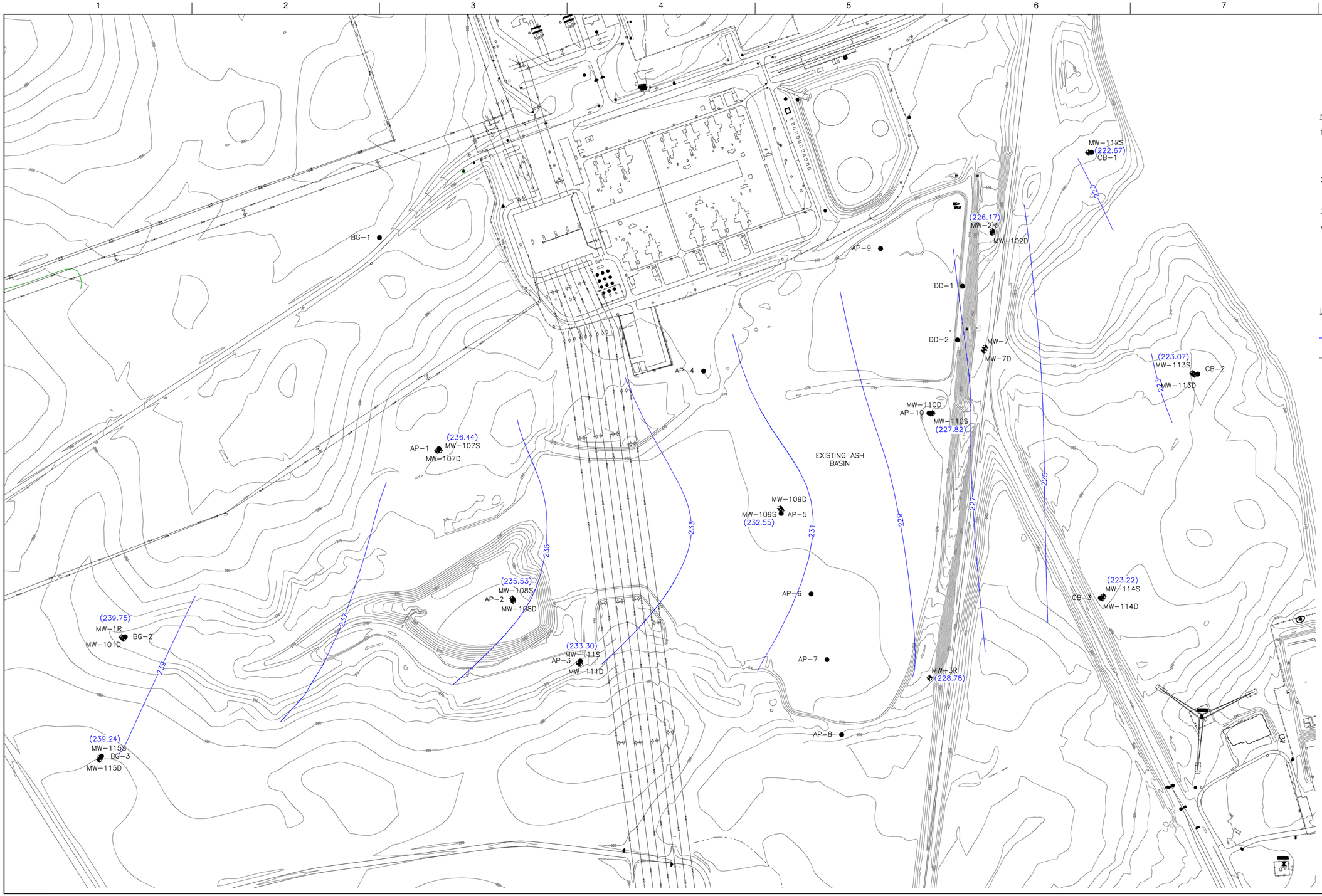
CROSS SECTIONS B-B', C-C' AND D-D'

0 1" 2"

FILENAME 01C-04.DWG
SCALE AS SHOWN

SHEET
FIGURE 6

C:\pwworking\tpa\d0539781\01C-04.dwg, Plot-2, 12/20/2014 2:07:01 PM, chearn



NOTES:

1. BASE MAP PROVIDED BY WSP TRANSPORTATION AND INFRASTRUCTURE DATED NOVEMBER 13, 2014 BASED ON PHOTOGRAMMETRIC MAPPING COLLECTED ON JULY 27, 2014.
2. ALL DISTANCES ARE HORIZONTAL GROUND DISTANCE IN U.S. SURVEY FEET UNLESS OTHERWISE NOTED.
3. BASIS OF BEARINGS: NAD83.
4. VERTICAL DATUM: NAVD88.

LEGEND

229 — GROUNDWATER CONTOUR (APPROXIMATE)

OVERHEAD UTILITY LINES

UTILITY POLE

MW-115S — MONITORING WELL

(232.55) — GROUNDWATER ELEVATION

HDR

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ELECTRICAL	
DRAWN BY	C. HEARN, P.E.
PROJECT NUMBER	011237-243758-012

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DARLINGTON COUNTY SOUTH CAROLINA

POTENTIOMETRIC SURFACE MAP
ASH BASIN
NOVEMBER 17, 2014

0 1" 2"

FILENAME 01C-03.dwg

SCALE 1" = 200'

SHEET

FIGURE 7

C:\pwworking\tpa\d0539781\01C-03.dwg, Plot, 12/20/2014 2:20:22 PM, cheam

N

NOTES:

1. BASE MAP PROVIDED BY WSP TRANSPORTATION AND INFRASTRUCTURE DATED NOVEMBER 13, 2014 BASED ON PHOTOGRAMMETRIC MAPPING COLLECTED ON JULY 27, 2014.
2. ALL DISTANCES ARE HORIZONTAL GROUND DISTANCE IN U.S. SURVEY FEET UNLESS OTHERWISE NOTED.
3. BASIS OF BEARINGS: NAD83.
4. VERTICAL DATUM: NAVD88.
5. LIMITS OF 1960 FILL AREA OBTAINED FROM DRAWING ENTITLED 'ROBINSON STEAM PLANT LAY OF LAND AREA ASH THICKNESS ISOPACH' DATED AUGUST 20, 2014 BY AMEC ENVIRONMENT AND INFRASTRUCTURE.

LEGEND

229	GROUNDWATER CONTOUR (APPROXIMATE)
	OVERHEAD UTILITY LINES
	UTILITY POLE
MW-105S	MONITORING WELL
(226.30)	GROUNDWATER ELEVATION
	APPROXIMATE LIMITS OF ASH (SEE NOTE 5)

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STRUCTURAL	
PLUMBING	
ELECTRICAL	
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PROJECT NUMBER	011237-243758-012

NOT FOR CONSTRUCTION

DUKE ENERGY.

Duke Energy Progress

Robinson Plant
Ash Basin Closure Project

DARLINGTON COUNTY SOUTH CAROLINA

POTENTIOMETRIC SURFACE MAP
1960 FILL AREA
NOVEMBER 17, 2014

0 1" 2"

FILENAME 01C-03.dwg
SCALE 1" = 200'

SHEET
FIGURE 8

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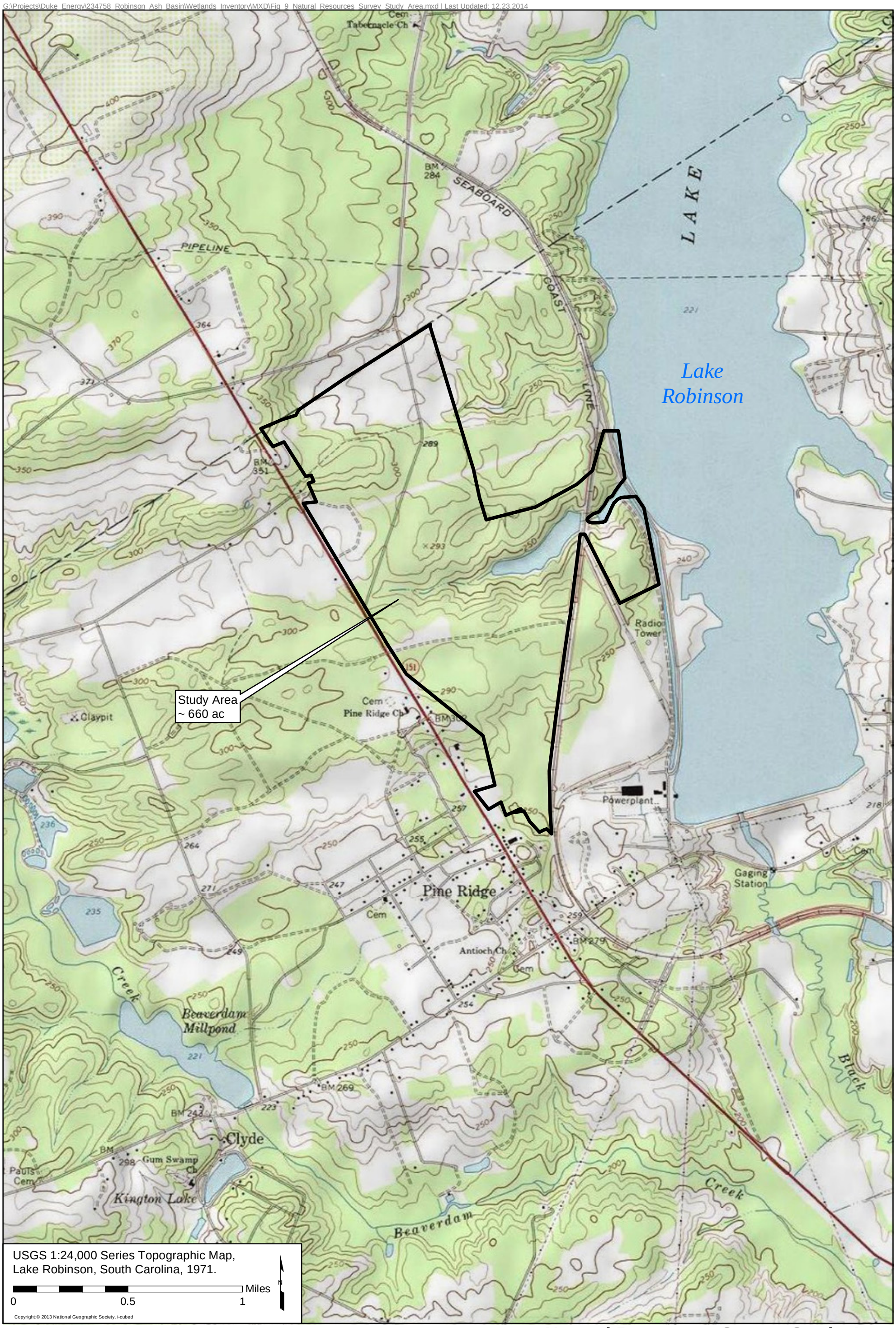
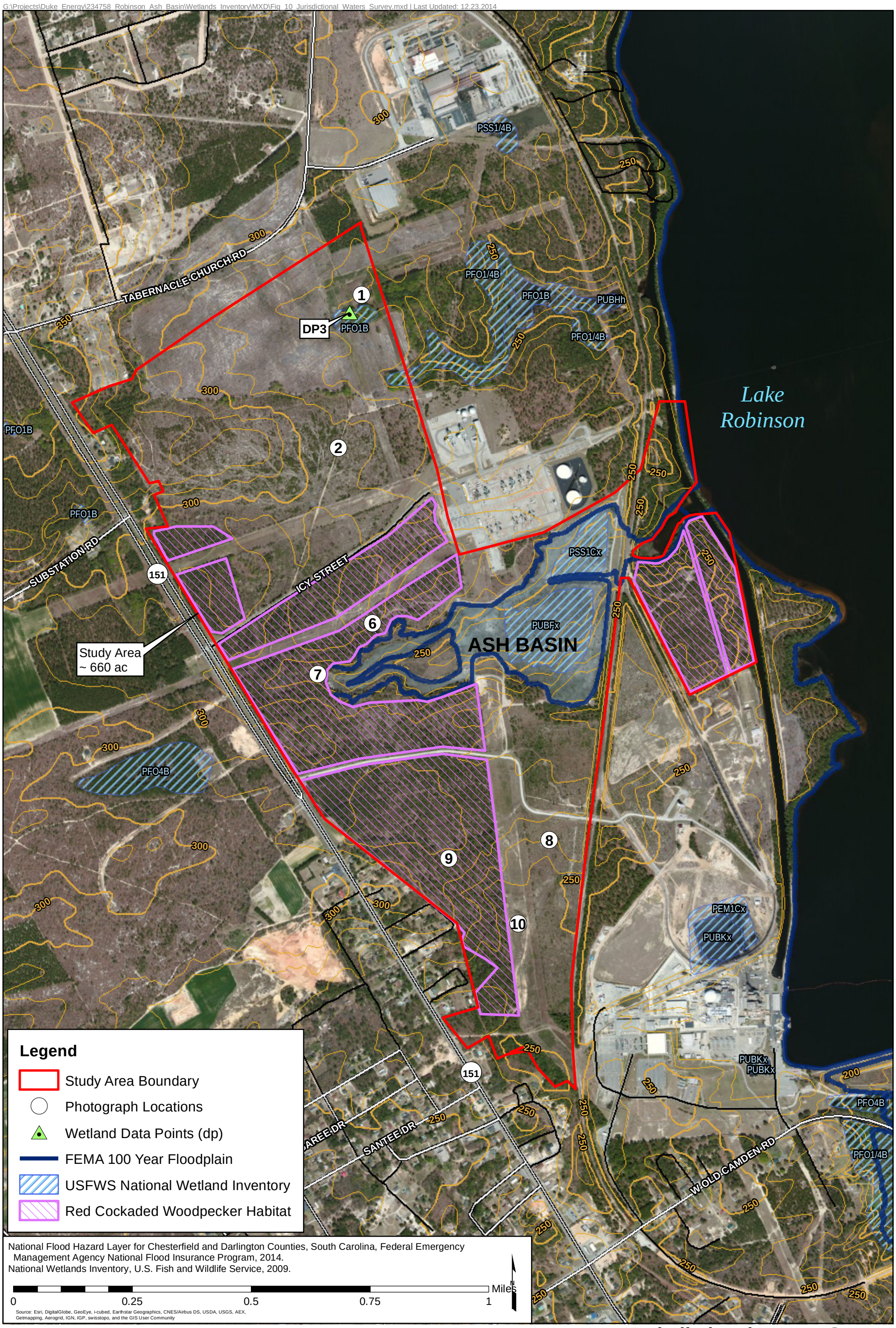


Natural Resources Survey Study Area

Figure 9

G:\Projects\Duke_Energy\234758_Robinson_Ash_Basin\Wetlands_Inventory\MXD\Fig_10_Jurisdictional_Waters_Survey.mxd | Last Updated: 12.23.2014



Jurisdictional Waters Survey

Figure 10

Tables

Table 1. Well construction and groundwater elevation data summary

Well Location	Well ID	Well Depth (ft bgs) [1]	Screen Interval (ft bgs) [1]	Ground Elevation (ft)	Top of Casing Elevation (ft)	Depth to Water (ft below TOC)	Water Elevation (ft)
Ash Basin Closure Monitoring Wells	MW-7D	60	55-60	242.94	245.06	18.69	226.37
	MW-101D	71	66-71	265.67	268.19	28.44	239.75
	MW-102D	85	80-85	253.75	256.34	30.09	226.25
	MW-107S	40.5	30.5-40.5	270.32	273.19	36.75	236.44
	MW-107D	67	62-67	270.14	273.14	36.73	236.41
	MW-108S	57	47-57	283.97	286.47	50.94	235.53
	MW-108D	83	78-83	283.85	286.36	51.51	234.85
	MW-109S	45	35-45	268.02	270.33	37.78	232.55
	MW-109D	82	77-82	268.08	270.29	38.87	231.42
	MW-110S	50	40-50	270.17	272.51	44.69	227.82
	MW-110D	75	70-75	270.40	272.37	44.74	227.63
	MW-111S	42	32-42	267.14	269.54	36.24	233.30
	MW-111D	73	68-73	267.38	269.67	36.04	233.63
	MW-112S	25	15-25	240.49	243.73	21.06	222.67
	MW-113S	37	27-37	252.68	255.16	32.09	223.07
	MW-113D	69	64-69	252.76	255.75	32.91	222.84
	MW-114S	37	27-37	254.81	257.53	34.31	223.22
	MW-114D	68	63-68	254.93	257.44	33.71	223.73
	MW-115S	50.5	40.5-50.5	286.19	288.67	49.43	239.24
	MW-115D	77	72-77	286.09	288.73	49.70	239.03
1960 Fill Area Monitoring Wells	MW-105S	35	25-35	254.86	256.86	29.08	227.78
	MW-105D	66	61-66	254.72	256.81	29.16	227.65
	MW-106S	34	24-34	253.53	255.84	29.23	226.61
	MW-106D	65	60-65	253.66	256.13	29.54	226.59
	MW-116S	34	24-34	255.07	257.51	28.82	228.69
	MW-116D	65	60-65	255.17	257.53	29.02	228.51
	MW-117S	32	22-32	252.66	255.33	26.08	229.25
	MW-117D	65	60-65	252.60	255.30	26.36	228.94
	MW-118S	25	15-25	244.71	246.82	20.52	226.30
	MW-118D	54	49-54	244.70	246.98	20.76	226.22
Existing Ash Basin Monitoring Wells [1]	MW-1R	36	26-36	265.25	267.55	27.80	239.75
	MW-2R	42.5	32.5-42.5	254.14	256.85	30.68	226.17
	MW-3R	69	59-69	277.22	280.34	51.56	228.78
	MW-5	39	29-39	--	--	--	--
	MW-6	49	39-49	--	--	--	--
	MW-7	34	24-34	--	--	19.44	--

Notes:

1. Existing ash basin groundwater monitoring well depths and screen intervals are measured from top of casing.
2. ft bgs indicates feet below ground surface.
3. TOC indicates top of well casing.
4. Water elevation measurements for all monitoring wells except MW-5 and MW-6 were gauged by HDR personnel on November 17, 2014.
5. Water elevation measurements for existing monitoring wells MW-5 and MW-6 were gauged by HDR personnel on July 15, 2014.
6. Elevations based on vertical datum NAVD88.

Table 2A. Geotechnical laboratory testing quantities by sample type and test method

Laboratory Test	Standard	Number Of Tests
Sieve Analysis (Mechanical Only)	ASTM D422	17
Sieve Analysis (With Hydrometer)	ASTM D422	7
Specific Gravity	ASTM D854	8
Atterberg Limits	ASTM D4318	10
Natural Moisture Content Determination	ASTM D 2216	18
Cu Triaxial Compression Test (3 Confining Stresses)	ASTM D4767	1
Hydraulic Conductivity	ASTM 5084	4

Table 2B. Geotechnical laboratory results summary – soil classifications

TB #	SAMPLE #	DEPTH (ft)	USCS LABORATORY DESCRIPTION	USCS CLASS	AASHTO CLASS	LL	PL	PI	NMC (%)	Gs	USCS GRAIN SIZE DISTRIBUTION							D60	D50	D30	D10
											GRAVEL		SAND			FINES	FINES				
											3"<%<3/4"	*3/4"<%<#4*	*#4<%<#10*	*#10<%<#40*	*#40<%<#200*	*<#200*	*<#200*				
											COARSE GRAVEL (%)	FINE GRAVEL (%)	COARSE SAND (%)	MED SAND (%)	FINE SAND (%)	SILT (%)	CLAY (%)				
AP-1	S-3	6' - 7.5'	Poorly Graded SAND with Silt	SP-SM	A-2-4(0)	NV	NP	NP	5.3	-	0	0	0.1	29.3	59.7	10.9		0.35	0.29	0.18	-
AP-2	S-4	18.5' - 20'	Poorly Graded SAND with Silt	SP-SM	A-1-b	NV	NP	NP	13.7	-	0	0	0.6	59.9	28.6	10.9		0.63	0.53	0.30	-
	S-8	98.5' - 100'	Fat CLAY	CH	A-7-6(32)	54	24	30	21.7	2.573	0	0	0	1.7	3.7	17.3	77.3	0.00	0.00	-	-
AP-3	S-7	23.5' - 25'	Fat CLAY with Sand	CH	A-7-6(23)	54	25	29	24.0	2.621	0	0	0	7.7	16.7	9.3	66.3	0.00	-	-	-
AP-4	S-4	8.5' - 10'	Poorly Graded SAND with Silt	SP-SM	A-3	NV	NP	NP	5.6	-	0	0	0	27.5	63.5	9		0.30	0.23	0.15	0.08
	S-6	18.5' - 20'	Sandy Lean CLAY	CL	A-6(4)	31	18	13	18.1	2.62	0	0	0.2	8.3	38	24	29.5	0.09	0.07	0.01	-
	S-9	33.5' - 35'	Silty, Clayey SAND	SC-SM	A-2-4(0)	22	15	7	12.8	2.647	0	0	3.4	59.6	23.7	0.5	12.8	0.78	0.62	0.33	-
	S-12	48.5' - 50'	Poorly Graded SAND	SP	A-1-b	NV	NP	NP	16.2	-	0	0	1.3	71.6	24.2	2.9		0.63	0.57	0.44	0.24
AP-5	S-2	63.5' - 65'	Sandy Lean CLAY	CL	A-4(4)	28	18	10	24.0	-	0	0	0.3	28.2	6.9	64.6		-	-	-	-
	S-6	87.4' - 88.8'	Lean CLAY	CL	A-7-6(20)	43	22	21	19.7	2.631	0	0	0	0.1	9	39.8	51.1	0.01	0.00	0.00	-
AP-8	S-2	3.5' - 5'	Poorly Graded SAND with Silt	SP-SM	A-3	NV	NP	NP	2.2	2.631	0	0	0.1	33.4	57.6	8.9		0.36	0.28	0.17	0.08
AP-9	S-4	21' - 22.5'	Silty SAND	SM	A-2-4(0)	NV	NP	NP	4.5	-	0	0	0.1	1.8	85.5	12.6		0.17	0.15	0.12	-
AP-11	S-4	8.5' - 10'	Silty SAND	SM	A-2-4(0)	NV	NP	NP	22.6	-	0	0	0.4	38.1	47.8	13.7		0.41	0.32	0.18	-
	S-11	43.5' - 45'	Poorly Graded SAND with Silt	SP-SM	A-1-b	NV	NP	NP	18.7	-	0	0	0.3	57.6	36.4	5.7		0.55	0.48	0.34	0.17
DD-1	S-9	33.5' - 35'	Silty SAND	SM	A-2-4(0)	NV	NP	NP	13.3	-	0	0	0.3	23.2	43.7	32.8		0.24	0.16	-	-
	S-12	48.5' - 50'	Lean CLAY with Sand	CL	A-4(6)	27	17	10	25.2	2.642	0	0	0	0.7	23.8	50.7	24.8	0.04	0.03	0.01	-
DD-2	S-9	38.5' - 40'	Silty SAND	SM	A-2-4(0)	NV	NP	NP	12.9	-	0	0	0.3	21.5	48.1	30.1		0.23	0.16	-	-
DD-2	S-13	70' - 71.5'	Poorly Graded SAND with Silt	SP-SM	A-1-b	NV	NP	NP	19.8	-	0	0	1.7	77.7	14.8	5.8		0.67	0.61	0.49	0.18
AP-10	UD #2 (top 6")	36' - 38'	Well Graded SAND with Silt	SW-SM	A-1-b	NV	NP	NP	-	-	0	0.2	21.6	58.6	12.6	7		1.43	1.21	0.79	0.15
	UD #2 (middle 6")	36' - 38'	Clayey SAND	SC	A-2-6(0)	37	19	18	-	-	0	0	6.5	64.1	10.2	19.2		1.07	0.90	0.45	-
	UD #2 (bottom 6")	36' - 38'	Lean CLAY with Sand	CL	A-6(7)	31	19	12	-	2.623	0	0	0	4.4	21.2	29.7	44.7	0.02	0.01	0.00	-
AP-11A	UD	18.5' - 20'	Poorly Graded SAND with Silt	SP-SM	A-1-b	NV	NP	NP	-	-	0	0	1.2	83.3	9.6	5.9		0.95	0.82	0.60	0.16
DD-2	UD #1 (top 6")	23' - 24.5'	Poorly Graded SAND	SP					-	-	0	0	3.6	74.8	17.9	3.7		0.82	0.70	0.50	0.28
	UD #1 (bottom 6")	23' - 24.5'	Clayey SAND	SC	A-2-4(0)	22	14	8		-	0	0	1	34	40.9	24.1		0.37	0.27	0.11	-

Table 3A. Soil sampling results – background samples

Parameter	Units	Sample ID and Location														EPA Industrial SSL	MCL-Based EPA Protection of Groundwater SSL
		BG-1 (1-2')	BG-1 (10-11')	BG-1 (20-21')	BG-1 (30-31')	BG-2 (1-2')	BG-2 (10-11')	BG-2 (20-21')	BG-3 (1-2')	BG-3 (10-11')	BG-3 (20-21')	BG-3 (30-31')	BG-4 (1-2')	BG-4 (10-11')	BG-4 (20-21')		
		Northwest of Ash Basin				West of Ash Basin			West-Southwest of Ash Basin				West of Lay of Land Area				
Antimony	mg/kg	< 0.51	< 0.36	< 0.51	< 0.54	< 0.55	< 0.42	< 0.51	< 0.54	< 0.48	< 0.48	< 0.51	< 0.42	< 0.40	< 0.40	470	0.27
Arsenic	mg/kg	< 1.0	**0.81**	**1.2**	< 1.1	**1.2**	**1.4**	**2.1**	< 1.1	**1.8**	< 0.95	**1.1**	**1.3**	< 0.81	< 0.80	3.0	0.29
Barium	mg/kg	2.8	2.7	2.5	6.4	2.6	6.5	1.9	15.8	6.6	1.5	3.1	5.4	0.85	0.62	220,000	82
Beryllium	mg/kg	< 0.10	< 0.073	< 0.10	< 0.11	< 0.11	< 0.085	< 0.10	< 0.11	< 0.096	< 0.095	< 0.099	< 0.083	< 0.081	< 0.080	2,300	3.2
Boron	mg/kg	< 0.84	< 3.94	< 4.37	< 4.19	< 4.18	< 4.35	< 5.31	< 3.77	< 4.17	< 4.27	< 4.25	< 0.72	< 5.10	< 4.01	230,000	NE
Cadmium	mg/kg	< 0.10	< 0.073	< 0.10	< 0.11	< 0.11	< 0.085	< 0.10	< 0.11	< 0.096	< 0.095	< 0.099	< 0.083	< 0.081	< 0.080	NE	0.38
Chloride	mg/kg	< 13	< 11	< 11	< 11	< 10	< 11	< 13	< 10	< 11	< 11	< 11	< 11	< 13	< 10	NE	NE
Chromium	mg/kg	10.9	9.1	14.3	4.2	5.5	7.3	4.8	5.7	14.6	4.8	13.6	5.1	4.2	5.7	NE	180,000
Cobalt	mg/kg	< 0.51	< 0.36	< 0.51	< 0.54	< 0.55	0.48	< 0.51	< 0.54	< 0.48	< 0.48	< 0.5	< 0.42	< 0.40	< 0.40	350	NE
Copper	mg/kg	1.5	2.3	2.3	1.2	1.7	2.5	3.3	1.2	3.3	0.93	2.0	1.6	0.69	< 0.40	47,000	46
Iron	mg/kg	2890	4690	8620	3200	2330	5160	5580	2850	9540	2840	6450	3250	1100	1070	820,000	NE
Lead	mg/kg	1.3	1.2	2.4	1.1	1.1	1.8	1.4	1.7	3.2	1.4	1.3	0.67	< 0.40	0.49	800	14
Manganese	mg/kg	6.6	5.2	3.4	7.7	1.9	83.1	13.6	7.1	12.1	1.6	1.6	20.3	5.8	3.5	26,000	NE
Mercury	mg/kg	0.0050	< 0.0052	0.0097	< 0.0055	0.0070	0.010	0.0063	0.0080	0.015	< 0.0043	0.0082	0.0070	< 0.0029	0.0041	40	0.1
Molybdenum	mg/kg	< 0.51	< 0.36	< 0.51	< 0.54	0.59	< 0.42	< 0.51	< 0.54	0.73	< 0.48	0.53	< 0.42	< 0.40	0.66	5,800	NE
Nickel	mg/kg	2.3	0.44	0.51	< 0.54	< 0.55	1.2	0.62	0.91	1.5	0.52	0.62	1.2	< 0.40	< 0.40	22,000	NE
Selenium	mg/kg	< 1.0	< 0.73	< 1.0	< 1.1	< 1.1	< 0.85	< 1.0	< 1.1	< 0.96	< 0.95	< 1.0	< 0.83	< 0.81	< 0.80	5,800	0.26
Thallium	mg/kg	< 1.0	< 0.73	< 1.0	< 1.1	< 1.1	< 0.85	< 1.0	< 1.1	< 0.96	< 0.95	< 1.0	< 0.83	< 0.81	< 0.80	12	0.14
Zinc	mg/kg	1.3	< 0.73	1.1	< 1.1	1.6	3.3	1.5	1.8	3.0	< 0.95	1.3	2.5	< 0.81	< 0.80	350,000	NE
pH	SU	6.2	5.0	5.1	4.9	5.0	4.3	4.5	4.8	5.0	5.4	5.0	5.2	4.5	5.2	NE	NE

Notes:
1. Concentrations presented in milligrams per kilogram (mg/kg).
2. Screening levels from the Environmental Protection Agency (EPA) Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) dated May 2014.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater Soil Screening Level (SSL).
8. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.

Table 3B. Ash and soil sampling results – within ash basin boundary

Parameter	Units	Sample ID and Location																EPA Industrial SSL	MCL-Based EPA Protection of Groundwater SSL
		AP-2 (2-3')	AP-2 (40-42')	AP-5 (1-3')	AP-5 (31-34')	AP-6 4-6')	AP-6 (14-16')	AP-6 (24-26')	AP-7 (2-4')	AP-7 (11-13')	AP-7 (17-20')	AP-9 (1-2')	AP-9 (7-10')	AP-9 (13-16')	AP-10 (1-3')	AP-10 (28-30')	AP-10 (36-39')		
		West Portion of Ash Basin		Central Portion of Ash Basin					Southeast Portion of Ash Basin			Northeast Portion of Ash Basin			East Portion of Ash Basin				
Total Inorganics																			
Antimony	mg/kg	< 1.3	0.61	**0.63**	< 0.57	**1.6**	< 0.54	< 0.57	**0.66**	**0.82**	< 0.41	**1.1**	**2.8**	< 0.51	< 0.88	< 0.72	< 0.43	470	0.27
Arsenic	mg/kg	**254**	**195**	**63.7**	**53.9**	**122**	**83.5**	< 1.1	**89.3**	**87.5**	**1.7**	**54.4**	**94.0**	**5.2**	**52.6**	**66.1**	**0.86**	3.0	0.29
Barium	mg/kg	**786**	**342**	**550**	**566**	**429**	**332**	4.6	**389**	**350**	3.0	**149**	**273**	10.2	**696**	**743**	6.5	220,000	82
Beryllium	mg/kg	5.3	4.1	3.1	2.8	**3.8**	**3.3**	< 0.11	**3.9**	**4.2**	< 0.082	2.8	**4.7**	0.23	2.6	**3.2**	< 0.085	2,300	3.2
Boron	mg/kg	16.6	29.5	17.9	19.4	15.8	23.1	< 4.52	22.0	21.0	< 4.06	20.7	19.1	< 4.22	5.99	11.2	< 4.39	230,000	NE
Cadmium	mg/kg	0.90	0.55	0.15	0.17	**0.39**	0.26	< 0.11	0.33	0.31	< 0.082	0.24	0.33	< 0.10	0.29	0.21	< 0.085	NE	0.38
Chloride	mg/kg	< 12	< 16	< 12	< 14	< 14	< 15	< 12	< 14	< 15	< 11	14	< 14	< 11	< 12	< 13	< 11	NE	NE
Chromium	mg/kg	32.6	17.3	11.9	14.7	15.2	18.2	6.0	15.1	18.0	1.4	19.2	31.7	6.3	12.3	21.5	2.0	NE	180,000
Cobalt	mg/kg	NA	NA	7.2	5.9	8.0	7.7	< 0.57	10.0	9.4	< 0.41	11.2	19.3	< 0.51	7.3	6.4	< 0.43	350	NE
Copper	mg/kg	91.1	54.4	29.8	32.3	42.6	37.6	1.9	41.7	44.2	1.0	**51.7**	**81.7**	2.2	41.7	**46.1**	0.99	47,000	46
Iron	mg/kg	19100	7650	8880	9250	6310	5000	2230	6340	5580	595	5460	9960	3430	27500	22900	346	820,000	NE
Lead	mg/kg	30.6	17.4	11.6	10	**14.0**	**15.8**	0.95	**18.9**	**18.8**	0.69	**22.1**	**37.5**	1.4	9.2	10.6	1.7	800	14
Manganese	mg/kg	110	43.5	25.0	50.5	51.9	27.1	0.79	27.9	37.0	1.4	24.2	42.1	7.8	56.3	87.1	1.9	26,000	NE
Mercury	mg/kg	**0.48**	**0.10**	**0.10**	0.095	**0.15**	**0.30**	0.013	**0.18**	**0.26**	0.015	**0.25**	**0.46**	0.0070	0.092	0.050	< 0.0052	40	0.1
Molybdenum	mg/kg	6.4	3.2	3.2	3.4	5.1	2.3	< 0.57	7.5	4.2	1.7	5.4	8.2	2.3	5.9	4.4	2.3	5,800	NE
Nickel	mg/kg	31.1	16.0	13.5	12.8	15.7	15.3	< 0.57	19.0	18.2	< 0.41	22.4	37.8	1.5	17.8	22.2	< 0.43	22,000	NE
Selenium	mg/kg	**12.6**	**6.7**	**11.5**	**10.0**	**12.1**	**9.0**	< 1.1	**15.7**	**13.3**	< 0.82	**10.8**	**17.8**	**1.8**	**4.7**	**12.7**	< 0.85	5,800	0.26
Thallium	mg/kg	< 2.6	< 0.95	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.0	< 0.82	< 0.97	< 2.3	< 1.0	< 1.8	< 1.4	< 0.85	12	0.14
Zinc	mg/kg	53.4	26.7	14.8	15.1	22.7	21.2	< 1.1	27.9	26.5	< 0.82	28.6	49.0	4.3	16.2	46.7	< 0.85	350,000	NE
pH	SU	6.2	7.2	6.0	7.4	6.5	7.0	4.7	6.1	6.9	7.0	5.6	5.8	6.8	4.6	7.3	6.9	NE	NE
Radiological																			
Cesium-137	pCi/g	-0.0869 U	-0.069 U	0.0368 U	-0.0405 U	-0.121 U	0.000349 U	-0.0127 U	0.00662 U	0.0186 U	-0.0225 U	-0.0473 U	-0.0359 U	-0.00213 U	-0.00698 U	-0.0826 U	0.00835 U	NE	NE
Cobalt-60	pCi/g	0.082 U	0.0295 U	0.0284 U	-0.0014 U	0.0206 U	0.0135 U	0.00324 U	0.025 U	-0.0151 U	-0.0114 U	-0.00265 U	0.00441 U	0.0244 U	0.028 U	0.0632 U	-0.0284 U	NE	NE

Notes:

1. Concentrations presented in milligrams per kilogram (mg/kg) and pico Curie per gram (pCi/g).
2. Screening levels from the Environmental Protection Agency (EPA) Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) dated May 2014.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater Soil Screening Level (SSL).
8. **Bold and underline** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater SSL and EPA Industrial SSL.
9. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.
10. Grey highlighted columns indicate ash samples.
11. NA indicates not analyzed.
12. U qualifier indicates analyte was analyzed for, but not detected above the MDL, MDA, or LOD.

Table 3C. Soil sampling results – outside ash basin boundary

Parameter	Units	Sample ID and Location																EPA Industrial SSL	MCL-Based EPA Protection of Groundwater SSL
		AP-1 (30-31')	AP-3 (30-31')	AP-4 (30-31')	AP-8 (33-35')	DD-1 (14-15')	DD-1 (34-35')	DD-1 (39-40')	DD-2 (14-15')	DD-2 (39-40')	DD-2 (43-44')	CB-1 (5-6')	CB-1 (12-13')	CB-2 (5-6')	CB-2 (24-25')	CB-3 (5-6')	CB-3 (19-21')		
		Cross Gradient of Ash Basin				Crest of Ash Basin Dam						Down-gradient of Ash Basin							
Antimony	mg/kg	< 0.62	< 0.37	< 0.44	< 0.39	< 0.60	< 0.52	< 0.48	< 0.48	< 0.45	< 0.43	< 0.47	< 0.50	< 0.42	< 0.51	< 0.53	< 0.50	470	0.27
Arsenic	mg/kg	< 1.2	< 0.74	< 0.89	< 0.78	< 1.2	**2.2**	< 0.96	< 0.96	**2.7**	< 0.87	< 0.95	< 1.0	**0.98**	< 1.0	< 1.1	< 1.0	3.0	0.29
Barium	mg/kg	0.97	< 0.37	2.0	2.4	7.1	8.2	1.8	1.3	3.0	1.8	0.85	1.7	2.2	< 0.51	6.1	0.75	220,000	82
Beryllium	mg/kg	< 0.12	< 0.074	< 0.089	< 0.078	< 0.12	< 0.10	< 0.096	< 0.096	< 0.090	< 0.087	< 0.095	< 0.10	< 0.084	< 0.10	< 0.11	< 0.10	2,300	3.2
Boron	mg/kg	< 0.84	< 3.79	< 0.90	< 4.20	< 4.26	< 4.12	< 4.22	< 3.95	< 4.48	< 0.86	< 3.75	< 3.90	< 4.02	< 4.06	< 4.12	< 3.95	250,000	NE
Cadmium	mg/kg	< 0.12	< 0.074	< 0.089	< 0.078	< 0.12	< 0.10	< 0.096	< 0.096	< 0.090	< 0.087	< 0.095	< 0.10	< 0.084	< 0.10	< 0.11	< 0.10	NE	0.38
Chloride	mg/kg	< 13	< 10	< 14	< 11	< 11	< 11	< 11	< 10	< 11	< 13	< 10	< 10	< 10	< 10	< 11	< 10	NE	NE
Chromium	mg/kg	2.6	0.70	0.95	5.2	20.8	18.0	1.9	5.7	8.2	2.2	2.3	3.8	9.1	1.0	7.3	1.1	NE	180,000
Cobalt	mg/kg	< 0.62	< 0.37	< 0.44	< 0.39	< 0.60	< 0.52	< 0.48	< 0.48	< 0.45	< 0.43	< 0.47	< 0.50	< 0.42	< 0.51	< 0.53	< 0.50	350	NE
Copper	mg/kg	< 0.62	< 0.37	< 0.44	1.7	3.1	4.2	< 0.48	1.3	1.8	0.64	0.70	0.77	1.7	< 0.51	1.4	< 0.50	47,000	46
Iron	mg/kg	1860	390	175	2710	5220	11700	975	2930	4640	1150	1010	2000	4330	636	3770	590	820,000	NE
Lead	mg/kg	< 0.62	< 0.37	0.71	0.91	1.8	3.0	0.72	1.1	2.0	0.90	< 0.47	0.89	1.2	< 0.51	1.9	< 0.50	800	14
Manganese	mg/kg	0.78	< 0.37	< 0.44	6.2	27.0	5.0	0.64	1.9	5.6	1.9	3.2	1.9	3.5	< 0.51	1.7	1.2	26,000	NE
Mercury	mg/kg	0.0058	< 0.0036	0.0058	0.0080	0.0085	0.028	< 0.0045	< 0.0040	0.013	< 0.0045	< 0.0054	< 0.0049	0.0066	< 0.0047	0.014	< 0.0040	40	0.1
Molybdenum	mg/kg	< 0.62	< 0.37	< 0.44	< 0.39	4.7	0.61	< 0.48	< 0.48	< 0.45	< 0.43	< 0.47	< 0.50	< 0.42	< 0.51	< 0.53	< 0.50	5,800	NE
Nickel	mg/kg	< 0.62	< 0.37	< 0.44	0.76	2.5	1.3	< 0.48	< 0.48	0.45	< 0.43	< 0.47	< 0.50	0.58	< 0.51	< 0.53	< 0.50	22,000	NE
Selenium	mg/kg	< 1.2	< 0.74	< 0.89	< 0.78	< 1.2	< 1.0	< 0.96	< 0.96	< 0.90	< 0.87	< 0.95	< 1.0	< 0.84	< 1.0	< 1.1	< 1.0	5,800	0.26
Thallium	mg/kg	< 1.2	< 0.74	< 0.89	< 0.78	< 1.2	< 1.0	< 0.96	< 0.96	< 0.90	< 0.87	< 0.95	< 1.0	< 0.84	< 1.0	< 1.1	< 1.0	12	0.14
Zinc	mg/kg	< 1.2	< 0.74	< 0.89	< 0.78	6.6	1.3	< 0.96	< 0.96	0.96	< 0.87	1.3	< 1.0	1.6	< 1.0	< 1.1	< 1.0	350,000	NE
pH	SU	4.8	5.0	4.6	5.6	5.6	5.0	5.6	4.8	4.8	5.2	5.2	5.4	4.9	5.4	5.0	4.8	NE	NE

Notes:
1. Concentrations presented in milligrams per kilogram (mg/kg).
2. Screening levels from the Environmental Protection Agency (EPA) Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) dated May 2014.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater Soil Screening Level (SSL).
8. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.

Table 3D. Ash and soil sampling results – within 1960 Fill Area

Parameter	Units	Sample ID and Location							EPA Industrial SSL	MCL-Based EPA Protection of Groundwater SSL
		LOL - 2 (4-6')	LOL - 2 (9-11')	LOL - 3 (2-4')	LOL - 3 (7-9')	LOL - 3 (11-13')	LOL - 4 (4-6')	LOL - 4 (9-11')		
		Central Portion of 1960 Fill Area		Central Portion of 1960 Fill Area			Southwest Portion of 1960 Fill Area			
Antimony	mg/kg	< 0.66	< 0.51	< 0.52	< 0.58	< 0.48	< 0.59	< 0.44	470	0.27
Arsenic	mg/kg	**<u>37.0</u>**	< 1.0	**<u>39.0</u>**	**<u>38.7</u>**	**<u>11.0</u>**	**<u>58.0</u>**	**1.6**	3.0	0.29
Barium	mg/kg	**828**	10	**385**	**424**	20.5	**526**	12.7	220,000	82
Beryllium	mg/kg	**4.4**	< 0.10	**3.3**	2.1	< 0.097	**4.1**	< 0.088	2,300	3.2
Boron	mg/kg	6.87	< 0.72	9.67	16.9	< 0.9	18.0	< 4.76	230,000	NE
Cadmium	mg/kg	**0.41**	< 0.10	0.21	0.12	< 0.097	0.33	< 0.088	NE	0.38
Chloride	mg/kg	< 13	< 11	< 15	< 17	< 14	< 12	< 13	NE	NE
Chromium	mg/kg	14.1	5.6	12.5	10.4	6.7	15.6	7.1	NE	180,000
Cobalt	mg/kg	6.5	< 0.51	7.0	4.7	< 0.48	8.8	< 0.44	350	NE
Copper	mg/kg	43.8	1.3	31.5	27.4	2.1	44.5	0.91	47,000	46
Iron	mg/kg	12400	3070	5740	10900	4500	7260	2810	820,000	NE
Lead	mg/kg	10.4	1.0	9.2	6.0	1.9	13.7	0.96	800	14
Manganese	mg/kg	208	13.2	49.3	115	13.5	78.6	5.7	26,000	NE
Mercury	mg/kg	0.058	0.0094	0.097	0.067	0.020	0.094	< 0.0035	40	0.1
Molybdenum	mg/kg	1.1	2.1	0.78	1.2	1.3	1.2	< 0.44	5,800	NE
Nickel	mg/kg	15.6	0.61	12.3	9.8	1.2	20.7	0.53	22,000	NE
Selenium	mg/kg	**3.8**	< 1.0	**2.9**	**9.2**	**1.4**	**5.0**	< 0.88	5,800	0.26
Thallium	mg/kg	< 1.3	< 1.0	< 1.0	< 1.3	< 1.2	< 1.2	< 0.88	12	0.14
Zinc	mg/kg	12.0	1.1	13.0	12	8.6	19.1	< 0.88	350,000	NE
pH	SU	6.3	7	5.9	6.3	6.8	6.2	7.1	NE	NE

Notes:
1. Concentrations presented in milligrams per kilogram (mg/kg).
2. Screening levels from the Environmental Protection Agency (EPA) Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) dated May 2014.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceeding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater Soil Screening Level (SSL).
8. **<u>Bold and underline</u>** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater SSL and EPA Industrial SSL.
9. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.
10. Grey highlighted columns indicate ash samples.

Table 4. Ash SPLP leaching results – within ash basin and 1960 Fill Area

Parameter	Units	Sample ID and Location												SC DHEC Primary & Secondary MCLs
		AP-2 (2-3')	AP-2 (40-42')	AP-5 (1-3')	AP-5 (31-34')	AP-6 (4-6')	AP-6 (14-16')	AP-7 (2-4')	AP-7 (11-13')	AP-10 (28-30)	LOL-2 (4-6')	LOL-3 (7-9')	LOL-4 (4-6')	
		West Portion of Ash Basin		Central Portion of Ash Basin				Southeast Portion of Ash Basin		East Portion of Ash Basin	Central Portion of 1960 Fill Area	Central Portion of 1960 Fill Area	Southwest Portion of 1960 Fill Area	
Antimony	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.9	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic	µg/L	**80**	**75**	**14**	**29**	7.9	8.2	6.6	**37**	**11**	3.0	8.9	3.1	10
Barium	µg/L	39	< 10	< 10	74	< 10	< 10	19	< 10	< 10	11	190	26	2000
Beryllium	µg/L	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	4
Boron	µg/L	< 200	< 200	310	< 200	< 200	< 200	< 200	< 200	220	< 200	< 200	< 200	NE
Cadmium	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5
Chloride	mg/L	3.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	3.3	< 1.0	4.2	250*
Chromium	µg/L	11	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	100
Cobalt	µg/L	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	NE
Copper	µg/L	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	1000*
Iron	µg/L	1400	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	**330**	300*
Lead	µg/L	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	NE
Manganese	µg/L	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	**110**	< 10	50*
Mercury	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	NA	< 0.20	NA	2
Molybdenum	µg/L	13	14	< 10	32	14	< 10	63	54	< 10	< 10	< 10	< 10	NE
Nickel	µg/L	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	NE
Selenium	µg/L	21	< 20	26	36	27	< 20	42	< 20	< 20	< 20	22	< 20	50
Thallium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc	µg/L	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	20	< 20	< 20	< 20	5000*
pH	SU	7.4	8.1	7.9	7.3	**8.5**	8.4	**9.6**	**8.5**	**3.4**	**9.8**	6.5	**10**	6.5-8.5

Notes:
1. Concentrations presented in micrograms per liter (µg/L) and milligrams per liter (mg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceeding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
8. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.
9. NA indicates not analyzed.

Table 5A. Groundwater monitoring well sample results – total inorganics (total concentrations)

Parameter	Units	Sample Location																SC DHEC Primary & Secondary MCLs
		MW-7	MW-7D	MW-101D	MW-102D	MW-105D	MW-105S	MW-106D	MW-106S	MW-107S	MW-107D	MW-108D	MW-108S	MW-109D	MW-109S	MW-110D	MW-110S	
Field Parameters																		
Field pH	SU	7.0	**6.4**	**11.2**	**6.5**	7.6	**5.0**	**6.3**	**4.5**	**5.2**	**11.4**	6.6	**6.5**	6.6	7.8	6.7	**6.1**	6.5-8.5*
Field Specific Conductance	µmhos/cm	308	372	394	52	91	97	136	49	21	669	229	644	208	661	312	369	NE
Field Temperature	°C	22.2	15	20.7	20.9	19	19	19.4	18.5	20.6	20.7	19.2	20.4	21	22.7	23.4	24	NE
Dissolved Oxygen	mg/L	0.1	0.1	8.7	4.8	5	5.3	6.1	8.0	5.8	5.7	8.7	0.1	0	0.6	1.4	3.8	NE
ORP (REDOX)	mV	-135	-101	-2	423	348	490	409	521	281	-58	86.5	-46	-108	-158	-157	366	NE
Total Inorganics																		
Antimony	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic	µg/L	**117**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**97.4**	< 10.0	**1100**	< 10.0	< 10.0	10
Barium	µg/L	120	70.0	27.2	7.4	21.2	73.9	13	31.3	7.3	29.0	22.3	118	48.2	342	60.1	125	2000
Beryllium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4
Boron	µg/L	774	893	< 50.0	62.3	217	238	< 50	65.0	< 50.0	< 50.0	232	940	441	1550	758	632	NE
Cadmium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.4	< 1.0	< 1.0	5
Chromium	µg/L	< 5.0	12.6	36.4	8.4	3.2	< 5.0	< 5	< 5.0	< 5.0	55.0	6.6	< 5.0	< 5	< 5	< 5	6.9	100
Cobalt	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Copper	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.0	< 5.0	< 5.0	< 5.0	1000*
Iron	µg/L	**3080**	**8720**	189	105	83.6	< 50.0	250	< 50.0	**339**	61.3	**314**	**6450**	**740**	259	**10700**	**733**	300*
Lead	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Manganese	µg/L	**200**	**177**	< 5.0	8.9	17.6	**68.6**	33.2	11.2	< 5.0	< 5.0	**208**	**1150**	**379**	**94.9**	**340**	**232**	50*
Mercury	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	2
Molybdenum	µg/L	17.7	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	10.5	< 5.0	24.1	< 5.0	79.0	< 5.0	12.7	NE
Nickel	µg/L	< 5.0	18.2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	13.2	7.0	NE
Nitrogen, Nitrate	µg/L	< 20	< 20.0	1140	302	824	426	1900	1850	366	985	562	< 20	< 20	< 20	< 20	< 20	10000
Selenium	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	20.8	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	50
Thallium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	11.7	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	5000*

Notes:
1. Concentrations presented in milligrams per liter (mg/L) and micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5A (cont'd.) Groundwater monitoring well sample results - total inorganics (total concentrations)

Parameter	Units	Sample Location															SC DHEC Primary & Secondary MCLs
		MW-111D	MW-111S	MW-112S	MW-113S	MW-113D	MW-114S	MW-114D	MW-115D	MW-115S	MW-116D	MW-116S	MW-117D	MW-117S	MW-118D	MW-118S	
Field Parameters																	
Field pH	SU	**5.4**	**6.3**	**5.0**	**4.1**	**6.1**	8.0	6.6	**12.2**	**5.6**	**6.2**	**5.9**	**6.1**	**5.2**	**6.2**	**6.4**	6.5-8.5*
Field Specific Conductance	µmhos/cm	150	347	89	629	519	451	564	3330	23	90	63	188	92	80	91	NE
Field Temperature	°C	21.1	20.3	21.5	21.7	21.3	21.9	21.9	19.6	19.8	17.8	18.4	17.5	18.6	19.1	21.5	NE
Dissolved Oxygen	mg/L	6.6	0.3	0.5	6.0	1.0	6.4	0.5	5.8	5.8	3.7	6.8	2.9	7.1	5.6	6.1	NE
ORP (REDOX)	mV	375	156	239	407	127	106	66	-80	437	453	353	-1	498	451	341	NE
Total Inorganics																	
Antimony	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	10
Barium	µg/L	46.2	67.4	24.4	66.7	32.4	46.7	70	780	7.6	21.0	22.9	84.1	54.2	39.1	14.3	2000
Beryllium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4
Boron	µg/L	416	660	210	643	1370	1100	1260	< 50.0	< 50.0	< 50	82.8	394	189	205	75.8	NE
Cadmium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	5
Chromium	µg/L	< 5	6.6	< 5.0	< 5.0	< 5.0	12.3	< 5.0	51.2	< 5.0	< 5	< 5	7.7	< 5.0	< 5.0	< 5	100
Cobalt	µg/L	< 5.0	< 5.0	< 5.0	11.1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Copper	µg/L	< 5.0	< 5.0	< 5.0	13.1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	1000*
Iron	µg/L	61.3	**2010**	117	252	59.3	70	**300**	< 50.0	**596**	**785**	< 50	94.8	< 50.0	168	228	300*
Lead	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Manganese	µg/L	**165**	**157**	35.1	**328**	**226**	5.0	**75.2**	< 5.0	**100**	**52.4**	**51.4**	**143.0**	**124**	25.8	29.2	50*
Mercury	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	2
Molybdenum	µg/L	< 5.0	10.7	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	7.5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Nickel	µg/L	< 5.0	< 5.0	6.2	29.5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.1	< 5.0	< 5.0	< 5.0	NE
Nitrogen, Nitrate	µg/L	608	27.1	271	389	197	233	136	1870	392	1600	398	234	808	553	553	10000
Selenium	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	10.5	< 10.0	< 10.0	50
Thallium	µg/L	1.1	1.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc	µg/L	< 10.0	< 10.0	< 10.0	53.4	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	5000*

Notes:
1. Concentrations presented in milligrams per liter (mg/L) and micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5B. Groundwater monitoring well sample results – major anions and cations

Parameter	Units	Sample Location																SC DHEC Primary & Secondary MCLs
		MW-7D	MW-7	MW-101D	MW-102D	MW-105D	MW-105S	MW-106D	MW-106S	MW-107S	MW-107D	MW-108D	MW-108S	MW-109D	MW-109S	MW-110D	MW-110S	
Alkalinity, Total as CaCO3	mg/L	60.8	106	85.7	16.7	26.1	< 5.0	20.3	< 5.0	< 5.0	150	47.9	312	53.6	238	47.5	71.3	NE
Bromide	mg/L	0.13	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.10	< 0.10	0.2	0.1	0.11	NE
Calcium	µg/L	40500	46100	35700	6570	1820	8160	1790	1340	843	58200	7010	77900	20100	106000	38700	53300	NE
Chloride	mg/L	3.0	2.2	1.7	2.1	3.2	2.3	4	4.4	1.9	2.0	2.7	2	2.4	4.2	3.2	3.5	250*
Iron, Ferrous	mg/L	8.2	2.2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	2.6	0.64	< 0.5	6	< 0.5	NE
Magnesium	µg/L	4950	200	179	267	326	2180	526	1240	175	< 100	1280	19700	2620	10600	3810	4710	NE
Methane	µg/L	30.4	52.4	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	15.4	62.8	< 6.6	458	< 6.6	13	NE
Nitrogen, Nitrate	µg/L	< 20	< 20	1140	302	824	426	1900	1850	366	985	562	< 20	< 20	< 20	< 20	< 20	10000
Potassium	µg/L	7310	7340	< 5000	< 5000	7640	< 5000	< 5000	< 5000	< 5000	< 5000	6890	< 5000	6220	10900	7930	7410	NE
Sodium	µg/L	6840	< 5000	< 5000	< 5000	11200	< 5000	24400	< 5000	< 5000	10600	29700	26600	11700	9840	< 5000	5180	NE
Sulfate	mg/L	91.7	< 1.0	4.3	1.8	5.9	30.3	27.2	3.2	1.0	18.1	42.5	46	41.5	135	86.4	102	250*
Sulfide	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	NE
Total Dissolved Solids	mg/L	232	195	136	49	66	66	99	< 25	< 25	186	151	389	130	442	201	228	500*

Notes:
1. Concentrations presented in milligrams per liter (mg/L) and micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5B (cont'd.) Groundwater monitoring well sample results – major anions and cations

Parameter	Units	Sample Location															SC DHEC Primary & Secondary MCLs
		MW-111D	MW-111S	MW-112S	MW-113S	MW-113D	MW-114S	MW-114D	MW-115D	MW-115S	MW-116D	MW-116S	MW-117D	MW-117S	MW-118D	MW-118S	
Alkalinity, Total as CaCO3	mg/L	< 5.0	134	< 5.0	< 5.0	66.5	126	144	696	< 5.0	14.4	11.4	15.4	< 5.0	14.5	17.8	NE
Bromide	mg/L	< 0.10	< 0.10	< 0.10	0.12	0.15	0.15	0.18	< 0.10	0.12	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	NE
Calcium	µg/L	15900	45300	8250	56500	49400	70200	67300	224000	995	2590	2600	15500	8390	2890	10700	NE
Chloride	mg/L	2.8	2.2	1.3	2.9	3.4	3.2	3.7	3.5	2.7	3.7	2.9	3.4	2.1	3	3.8	250*
Iron, Ferrous	mg/L	< 0.50	2.10	< 0.50	< 0.50	< 0.50	< 0.50	< 0.5	< 0.50	0.7	< 0.5	< 0.5	< 0.50	< 0.50	< 0.50	< 0.5	NE
Magnesium	µg/L	1740	9630	944	4640	8110	5410	8520	< 100	272	708	714	2970	1280	967	814	NE
Methane	µg/L	< 6.6	< 6.6	< 6.6	< 6.6	18.0	< 6.6	11.2	< 6.6	11.7	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	NE
Nitrogen, Nitrate	µg/L	608	27.1	271	389	197	233	136	1870	392	1600	398	234	808	553	1940	10000
Potassium	µg/L	< 5000	7140	< 5000	7090	< 5000	6620	6700	< 5000	< 5000	< 5000	< 5000	< 5000	< 5000	7020	< 5000	NE
Sodium	µg/L	< 5000	< 5000	< 5000	< 5000	42300	6010	31600	73100	< 5000	14000	7530	8750	< 5000	6420	< 5000	NE
Sulfate	mg/L	50.8	43.7	23.7	**319**	176	99.0	127	3.7	38.7	12.5	8.4	58.0	25.6	12.2	7.1	250*
Sulfide	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	NE
Total Dissolved Solids	mg/L	105	214	< 25	167	116	285	346	**670**	32	93	52	136	71	65	46	500*

Notes:
1. Concentrations presented in milligrams per liter (mg/L) and micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5C. Groundwater monitoring well sample results – total inorganics (dissolved concentrations)

Parameter	Units	Sample Location																SC DHEC Primary & Secondary MCLs
		MW-7D	MW-7	MW-101D	MW-102D	MW-105D	MW-105S	MW-106D	MW-106S	MW-107S	MW-107D	MW-108D	MW-108S	MW-109D	MW-109S	MW-110D	MW-110S	
Antimony, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic, Dissolved	µg/L	< 10.0	**77.4**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**22.3**	< 10.0	**1040**	< 10.0	< 10.0	10
Barium, Dissolved	µg/L	63.1	102	22.8	6.3	18.4	70.8	9.8	29.3	6.6	27.5	21.1	99.1	44.9	331	54.6	116	2000
Beryllium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4
Boron, Dissolved	µg/L	852	682	< 50.0	54.8	196	215	< 50.0	60.4	< 50.0	< 50.0	218	912	435	1570	712	598	NE
Cadmium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.0	< 1.0	< 1.0	5
Chromium, Dissolved	µg/L	< 5.0	< 5.0	21.1	< 5.0	< 5.0	< 5.0	< 5.0	5.8	< 5.0	54.4	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	100
Cobalt, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Copper, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	1000*
Iron, Dissolved	µg/L	7050	**1510**	< 50.0	< 50.0	< 50.0	< 50.0	104	< 50.0	< 50.0	< 50.0	< 50.0	**1120**	**537**	ND	**8090**	**482**	300*
Lead, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Manganese, Dissolved	µg/L	**176**	**180**	< 5.0	7.8	15.3	**64.5**	26.9	14.2	< 5.0	< 5.0	**194**	**1060**	**361**	**92.1**	**308**	**212**	50*
Mercury, Dissolved	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	2
Molybdenum, Dissolved	µg/L	< 5.0	15.9	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.4	< 5.0	22.1	< 5.0	76.2	< 5.0	11.2	NE
Nickel, Dissolved	µg/L	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	11.9	< 5.0	NE
Nitrogen, Nitrate	µg/L	< 20.0	< 20	1140	302	824	426	1900	< 10.0	366	985	562	< 20	< 20	ND	< 20	< 20	10000
Selenium, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	21.0	< 10.0	29.38	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	50
Thallium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	5000*

Notes:
1. Concentrations presented in micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding SC DEHC Groundwater Standard.
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5C (cont'd.) Groundwater monitoring well sample results – total inorganics (dissolved concentrations)

Parameter	Units	Sample Location															SC DHEC Primary & Secondary MCLs
		MW-111D	MW-111S	MW-112S	MW-113S	MW-113D	MW-114S	MW-114D	MW-115D	MW-115S	MW-116D	MW-116S	MW-117D	MW-117S	MW-118D	MW-118S	
Antimony, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	**9.0**	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10.0	< 10.0	< 10.0	< 10.0	10
Barium, Dissolved	µg/L	42.5	63.4	22.1	63.3	28.5	43.9	63.5	694	6.4	14.8	21	75.6	47.8	35.5	12.7	2000
Beryllium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4
Boron, Dissolved	µg/L	384	617	168	556	1160	939	1090	< 50.0	< 50.0	< 50	74.5	377	182	190	65.3	NE
Cadmium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	5
Chromium, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	12.6	< 5.0	44.7	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	100
Cobalt, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	11.9	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Copper, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	11.1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	1000*
Iron, Dissolved	µg/L	< 50.0	**1830**	76.2	186	< 50.0	< 50.0	< 50.0	< 50.0	**585**	110	< 50	< 50.0	< 50.0	70.1	106	300*
Lead, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Manganese, Dissolved	µg/L	**152**	**147**	33	**312**	**203**	5.8	**68.5**	< 5.0	**103**	33.5	48.6	**152**	**125**	22.5	27.2	50*
Mercury, Dissolved	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	2
Molybdenum, Dissolved	µg/L	< 5.0	9.7	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	8.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Nickel, Dissolved	µg/L	< 5.0	< 5.0	7.1	29.2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Nitrogen, Nitrate	µg/L	608	27.1	271	389	197	233	136	1870	392	1600	398	234	808	553	1940	10000
Selenium, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	12.6	< 10.0	10.9	11.3	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	50
Thallium, Dissolved	µg/L	1.1	1.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	52.6	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	5000*

Notes:
1. Concentrations presented in micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding SC DEHC Groundwater Standard.
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5D. Groundwater monitoring well sample results – radiological isotopes

Parameter	Units	Sample Location								
		MW-7	MW-108S	MW-108D	MW-109S	MW-109D	MW-110S	MW-110D	MW-111S	MW-111D
Cesium - 137	pCi/L	U 0.857	U -0.709	U 0.679	UI 0.00	U 0.885	U -0.367	U -0.589	U 0.388	U -0.862
Cobalt - 60	pCi/L	U -1.53	U 3.67	U 3.08	U -2.21	U -3.21	U -0.0306	U 0.407	U -0.465	U 0.778

Notes:

1. Concentrations presented in picocuries per liter (pCi/L).
2. U indicates that analytes was analyzed for, but not detected above the MDL, MDA, or LOD.
3. UI indicates that uncertain identification via gamma spectroscopy.
4. Analytical results obtained from GEL Laboratories LLC.

Table 6. Free water sample results – total inorganics and anions and cations

Parameter	Units	Sample Location Discharge Canal SS-1
Field Parameters		
Field pH	SU	6.0
Field Specific Conductance	umhos/cm	31.0
Field Temperature	°C	39.1
Dissolved Oxygen	mg/L	7.3
ORP (REDOX)	mV	223
Total Inorganics (Total Concs.)		
Antimony	µg/L	< 5.0
Arsenic	µg/L	< 10.0
Barium	µg/L	10.2
Beryllium	µg/L	< 1.0
Boron	µg/L	< 50.0
Cadmium	µg/L	< 1.0
Chromium	µg/L	< 5.0
Cobalt	µg/L	< 5.0
Copper	µg/L	< 5.0
Iron	µg/L	888
Lead	µg/L	< 5.0
Manganese	µg/L	17.8
Mercury	µg/L	< 0.20
Molybdenum	µg/L	< 5.0
Nickel	µg/L	< 5.0
Nitrogen, Nitrate	µg/L	< 20.0
Selenium	µg/L	< 10.0
Thallium	µg/L	< 1.0
Zinc	µg/L	< 10.0
Anions and Cations		
Alkalinity, Total as CaCO3	mg/L	< 5000
Bromide	mg/L	< 0.10
Calcium	µg/L	1120
Chloride	mg/L	2.8
Iron, Ferrous	mg/L	< 0.50
Magnesium	µg/L	511
Methane	µg/L	13.5
Nitrogen, Nitrate	µg/L	< 20.0
Potassium	µg/L	< 5000
Sodium	µg/L	< 5000
Sulfate	mg/L	2.2
Sulfide	mg/L	< 0.10
Total Dissolved Solids	mg/L	175
Total Inorganics (Dissolved)		
Antimony, Dissolved	µg/L	< 5.0
Arsenic, Dissolved	µg/L	< 10.0
Barium, Dissolved	µg/L	8.2
Beryllium, Dissolved	µg/L	< 1.0
Boron, Dissolved	µg/L	< 50.0
Cadmium, Dissolved	µg/L	< 1.0
Chromium, Dissolved	µg/L	< 5.0
Cobalt, Dissolved	µg/L	< 5.0
Copper, Dissolved	µg/L	< 5.0
Iron, Dissolved	µg/L	592
Lead, Dissolved	µg/L	< 5.0
Manganese, Dissolved	µg/L	13.2
Mercury, Dissolved	µg/L	< 0.20
Molybdenum, Dissolved	µg/L	< 5.0
Nickel, Dissolved	µg/L	< 5.0
Nitrogen, Nitrate	µg/L	< 20.0
Selenium, Dissolved	µg/L	< 10.0
Thallium, Dissolved	µg/L	< 1.0
Zinc, Dissolved	µg/L	< 10.0

Table 7. Slug test results

Well ID	Static Water Level Measurement (ft bgs)[1]	Screen Depth (ft bgs)	Slug Test Type[2,3]	K (ft/day)[4]	K (cm/sec)
MW-7D	16.53	55-60	Injection	1.2	4.1E-04
			Withdrawal	0.9	3.0E-04
MW-101D	26.04	66-71	Injection	13.2	4.7E-03
			Withdrawal	5.0	1.8E-03
MW-102D	27.61	80-85	Injection	5.8	2.1E-03
			Withdrawal	5.2	1.8E-03
MW-105D	27.30	60-65	Injection	5.8	2.1E-03
			Withdrawal	5.4	1.9E-03
MW-106D	27.25	60-65	Injection1	17.6	6.2E-03
			Withdrawal	15.5	5.5E-03
			Injection2	10.1	3.6E-03
MW-107D	27.18	24-34	Injection	3.3	1.2E-03
			Withdrawal	3.3	1.2E-03
MW-108D	49.15	78-83	Injection	3.9	1.4E-03
			Withdrawal	3.6	1.3E-03
MW-109S	35.28	35-45	Withdrawal	1.1	4.0E-04
MW-109D	36.64	77-82	Injection	3.8	1.3E-03
			Withdrawal	4.1	1.4E-03
MW-110S	42.27	40-50	Withdrawal	2.6	9.2E-04
MW-110D	42.34	70-75	Injection	6.6	2.3E-03
			Withdrawal	6.9	2.4E-03
MW-111D	34.00	68-73	Injection	29.0	1.0E-02
			Withdrawal	34.7	1.2E-02
MW-112S	18.00	15-25	Withdrawal	7.4	2.6E-03
MW-113S	31.19	27-37	Withdrawal	1.7	6.1E-04
MW-113D	31.30	64-69	Injection	14.7	5.2E-03
			Withdrawal	14.8	5.2E-03
MW-114S	29.65	27-37	Withdrawal	0.9	3.3E-04
MW-114D	30.89	63-68	Injection	1.4	4.9E-04
			Withdrawal	15.6	5.5E-03
MW-115D	47.32	72-77	Injection	3.3	1.2E-03
			Withdrawal	1.5	5.2E-04
MW-116D	26.71	60-65	Injection	9.3	3.3E-03
			Withdrawal	7.1	2.5E-03
MW-117S	23.66	22-32	Withdrawal	2.2	7.6E-04
MW-117D	23.97	60-65	Injection	3.7	1.3E-03
			Withdrawal	1.9	6.5E-04
MW-118S	18.66	15-25	Withdrawal	0.9	3.1E-04
MW-118D	18.75	49-54	Injection	4.7	1.7E-03
			Withdrawal	4.5	1.6E-03

Notes:

1. ft bgs = feet below ground surface
2. Injection = Falling Head Slug Test; Withdrawal = Rising Head Slug Test
3. Falling Head Test is not valid when the static water level measurement is below the top of the well screen (e.g., S Wells) as outflow occurs above the water table into the unsaturated zone
4. The Bouwer and Rice Method was used to analyze slug test data and calculate hydraulic conductivity (K): *Bouwer, H. and R.C. Rice. 1976. A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. Water Resources Research, V.12, pp.423-428. Bouwer, H. 1989. The Bouwer and Rice Slug Test - An Update. Ground Water, Vol. 27, No.3, May-June, pp. 304-309.*
5. Assumptions:
   a. The groundwater zone is infinite in extent, homogeneous and uniform in thickness
   b. Groundwater flow can be described by Darcy's Law
   c. The water table or piezometric surface is horizontal and extends infinitely in the radial direction
   d. At time = 0, the change in head occurs instantly
   e. The inertia of the water column in the well and linear/non-linear well losses are considered negligible
   f. The well diameter is finite; hence storage in the well is not neglected
   g. Groundwater density and viscosity are constant throughout the test

Table 8. Conceptual closure ash and earthwork quantities

Location	Material	Quantity[1] (cy)
1960 Fill Area	Excavated Ash	276,000[2]
	Excavated Cover Soil	19,600[2]
	Excavated Impacted Soil	80,800[3]
Ash Basin	Excavated Ash	2,547,000[4]
	2' Soil Cover	215,600[5]
	Ash Basin Embankment Fill	309,400[6]
	TOTAL	3,448,400

Notes:
1. Quantities are in-place (bank measure) quantities without shrink or swell factors; units are in cubic yards (cy).
2. Source: AMEC, 2014.
3. Assumes 2' of impacted soil over location footprint.
4. Source: ANECFW, 2015.
5. Includes 18" soil cover and 6" topsoil.
6. Estimated using AutoCAD.

Table 9. Estimated quantity of material to be placed in ash landfill – On-Site Ash Landfill Closure Option

Location	Material	Excavated Quantity[1] (cy)	Compaction Factor	Compacted Quantity (cy)
1960 Fill Area	Excavated Ash	275,800	20%	220,600
	Excavated Cover Soil	19,600	12%	17,200
	Excavated Impacted Soil	80,800	12%	71,100
Ash Basin	Excavated Ash	2,547,000	20%	2,037,600
	Excavated Impacted Soil	233,300	12%	205,300
	2' Soil Cover[2]	241,500	N/A	180,700
			TOTAL	2,732,500

Notes:
1. See Table 7 for notes.
2. Assumes 56 acre landfill footprint.