Prepared for

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2016 SURFACE IMPOUNDMENT PERIODIC STRUCTURAL STABILITY ASSESSMENT REPORT

SOUTH ASH POND
WINYAH GENERATING STATION
GEORGETOWN, SOUTH CAROLINA

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CERTIFICATION STATEMENT

This initial periodic structural stability assessment was conducted in accordance with the requirements of §257.73(d) of the Code of Federal Regulations Title 40, Part 257, Subpart D, and was prepared in accordance with current practices and the standard of care exercised by scientists and engineers performing similar tasks in the field of civil engineering, and no other warranty is provided in connection therewith. The contents of this report are based solely on the observations of the conditions observed by Geosyntec personnel and information provided to Geosyntec by Santee Cooper. Consistent with applicable professional standards of care, our opinions and recommendations were based in part on data furnished by others. Although we were not able to independently verify such data, we found that it was consistent with other information that we developed in the course of our performance of the scope of services. The information contained in this report is intended for use solely by Santee Cooper and their subconsultants.

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10/12/2016

Date

EXECUTIVE SUMMARY

The Winyah Generating Station (WGS or "Site") is a coal-fired, electric generating facility owned and operated by Santee Cooper and located approximately four miles southwest of Georgetown, South Carolina (SC). Historically, WGS has utilized six surface impoundments designated for disposal of coal combustion residuals (CCR): Slurry Pond 3&4 (Slurry Pond), West Ash Pond, Unit 2 Slurry Pond, Ash Pond A, Ash Pond B, and South Ash Pond.

On 17 April 2015, the United States Environmental Protection Agency (USEPA) published rules in 40 CFR (Code of Federal Regulations) Parts 257 and 261, regulating the design and management of existing and new CCR units (commonly referred to as the "CCR Rule"). The CCR Rule became effective on 17 October 2015. The CCR Rule requires owners and operators of existing CCR surface impoundments to conduct periodic structural stability assessments in accordance with §257.73(d) of each surface impoundment and publish the results to the facility's operating record.

The South Ash Pond at WGS is classified as an "existing CCR surface impoundment" under the CCR Rule. On behalf of Santee Cooper, Geosyntec Consultants (Geosyntec) prepared the *2016 Surface Impoundment Periodic Structural Stability Assessment Report: South Ash Pond* (Stability Assessment Report), which describes the first periodic (i.e., initial) structural stability assessment in accordance with the CCR Rule for the South Ash Pond.

A hydrologic and hydraulic (H&H Analysis) of the South Ash Pond and its appurtenances was conducted to demonstrate the Inflow Design Flood (IDF) can be managed and conveyed safely (i.e., without overtopping the perimeter dikes) during and after the rainfall event. The H&H Analysis is presented in Attachment 1 of the *2016 Surface Impoundment Periodic Safety Factor Assessment Report: South Ash Pond* (Safety Factor Assessment Report). Because the South Ash Pond has been classified as a "Low Hazard Potential" surface impoundment, the 100-yr rainfall event with a rainfall duration of 72 hours was selected as the IDF. The free water level in the South Ash Pond is maintained at an elevation of 28.73 ft National Geodetic Vertical Datum of 1929 (NGVD29) by a concrete riser structure which discharges eastward into the Discharge Canal. The peak water level during and after the IDF within the South Ash Pond was computed as 31.8 ft NGVD29, which is below the minimum dike crest elevation of 36.9 ft NGVD29. Thus, the South Ash Pond will adequately manage inflows during and following the peak discharge from the IDF in accordance with §257.73(d)(1)(v) of the CCR Rule.

In support of this periodic structural stability assessment, Geosyntec developed and performed geotechnical subsurface investigations and laboratory testing programs in 2013 and 2016 to characterize the dike and subsurface soils and supplement historical data for the South Ash Pond perimeter dikes. Boring logs, cone penetration test (CPT) sounding data, and laboratory testing results are provided in Attachments 2, 3, and 4, respectively, of the Safety Factor Assessment Report, and the interpretation of the in-situ and laboratory data is described and presented in Attachment 5 of the Safety Factor Assessment Report.

Geosyntec reviewed the available data, performed the safety factor assessment, and inspected the perimeter dikes of the South Ash Pond on 10 and 11 July 2016. The condition of the foundation soils, the compaction of dike fill soils, the slope protection and vegetation of perimeter dike slopes, and the existing pipe penetrations through the perimeter dikes were evaluated and found to meet the requirements listed in §257.73(d)(1)(i) through (vii). Therefore, the South Ash Pond was considered to meet the periodic structural stability criteria for existing surface impoundments described within §257.73(d) of the CCR Rule.

1. INTRODUCTION

1.1 Project Background

The Winyah Generating Station (WGS or "Site") is an electric generating facility owned and operated by Santee Cooper. WGS is located between Pennyroyal and Turkey Creeks, tributaries to Sampit River, and is situated approximately four miles southwest of Georgetown, South Carolina (SC) (see Figures 1a and 1b for Site Location and Site Vicinity Maps). WGS has historically utilized six surface impoundments (Figure 2) designated for disposal of coal combustion residuals (CCR): Slurry Pond 3&4 (Slurry Pond), West Ash Pond, Unit 2 Slurry Pond, Ash Pond A, Ash Pond B, and South Ash Pond.

On 17 April 2015, the United States Environmental Protection Agency (USEPA) published rules in 40 CFR Parts 257 and 261 that regulate the design and management of existing and new CCR units (commonly referred to as the "CCR Rule"). The CCR Rule became effective on 17 October 2015. Within the CCR Rule, §257.73(d) outlines the structural stability criteria for existing CCR surface impoundments.

The South Ash Pond is situated immediately south of the Coal Pile and power block and west of the Discharge Canal. The South Ash Pond manages CCR in the form of fly ash, boiler slag, and bottom ash as well as process water resulting from power generating activities. It is considered as an existing surface impoundment under the CCR Rule. The *2016 Surface Impoundment Periodic Structural Stability Assessment Report: South Ash Pond* (Stability Assessment Report) has been prepared by Geosyntec Consultants (Geosyntec) on behalf of Santee Cooper to demonstrate that the South Ash Pond meets criteria for periodic structural stability assessment in accordance with §257.73(d) of the CCR Rule.

1.2 Project Site and Construction History

The South Ash Pond, spanning approximately 76 acres, is located immediately south of the Coal Pile and power block and west of the Discharge Canal. This unlined surface impoundment was commissioned in 1980 and is designated for the disposal of fly ash, bottom ash, and boiler slag. The South Ash Pond is bounded by the Coal Pile and power block to the north, Pennyroyal Creek to the west, a forested area to the south, and an access road and the Discharge Canal to the east.

The South Ash Pond was constructed by recompacting excavated soils from the surface impoundment interior to form perimeter dikes and a divider dike. The South Ash Pond perimeter dikes have a maximum height of approximately 24 feet (ft), with a crest elevation of approximately 38.0 ft National Geodetic Vertical Datum of 1929 (NGVD29) and toe elevation of approximately 24.0 ft NGVD29. The interior and downstream side slopes of the dikes are approximately 3 horizontal to 1 vertical (3H:1V), except in the western corner where the downstream side slopes are approximately 4H:1V. The dike crest is typically 12 to 15 ft wide (Thomas and Hutton, 2012). The minimum elevation of the dike crest is 36.9 NGVD29 (Thomas and Hutton, 2012).

The South Ash Pond receives low volume wastewater, hydroveyor water, fly ash sluice water from Units 3 and 4, and stormwater from the SEFA Star Facility. Bottom ash sluice water from Units 3 and 4 and Coal Pile runoff may also be conveyed into this surface impoundment, but are typically directed to Ash Pond A and the Slurry Pond, respectively.

1.3 Report Organization

This Stability Assessment Report presents the first (i.e., initial) periodic structural stability assessment for the South Ash Pond at WGS based on the results of recent and historical subsurface investigation programs, hydrologic and hydrology (H&H) analysis, geotechnical engineering analyses, a site visit, and a review of available Site documentation. The remainder of this Stability Assessment Report is organized as follows:

- Descriptions of the performance of the South Ash Pond hydraulic structures are presented in Section 2;
- Geotechnical subsurface investigation programs performed previously by Soil and Materials Engineers, Inc. (S&ME) and recently by Geosyntec are presented in Section 3;
- Subsurface conditions and geology at WGS are discussed in Section 4;
- The structural stability assessment of the South Ash Pond perimeter dikes is presented in Section 5; and
- The summary and general conclusions from the structural stability assessment are presented in Section 6.

2. HYDROLOGIC AND HYDRAULIC EVALUATION

2.1 Hydrologic and Hydraulic Analysis

The following section discusses the regulatory framework, methodology and assumptions, and results of the H&H analysis for the South Ash Pond and its appurtenances.

2.1.1 Regulatory Framework

The CCR Rule (§257.73(d)(1)) requires that a periodic stability assessment:

> *"...at minimum, document whether the CCR unit has been designed, constructed, and maintained with:*
>
> *...*
>
> *(v) a single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this section. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge event specified in paragraph (d)(1)(v)(B) of this section."*

The CCR Rule (§257.73(d)(1)(v)(B)(3)) also states that the spillway or spillways must manage the peak discharge from the *"100-year flood for a low hazard potential CCR Surface Impoundment"*. Additionally, §257.73(d)(1)(v)(A) indicates that *"All spillways must be either:*

> *(1) Of non-erodible construction and designed to carry sustained flows; or*
>
> *(2) Earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected."*

A 4-ft by 4-ft concrete riser structure and 36-inch (in.) diameter reinforced concrete pipe (RCP) located on the east side of the South Ash Pond serve as the spillway for the surface impoundment, manage the free water and process water within the South Ash Pond, and discharge to the east into the Discharge Canal. This spillway also manages discharge during and after the Inflow Design Flood (IDF). Because the South Ash Pond has been classified as a "Low Hazard Potential" surface impoundment, the 100-yr rainfall event with a rainfall duration of 72 hours was selected as the IDF. The South Ash Pond was assigned a "Low Hazard Potential" classification (Geosyntec, 2016a) since a potential failure would be contained within the property boundary and would not be anticipated to migrate offsite. The H&H analyses were performed to demonstrate that the South Ash

Pond spillway is able to adequately manage flow during and following the 100-yr design rainfall (i.e., peak discharge event) without overtopping of perimeter dikes, meeting the criteria in §257.73(d)(1)(v).

2.1.2 Methodology and Assumptions

Details of the H&H analysis are provided in a calculation package titled "*Hydrologic and Hydraulic Analysis: South Ash Pond*", which is provided as Attachment 1 of the *2016 Surface Impoundment Periodic Safety Factor Assessment Report: South Ash Pond* (Safety Factor Assessment Report) prepared by Geosyntec (2016b) and published in the operating record. The remainder of this section describes the assumptions, conditions, and results of the H&H analysis for the South Ash Pond.

The concrete riser structure and RCP manage the discharge from the South Ash Pond. The inlet and outlet inverts for the RCP were 16.93 ft (Lockwood-Greene, 1978).

The South Ash Pond receives contact stormwater from the Coal Pile after rainfall events, which was modeled to have an inflow of 2,450 gallons per minute (gpm) (5.46 ft^3/s) (Santee Cooper, 2014). Units 3 and 4 low volume wastewater, Units 3 and 4 hydroveyor water, and SEFA Star II Scrubber blowdowns were considered to have a combined base inflow to the South Ash Pond totaling 2,740 gpm (6.10 ft^3/s).

The operating level in the South Ash Pond is maintained by the concrete riser structure with a top stop log elevation of 28.73 ft NGVD 29 and associated RCP (Thomas and Hutton, 2016). The tailwater conditions associated with discharge from the South Ash Pond into the Discharge Canal were modeled using a fixed water surface elevation within the Discharge Canal and Cooling Pond. The tailwater surface elevation was estimated by conservatively assuming 2.5-ft depth of free water over the Cooling Pond emergency spillway during the 100-yr storm event. The top of the stop log bolted to the top of the concrete spillway of the Cooling Pond is at elevation 21.65 ft NGVD 29 (Thomas and Hutton, 2015). The water surface of the Discharge Canal and Cooling Pond was assumed to be at 24.15 ft NGVD 29 (21.65 ft NGVD 29 plus an additional 2.5 ft of water) during the IDF.

HydroCAD® Version 10.0 software (HydroCAD, 2011) was utilized to apply the Soil Conservation Service (SCS) Technical Release 20 (TR-20) method (SCS, 1982) to compute the stormwater volume and to model the performance of the hydraulic structures of the South Ash Pond during the 100-yr rainfall event. The 100-yr rainfall event was selected with a 72-hour (hr) duration precipitation event resulting in a rainfall depth of

12.8 in. (NOAA, 2006), and was modeled within HydroCAD® using a SCS Type III rainfall distribution.

2.1.3 Analysis Results

Under the conditions and assumptions described in Section 2.2, the maximum free water level or "maximum surcharge pool" level during and following the 100-yr rainfall event was computed as 31.8 ft NGVD29 occurring 38.1 hours into the rainfall event.

3. GEOTECHNICAL SUBSURFACE INVESTIGATION PROGRAMS

3.1 Overview

This section summarizes the geotechnical subsurface investigation and laboratory testing programs performed in the vicinity of the South Ash Pond perimeter dikes at WGS. In 1977 and 1978, S&ME performed a general subsurface investigation supporting the construction of CCR surface impoundments, including the South Ash Pond, at the WGS (S&ME, 1978). In October 2013, Geosyntec conducted a subsurface investigation in the vicinity of the South Ash Pond to collect geotechnical data supporting the evaluation of closure alternatives for the surface impoundment. Geosyntec remobilized to the site in March 2016 to conduct a focused subsurface investigation of the soft clay foundation layer that underlies the dike on the west corner of the pond. Figure 3 presents the locations of soil test borings performed during the investigations and cone penetration test (CPT) soundings conducted as part of Geosyntec's subsurface investigations.

Soil test borings, CPT sounding data, and laboratory test results for the subsurface investigation programs are included in Attachments 2, 3, and 4, respectively, of the Safety Factor Assessment Report (Geosyntec, 2016b). The interpretation of the subsurface stratigraphy and materials properties used in the geotechnical analyses for the South Ash Pond are presented in Attachment 5 of the Safety Factor Assessment Report (Geosyntec, 2016b).

3.2 Subsurface Investigations

3.2.1 Historical Investigation

The S&ME investigation (S&ME, 1978) was conducted to assess the suitability of on-site materials for construction and to design the perimeter dikes. In the vicinity of the South Ash Pond, the investigation included 18 soil test borings (SC-63, SC-64, SC-66 to SC-78, SC-80, SC-81, and SC-84) advanced before construction of the surface impoundment from 26.5 to 41 feet (ft) below ground surface (bgs) until the refusal was encountered at the Chicora Member (dense cemented shell unit). SPT blow counts (i.e., N-values) were recorded at approximately 2.5-ft intervals up to 10 ft bgs and at 5-ft depth intervals thereafter. Representative samples were collected by a standard split spoon sampler or by thin-walled Shelby tubes, which were utilized for index, consolidation, and triaxial shear strength testing. The geotechnical laboratory program consisted of index (grain size distribution and Atterberg limits), unit weight, compaction, consolidation, and shear strength testing of select samples.

3.2.2 Geosyntec Investigations

The October 2013 subsurface investigation conducted by Geosyntec included five soil test borings (SPT-109 to SPT-113) and twelve CPT soundings (CPT-122 to CPT-126, CPT-128 to CPT-133, and CPT-130A). One of the soil borings (SPT-113) and three of the CPT soundings (CPT-131 to CPT-133) were advanced within the interior South Ash Pond and were terminated once native foundation materials were encountered. The remaining borings and soundings were conducted in the dike materials and, except as described below for SPT-110 and SPT-112, were terminated once refusal was encountered. Refusal was defined in the field as an SPT N-value of 50 blows per ft over an advancement of 6 inches (in.) or the inability to further advance the cone; refusal occurred at the top of the Chicora Member. Soil Consultants, Inc. (SCI) of Charleston, SC was the drilling subcontractor, and Mid-Atlantic Drilling, Inc. (MAD) of Wilmington, North Carolina conducted the CPT soundings.

The four soil test borings drilled in the dike materials were advanced to a depth of 51 to 68 ft bgs using a CME-550X drill rig. Drilling was performed using the mud rotary wash method in general accordance with recommendations of Idriss and Boulanger (2008) (Table 1). Split-spoon samples and SPT blow counts (i.e., N-values) were generally collected in 5-ft depth intervals. Several thin-walled Shelby tube samples were also collected in the vicinity of the perimeter dikes. In two soil borings (SPT-110 and SPT-112), SCI replaced the side discharge drill bit with a tri-cone drill bit once the Chicora Member was encountered in order to penetrate the unit. The Chicora Member was slowly drilled through until the underlying Williamsburg Formation Clay was encountered, and then these borings were advanced an additional 5 ft before attempting the collection of a Shelby tube sample and terminating the borings. Boreholes located on the dike centerline were left open for two to three days prior to abandonment, and depth to water levels were recorded before the borings were plugged with a cement-bentonite grout.

Of the nine CPT soundings advanced in the area of the perimeter dike, six were advanced through the perimeter dike centerline, and three CPT soundings were advanced at the dike toe. Shear wave velocity (V_S) testing was conducted at 5-ft depth intervals for three locations along the perimeter dike centerline (CPT-123, CPT-124, CPT-129), two locations at the dike toe (CPT-125, CPT-130A), and two locations within the impoundment interior (CPT-132, CPT-133). Pore pressure dissipation tests were performed as well along the dike centerline (CPT-122, CPT-129), dike toe (CPT-130A), and within the CCR (CPT-131, CPT-133). Results of the V_S and pore pressure dissipation tests are included in Attachment 3 of the Safety Factor Assessment Report.

In March 2016, Geosyntec remobilized to WGS to conduct supplemental soil test borings and CPT soundings on the west corner of the South Ash Pond. Three soil test borings (SPT-302, SPT-303, and SPT-303A) were advanced by the mud rotary wash drilling method, four CPT soundings (CPT-204 to CPT-206 and CPT-208) were advanced through the perimeter dike centerline, and one CPT sounding (CPT-207) was advanced at the dike toe. Two of the CPT soundings were conducted with shear wave velocity (V_S) measurements. The purpose of the subsurface investigation was to: (i) collect physical samples of foundation soils immediately underlying the dike fill for geotechnical laboratory testing; (ii) further characterize the material properties of the observed soft clay foundation soil; and (iii) evaluate the relative density of dike fill soils.

3.3 Laboratory Testing

Geotechnical laboratory testing of soils was conducted during the S&ME and Geosyntec investigations. Laboratory testing results are provided in Attachment 4, and the interpretation of the laboratory testing program is discussed in Attachment 5 of the Safety Factor Assessment Report (Geosyntec, 2016b).

The SM&E laboratory testing program included index testing (percent fines and natural water content), shear strength testing (consolidated undrained (CU) and unconsolidated undrained (UU) triaxial compression), one-dimensional (1-D) consolidation testing, and unit weight testing.

Geosyntec subcontracted Excel Geotechnical Testing, Inc. (EGT) of Roswell, Georgia to conduct geotechnical laboratory testing of select split spoon and thin-walled Shelby tube samples collected within the dike fill, foundation soils, and CCR (split-spoon only). The geotechnical laboratory testing program included index testing (20 fines content tests, 19 grain size distributions, seven Atterberg limits tests, and 41 natural water content tests), shear strength testing (four CU triaxial compression tests), three 1-D consolidation tests, and nine unit weight tests.

4. SUBSURFACE CONDITIONS AND GEOLOGY

This section presents the regional geology and subsurface conditions for the South Ash Pond based on the geotechnical surface investigation programs discussed in Section 3. A summary of the regional geology is provided as a framework to develop the subsurface stratigraphy model. Additional information on the subsurface conditions and the material properties is presented in Attachment 5 of the Safety Factor Assessment Report (Geosyntec, 2016b).

4.1 Regional Geology

Georgetown County, SC is located in the Atlantic Coastal Plain physiographic province which is characterized by Quaternary terrace deposits produced by fluctuating sea levels. Coastal Plain sediments are underlain by Tertiary and late Cretaceous sediments to a depth of approximately 2,200 ft bgs in the Georgetown area. Descriptions of geologic units of interest in the area have been referenced from Campbell and Coes (2010) and are summarized below from top to bottom. The approximate thicknesses of each unit were estimated from several borings referenced in Campbell and Coes (2010). The specific borings used for this estimation include: 1) CHN-0820 located approximately 12 miles to the south of WGS; 2) GEO-0088 located approximately 7 miles to the southeast of WGS; and 3) GEO-0185 located less than 1.5 miles to the northwest of WGS.

- Undifferentiated Quaternary sediments consist of yellowish-brown and reddish-orange poorly sorted, very fine to very coarse, clayey sand and gravel. Accessory minerals include opaque heavy minerals, mica, and feldspar. The reported thickness of Undifferentiated Quaternary sediments ranges between 20 and 42 ft in the area.

- The Williamsburg Formation (Williamsburg) consists of gray to black interbedded clay and coarse quartz sand overlying shelly clay and calcareous clay. The Williamsburg can include sandy shale, fuller's earth, fossiliferous clayey sand (Lower Bridge Member), and fossiliferous clayey sand and mollusk-rich, bioclastic limestones (Chicora Member). The reported thickness of the Williamsburg in the vicinity of the site ranges between 30 and 90 ft.

- The Lang Syne Formation (Muthig and Colquhoun, 1988) was described as consisting of red and yellow (where weathered) or white, gray, and black (where freshly exposed) interbedded sand, silt, and clay and thin beds of silicified shell debris. Opaline clay stone is the most characteristic lithology.

- The Rhems Formation consists of light-gray to black shale interlaminated with thin seams of fine-grained sand and mica.

- The Peedee Formation consists of a dark-green to gray, fossiliferous, glauconitic clayey sand and silt. The combined thickness of the Lang Syne and Rhems and Peedee Formations ranges between 185 and 378 ft in the vicinity of the WGS.

Additional late Cretaceous Formations are present to a depth of approximately 2,200 ft bgs in the area. These Formations, in descending order, include: Donoho Creek, Bladen, Coachman, Cane Acre, Caddin, Sheppard Grove, Pleasant Creek, Cape Fear and undifferentiated Cretaceous sediments. The most important geologic units for this Stability Assessment Report are the undifferentiated Quaternary and Williamsburg Formations, which are encountered within 60 to 100 ft bgs as described in detail by Doar (2012).

4.2 <u>Perimeter Dike Subsurface Conditions</u>

4.2.1 Subsurface Stratigraphy

The subsurface stratigraphy at the Site was developed from information obtained from the historical and Geosyntec geotechnical subsurface investigations at WGS and is supported by the regional geology. The information indicates that the subsurface soils primarily consist of four geotechnical units within the depths of interest for the analyses presented in this Stability Assessment Report. A brief description on each unit is presented as follows:

- Dike Fill: Dike fill soils for the South Ash Pond perimeter dikes were generally observed to be medium dense to very dense, poorly graded to silty sands with uncorrected SPT blow counts typically ranging between 15 and 60 blows per foot and CPT sounding tip resistances typically ranging between 100 and 500 tsf. Grain size testing indicated that dike fill soils typically consist of 60 percent to 91 percent sand-sized material (smaller than No. 4 sieve but greater than No. 200 sieve) and 10 percent to 40 percent silt and clay-sized material (percent fines), with most samples containing 5 percent to 20 percent fines by weight.

- Foundation Soils: Foundation soils were observed to be variable across the South Ash Pond footprint and consist primarily of poorly graded to silty sands with shells and pockets of clayey sand to high plasticity clay. Uncorrected blow counts within foundation soils typically ranged between 2 and 35 blows per foot, and CPT sounding tip resistances typically ranged between 40 and 200 tsf. A 15 to

20-ft thick layer of soft clay, with uncorrected blow counts ranging from 0 to 4 blows per foot and CPT tip resistances below 20 tsf, was observed in the west to southwest corner of the South Ash Pond.

- Chicora Member: A layer of dense to very dense, partially cemented to heavily cemented shells was encountered beneath the foundations soils during the past subsurface investigations at WGS. SPT blow counts in this layer exceeded 50 blows over less than 6 in. of advancement, with minimal sample recovery without rock coring. Based on review of historical (Doar, 2012) and existing data, this layer is the upper portion of the overall Williamsburg Formation and is referred to as the "Chicora Member", "Coquina", or "Shell Hash". Boring and CPT refusal was typically encountered at the top of this stratum. In the two South Ash Pond borings that penetrated the Chicora Member, the layer was found to be between 5 ft and 8 ft thick.

- Williamsburg Formation Clay: The Williamsburg Formation Clay was encountered beneath the Chicora Member and is described as stiff to very hard, dark gray to black, medium to high plasticity clay or silt with sand. The Williamsburg Formation Clay has historically been referred to as "Black Mingo Clay" or the "Black Mingo Formation" at the Site. The unit was found to be between 30 ft and 90 ft thick in the vicinity of WGS from a review of the regional geology. Based on two SPTs, uncorrected SPT blow counts within this stratum ranged from 10 to 19 blows per foot in the upper 10 ft of the unit. In other areas of the Site, uncorrected SPT blow counts exceeded 20 blows per foot, increasing with depth, in the upper 20 ft of the unit.

5. STRUCTURAL STABILITY ASSESSMENT

This section presents a summary of the structural stability assessment for the perimeter dikes surrounding the South Ash Pond, demonstrating that this structure meets the requirements of 257.73(d)(1)(i) through (iii) and (vi) to (vii) of the CCR Rule. Section 2 of this Stability Assessment Report presents the analysis demonstrating that the South Ash Pond meets the requirements of 257.73(d)(1)(v) of the CCR Rule.

5.1 Site Visit

Geosyntec visited WGS on 10 and 11 July 2016 to inspect the condition of the CCR surface impoundment dikes regulated by the CCR Rule. Prior to the dike inspection, weekly and annual dike inspection reports and available historical engineering reports were reviewed to develop an understanding of the operational and maintenance history of the South Ash Pond. During the inspection, Geosyntec observed the condition of the upstream slopes, downstream slopes, stormwater features, pond appurtenances, and pipe penetrations through the dikes of the South Ash Pond. Geosyntec observed that the South Ash Pond perimeter dikes were generally operated and maintained in accordance with commonly accepted engineering practice and did not observe evidence of a deficiency to the structural integrity of the surface impoundment.

5.2 Stable Foundations and Abutments

The CCR Rule (§257.73(d)(1)) requires that the periodic structural stability assessment:

"...at minimum, document whether the CCR unit has been designed, constructed, and maintained with: (i) Stable foundations and abutments;"

Based on the observations made during the geotechnical subsurface investigation programs (Section 3) and the results of the safety factor assessment (Geosyntec, 2016b), the South Ash Pond appears to have been designed, constructed, and maintained with stable foundations. Potential slip surfaces through the foundation soils of the perimeter dikes were evaluated under static and seismic loading and liquefaction (within dike soils) conditions in accordance with §257.73(e) and were found to meet or exceed the required safety factors under the CCR Rule. Details of the slope stability analysis are also provided in the Safety Factor Assessment Report (Geosyntec, 2016b).

5.3 Condition of Perimeter Dike Slopes

The CCR Rule (§257.73(d)(1)) requires that the periodic stability assessment:

"...at minimum, document whether the CCR unit has been designed, constructed, and maintained with:

...

(ii) Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown; ... "

The interior (upstream) side slopes of the South Ash Pond perimeter dikes have generally been lined with rip-rap slope protection. Over time, sluiced fly ash has been deposited and some vegetation (i.e., phragmites) has flourished within the voids of the rip-rap slope protection during the operations of the surface impoundment. The riprap armor provides protection from surface erosion and wave action generated during rainfall events and periods of high wind. Grass has been established and is routinely maintained on the downstream 3H:1V to 4H:1V perimeter dike slopes. WGS facility personnel cut the vegetation as a part of routine maintenance of the perimeter dikes. Since the concrete riser structure inlet has a minimum elevation of 28.73 ft NGVD29, a significant volume of ponded water is unable to drawn down rapidly within the South Ash Pond. Thus, the South Ash Pond perimeter dikes have been constructed, operated, and maintained in accordance with §257.73(d)(1)(ii) of the CCR Rule. Note that §257.73(d)(1)(iv) was vacated by the USEPA in 2016 and is no longer a requirement of the CCR rule. However, WGS continues to cut the grass on a routine basis as a part of regular maintenance activities.

5.4 Compaction of Dike Fill Materials

The CCR Rule (§257.73(d)(1)) requires that the periodic stability assessment:

"...at minimum, document whether the CCR unit has been designed, constructed, and maintained with:

...

(iii) Dike mechanically compacted to a density sufficient to withstand the range of loading."

Design reports, technical specifications, or construction quality assurance (CQA) certification reports for the construction of the South Ash Pond perimeter dikes were not available at the time of this Stability Assessment Report. However, a design drawing (Drawing 3-CV-551) provides design cross sections for the construction of the South Ash Pond perimeter dikes. The design cross sections indicate that the perimeter dikes are to consist of *"Suitable Compacted Fill"* and that *"all topsoil and other unsuitable material"* at the base of the structure shall be removed from the area.

Soil borings and CPT soundings conducted along the perimeter dikes during geotechnical subsurface investigation programs have been spaced at approximately 500-ft intervals along the dike crest in general accordance with the United States Army Corps of Engineers (USACE) EM-1110-2-1913 engineering manual (USACE, 2000). Typically, the perimeter dikes of the South Ash Pond were found to consist of medium dense to very dense, poorly graded to silty sands with blow counts ranging between 15 and 60 blows per foot and CPT sounding tip resistances typically ranging between 100 and 500 tsf. Based on interpretation of in-situ data (i.e., CPT soundings and SPT N-values) presented in Attachment 5 of the Safety Factor Assessment Report (Geosyntec, 2016b), the perimeter dikes of South Ash Pond appear to have been mechanically compacted to sufficient densities to withstand the range of anticipated loading conditions.

5.5 Hydraulic Structures Underlying the CCR Unit

The CCR Rule (§257.73(d)(1)) requires that the periodic stability assessment:

"...at minimum, document whether the CCR unit has been designed, constructed, and maintained with:

...

(vi) Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris, which may negatively affect the operation of the hydraulic structure"

As described within Section 2, the South Ash Pond manages and routes stormwater and process water through a concrete riser structure to a 36-in. diameter Class IV RCP and then Class III RCP into the Discharge Canal. The structure was rehabilitated and placed back into operation in September 2011. These culverts are routinely inspected and have been found to meet the criteria of §257.73(d)(1)(vi).

Design documents for the South Ash Pond show two decommissioned drainage structures that intersect the perimeter dike. During the initial construction, dewatering trenches were excavated in the surface impoundment interior to drawdown and route water through a 30-in. diameter bituminous coated corrugated metal pipe (BCCMP) located in the southwest corner (Lockwood Greene, 1978 [Drawing 3-CV-549]). In 2008, Santee Cooper constructed a cement-bentonite slurry cutoff wall through the South Ash Pond perimeter dike at the location of the abandoned construction drain. A Drawdown Structure in the south corner of the West Ash Pond that discharged water to the South Ash Pond was decommissioned in 2012 by Hayward-Baker. The project consisted of abandoning 350 ft of RCP in-place with low strength (50 psi), non-shrink grout pumped from the West Ash Pond discharge structure. The non-shrink grout was capped within the discharge structure with approximately 12-in. of neat cement (4,000 psi) (Santee Cooper, 2012).

5.6 Sudden Drawdown of Adjacent Water Body

The CCR Rule (§257.73(d)(1)) requires that the periodic stability assessment:

"...at minimum, document whether the CCR unit has been designed, constructed, and maintained with:

...

(vii) For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream, or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body of sudden drawdown of the adjacent water body."

The South Ash Pond is not located adjacent to a body of water at the Site. Therefore, sudden drawdown or structural stability during the low pool was not evaluated within this Stability Assessment Report.

6. SUMMARY AND GENERAL CONDITIONS

The following section provides a summary and general conclusions of the structural stability assessment presented in this Stability Assessment Report:

- The hydrologic and hydraulic performance of the South Ash Pond during the IDF was evaluated. Based on the evaluation results, the South Ash Pond will adequately contain and manage (i.e., without overtopping the perimeter dikes) the flow during and following the IDF in compliance with §257.73(d)(1)(v) of the CCR Rule.

- A desktop review of site history and engineering reports, geotechnical subsurface investigations, and laboratory testing programs was carried out to evaluate the construction history, characterize the dike and subsurface soils, and understand the existing conditions of the South Ash Pond. Based on the information available at the time of this Stability Assessment Report, the South Ash Pond appears to have been designed, operated, and maintained with mechanically compacted dikes and stable foundations under static and seismic conditions and slope protection in accordance with §257.73(d)(1)(i) through (iii) of the CCR Rule. The influence of hydraulic structures underlying and penetrating the perimeter dikes was evaluated and found to meet the requirements of §257.73(d)(1)(vi).

- The South Ash Pond is not located adjacent to a water body at the Site, and therefore sudden drawdown or structural stability during the low pool of an adjacent water body was not evaluated for the requirements of §257.73(d)(1)(vii).

Based on the evaluations presented within this Stability Assessment Report, the South Ash Pond at WGS satisfies the periodic structural stability criteria for existing surface impoundments within §257.73(d) of the CCR Rule.

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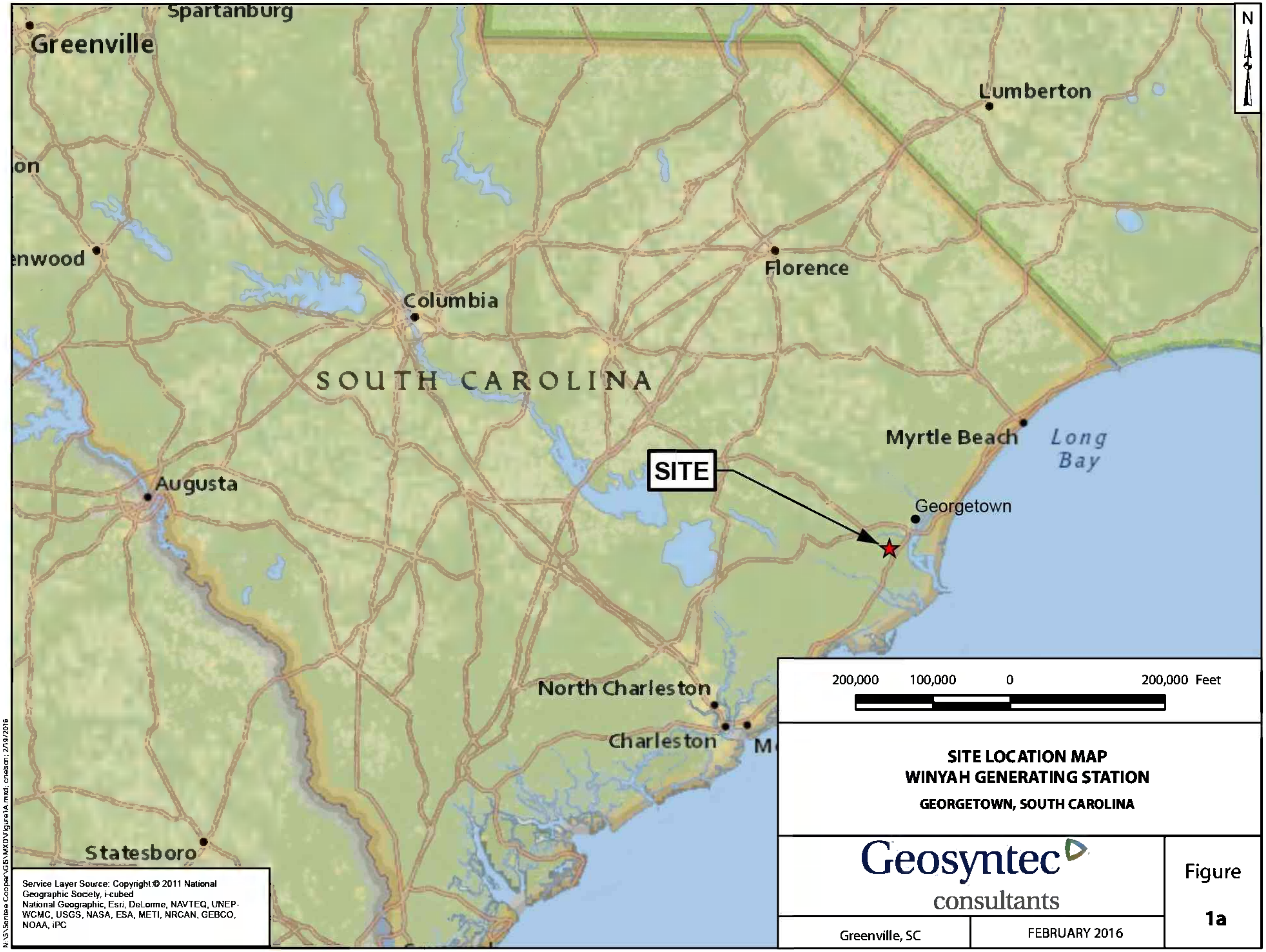
FIGURES



Spartanburg
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Myrtle Beach
Long Bay
SITE
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Georgetown
North Charleston
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Statesboro
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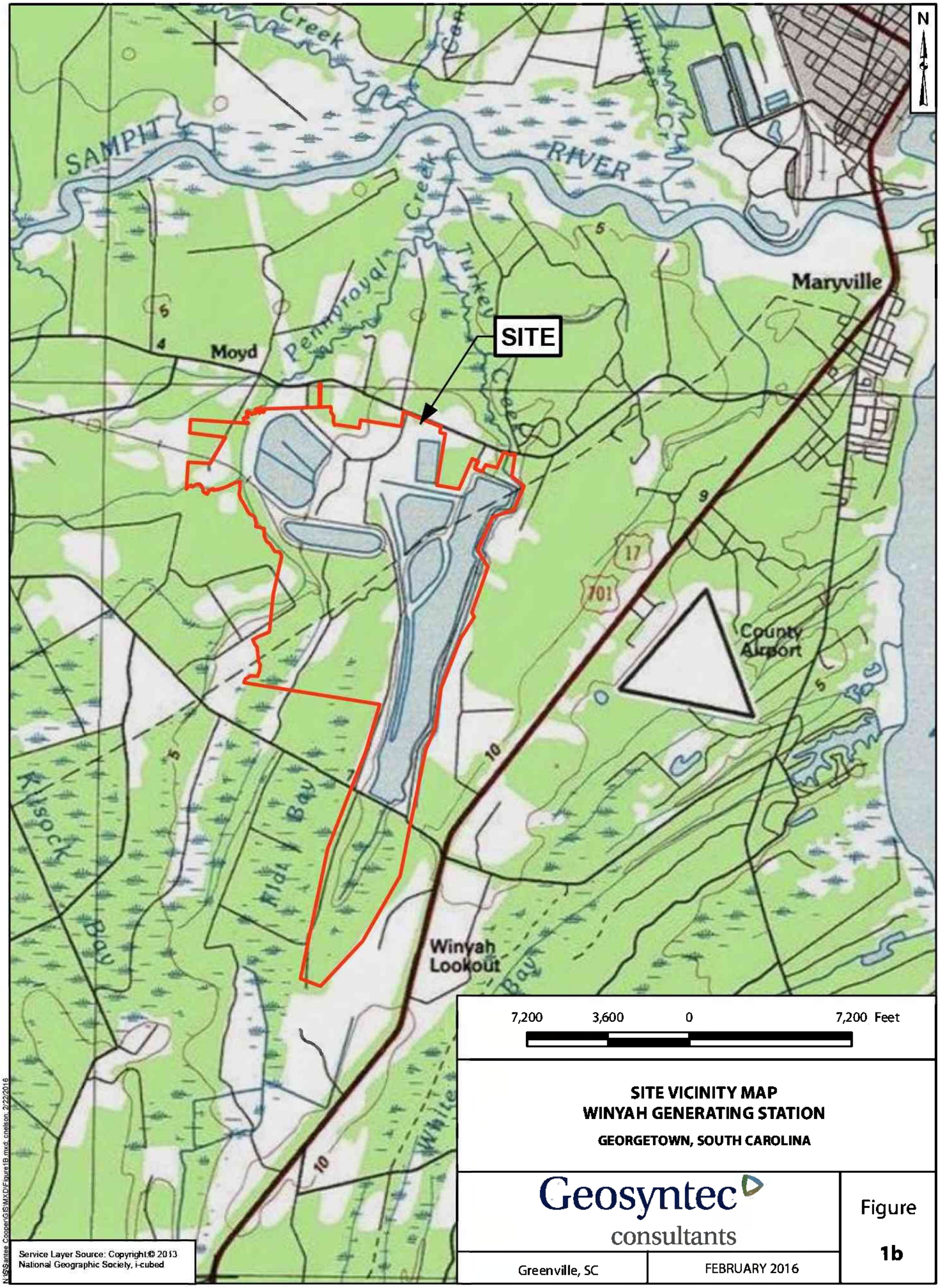
SITE LOCATION MAP
WINYAH GENERATING STATION
GEORGETOWN, SOUTH CAROLINA
Geosyntec consultants
Greenville, SC
FEBRUARY 2016
Figure
1a



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SITE VICINITY MAP
WINYAH GENERATING STATION

GEORGETOWN, SOUTH CAROLINA

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Figure **1b**

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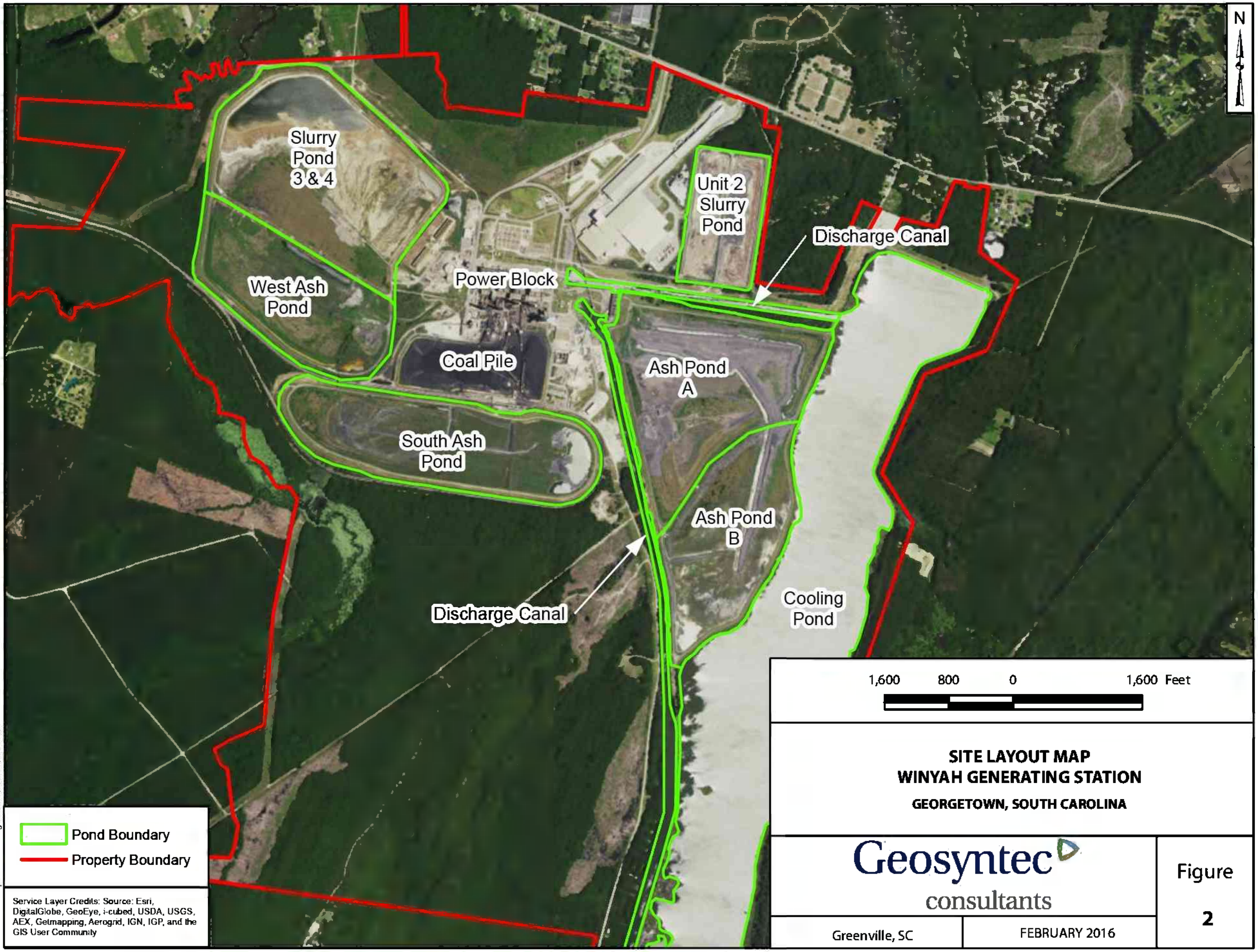
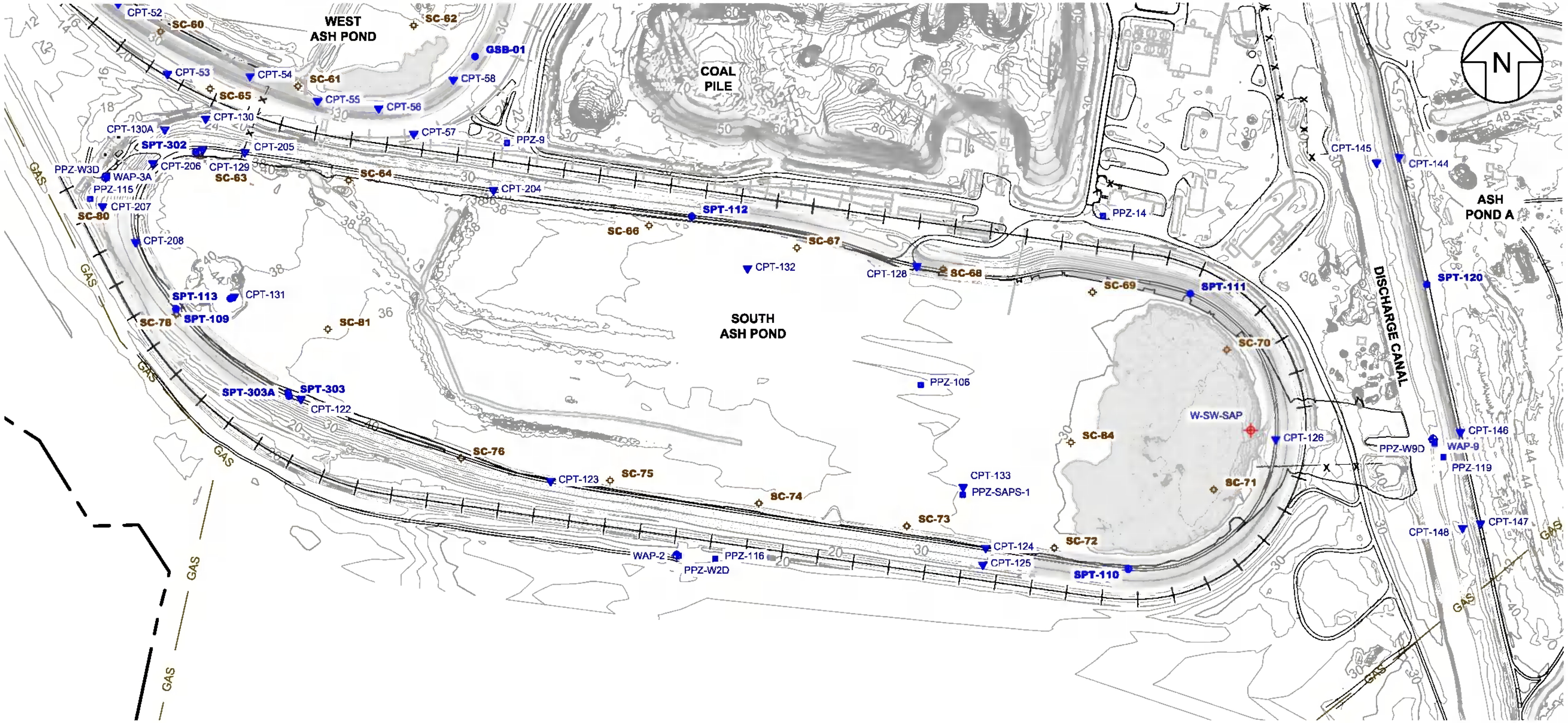


Slurry Pond 3 & 4
West Ash Pond
Power Block
Coal Pile
South Ash Pond
Unit 2 Slurry Pond
Discharge Canal
Ash Pond A
Ash Pond B
Discharge Canal
Cooling Pond
N
1,600 800 0 1,600 Feet
Pond Boundary
Property Boundary
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
SITE LAYOUT MAP
WINYAH GENERATING STATION
GEORGETOWN, SOUTH CAROLINA
Geosyntec consultants
Figure 2
Greenville, SC
FEBRUARY 2016



LEGEND

GAS — GAS	EXISTING GAS LINE
10	EXISTING MAJOR GRADE CONTOUR
	EXISTING RAILROAD
	EXISTING PONDED WATER (28.73 NGVD) (2016)
W-SW-SAP	EXISTING STAFF GAUGE
CPT-52	GEOSYNTEC CONE PENETRATION TEST
SPT-110	GEOSYNTEC SOIL BORING
SC-60	HISTORICAL BORING
WAP-9	MONITORING WELL
PPZ-9, PPZ-SAPS-1, PPZ-W3D	PIEZOMETER

NOTES:

1. TOPOGRAPHIC SURVEY PROVIDED BY THOMAS & HUTTON DATED 06/29/11 AND REVISED ON 01/14/12.
2. ELEVATIONS FROM THIS SURVEY ARE REFERENCED TO NGVD 1929 DATUM AS DERIVED FROM NGS MONUMENT PID#DD1957.
3. THE POSITION OF UNDERGROUND UTILITIES SHOWN ON THIS DRAWING IS BASED UPON THE LOCATION OF SURFACE APPURTENANCES AND/OR SURFACE MARKINGS AND SHOULD BE CONSIDERED APPROXIMATE.
4. HISTORICAL BORING SC-77 IS NOT SHOWN ON THIS MAP AS ITS LOCATION IS NOT KNOWN. IT IS ASSUMED TO BE A SOUTH ASH POND BORING BASED ON ITS NUMERICAL SEQUENCE RELATED TO OTHER SOUTH ASH POND BORINGS.

0 400' 800'

SCALE IN FEET

SOUTH ASH POND
BORING LOCATION MAP

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FIGURE 3

M:\S\SANTEE COOPER\SANTEE COOPER-WINYAH\0028-WINYAH H&H ANALYSES\FIGURES\F-0-SC-585-00-F0028-035