Prepared for

Santee Cooper Power
1 Riverwood Drive
Moncks Corner, South Carolina 29461

LOCATION RESTRICTIONS COMPLIANCE DEMONSTRATION

ASH POND A
WINYAH GENERATING STATION
GEORGETOWN, SOUTH CAROLINA

Prepared by

Geosyntec consultants

engineers | scientists | innovators

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Project Number GSC5242.01BT

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Certification Statement – Demonstration of Compliance with Location Restrictions

Federal CCR Rule: 40 CFR §257.60-64

CCR Unit: Ash Pond A

Certification:

This Location Restrictions Compliance Demonstration 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. Based on the evaluations presented in this Location Restrictions Compliance Demonstration Report, Ash Pond A does not meet the requirements of 40 CFR §257.60 for placement 5 feet above the uppermost aquifer. Therefore, the above-referenced CCR Unit is not, in my professional opinion, demonstrated to be in compliance with the United States Environmental Protection Agency (USEPA) minimum location restriction requirements for the siting criteria of 40 CFR §257.60-64 for existing coal combustion residuals (CCR) surface impoundments.

Firm Seal

Seal and Signature: ______________________

Printed Name: Carlos Fabian Benavente

PE License Number: 32067 State: South Carolina

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1 INTRODUCTION

Geosyntec Consultants (Geosyntec) has prepared this *Location Restrictions Compliance Demonstration* on behalf of the South Carolina Public Service Authority doing business as (d.b.a.) Santee Cooper (Santee Cooper). The subject of this compliance demonstration is the coal combustion residual (CCR) unit known as the "Ash Pond A" at the Winyah Generating Station (WGS) located in Georgetown, South Carolina (Figure 1). Ash Pond A is an existing CCR surface impoundment at the WGS site.

On April 17, 2015, the Environmental Protection Agency (EPA) promulgated the federal Coal Combustion Residual Rule (CCR Rule) that establishes national minimum criteria for existing and new CCR landfills and surface impoundments. Ash Pond A is subject to the CCR Rule as an existing CCR surface impoundment as defined in 40 CFR §257.53, and as such is required to make demonstrations documenting whether or not the CCR unit is in compliance with the location restriction requirements under 40 Code of Federal Regulations (CFR) §257.60 through §257.64. In March 2018, EPA proposed changes to the CCR Rule. The deadline for closure of units that do not meet the location restriction requirement pertaining to placement of CCR no less than five feet above the uppermost aquifer was extended until October 31, 2020.

This document serves as WGS's location restriction demonstrations for Ash Pond A at WGS.

1.1 <u>Facility Location</u>

The WGS is a coal-fired steam electric generating facility located at 661 Steam Plant Drive, Georgetown, SC 29440, owned and operated by Santee Cooper. The WGS site is located approximately 4 miles southwest of the city of Georgetown, South Carolina, and is accessed via US Hwy 17 to Pennyroyal Road. A general site vicinity map is presented on Figure 1. The WGS includes an approximately 2,184-acre parcel for station operations and an adjacent approximately 344-acre parcel of land that is presently undeveloped.

The WGS generates CCRs during power generation and the air quality control process. The CCRs are recycled for beneficial use to the extent possible. Historically, some of the CCRs generated by the WGS have been disposed in six on-site ponds/surface impoundments. One of these ponds is Ash Pond A, which is a 90-acre, unlined CCR surface impoundment, located within the Sampit River Watershed. Ash Pond A receives fly ash, boiler slag, bottom ash, and low volume wastewater. Ash Pond A provides treatment for solids removal from wastewater by gravity settling. Although Ash Pond A foundation materials are variable, foundation materials and dike fill soils primarily consist of poorly graded to silty sands. Ash Pond A does not have an outfall structure and discharges to Ash Pond B through rim ditches and culverts.

Ash Pond A is bounded by the Intake Canal to the north, the Cooling Pond to the east, Ash Pond B to the south, and the Discharge Canal to the west. Ash Pond A is separated from Ash Pond B by an intermediate dike which is generally aligned from west to east.

In 1975, Burns and Roe, completed the design and construction of the Ash Pond A to manage CCR. Ash Ponds A and B are separated by a divider dike, which is generally aligned from west to east from the Discharge Canal to the Cooling Pond. A high-pressure gas pipeline is located immediately north of the Ash Ponds A and B intermediate dike. It crosses Ash Pond A from the west to the east. The construction timeline, precise depth, construction methodology, and other construction information for this pipeline are not available (Drawing CV-504). The original design also shows two drawdown structures in the southwest corner of Ash Pond A near the intersection of the perimeter dike with the divider dike (Drawings CV-511 and CV-508).

In 2011, evidence of a corroded 18-in diameter corrugated metal pipe (CMP) was observed at the outlet of Drawdown Structure II which differed from the construction drawings that indicated a concrete discharge pipe. It was mentioned in discussion during the site visit that Drawdown Structure I was "abandoned in-place" and Drawdown Structure II was "bladder plugged and abandoned" (Dewberry and Davis, 2011). An available record drawing (Santee Cooper, 2011) indicates that Controlled Low Strength Material (CLSM) was used to abandon a 24- inch pipe from Drawdown Structure II. The drawing also indicates that the concrete drainage structure was filled above the pipe crown with CLSM, and the remainder of the structure was filled using random fill composed mostly of CCR found in Ash Pond A. Additionally, the excavation caused by the removal of the CMP was backfilled using the same soil that was removed.

In 2016, Santee Cooper constructed a spillway between the existing outlet pipes on the divider dike between Ash Pond A and Ash Pond B. The spillway has a base width of

100 ft., 10H:1V side slopes, and an invert elevation of 37 ft. National Geodetic Vertical Datum of 1929 (NGVD 29). Heights of the perimeter dikes typically ranged from 12 ft to 15 ft to the north and 20- to 24.5-ft to the east. Crest elevations range between 38.8 and 44 ft NGVD 29 (Thomas and Hutton, 2011). Ash Pond A is the subject of this demonstration and is shown on Figure 2.

1.2 Previous Investigations and Reports

Santee Cooper has implemented a number of investigations at the WGS site to collect geologic, hydrogeologic, and geotechnical data. In October 2013, Geosyntec conducted a subsurface investigation that included seven test borings and 16 CPT soundings in the Ash Pond A area. One of the test borings and four of the CPT soundings were advanced within the interior of Ash Pond A and were terminated once native foundation materials were encountered. Four of the test borings were drilled in the dike materials and advanced until native or foundation soils were encountered. Three test borings and 12 CPT soundings were advanced through the perimeter and divider dikes and were terminated when refusal was encountered. In 2016, Geosyntec conducted a supplementary investigation in Ash Pond A that consisted of three test borings and 15 CPT soundings through the perimeter dike centerline, dike crest, and dike toe.

This Federal CCR Rule Location Restrictions Compliance Demonstration is based on and supported by the detailed information contained in the following documents:

- *Subsurface Investigation Ash and Slurry Pond Dikes*, Winyah Generating Station, Georgetown, South Carolina, 1978, prepared by Soil and Material Engineers, Inc.;
- *Ash Pond A Dike Elevation*, Winyah Generating Station, 1993, prepared by Paul C. Rizzo Associates, Inc.;
- *Site Hydrogeologic Characterization Study Report*, Winyah Generating Station, Georgetown, South Carolina, April 2016, prepared by Geosyntec Consultants;
- *History of Construction Report –Ash Pond A*, Winyah Generating Station, Georgetown, South Carolina, October 2016, prepared by Geosyntec Consultants; and

- *2016 Surface Impoundment Periodic Safety Factor Assessment Report –Ash Pond A*, Winyah Generating Station, Georgetown, South Carolina, October 2016, prepared by Geosyntec Consultants.

1.3 Site Geology and Hydrogeology

The WGS site is located within the Atlantic Coastal Plain physiographic province which is a wedge of unconsolidated to well-consolidated, Cretaceous to recent sediments. A review of South Carolina Coastal Plain hydrostratigraphy (Campbell and Coes, 2010) identifies several hydrostratigraphic layers (aquifers and confining units). General information about the regional geologic units is summarized below, from the top unit to the bottom unit:

- Undifferentiated Quaternary Sediments: this geologic unit consists 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 Undifferentiated Quaternary sediments thickness ranges between 20 and 42 ft in the area.

- The Williamsburg Formation (Williamsburg): this geologic unit 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 thickness of the Williamsburg in the vicinity of the site ranges between 30 and 90 ft.

- The Lang Syne Formation: As described in the literature by Muthig and Colquhoun (1988), this geologic unit consists 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 of the Lang Syne Formation.

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

- The Peedee Formation: this geologic unit consists of a dark-green to gray, fossiliferous, glauconitic clayey sand and silt. The combined thickness of the

Lang Syne, 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 (Geosyntec, 2016a).

The aquifers of most interest at this site are the surficial aquifer and Gordon Aquifer. The surficial aquifer is the water-table aquifer and consists mainly of terrace sediments that were deposited during transgressions and regressions of a post-Miocene sea. The surficial aquifer is lithologically heterogeneous but generally consists of quartz gravel and sand, silt, clay, and shelly sand and unconformably overlies the Gordon aquifer, which is the lowermost aquifer of the Floridan Aquifer system. The Gordon Aquifer represents the permeable portion of the Williamsburg Formation (upper Chicora Member) in the vicinity of the site. As detailed in the *Site Hydrogeologic Characterization Study Report* (Geosyntec, 2016c), the surficial aquifer and Gordon Aquifer exhibit similar hydrogeologic properties and are not separated hydrogeologically. Therefore, the Gordon Aquifer and surficial aquifer are collectively termed the surficial aquifer (Geosyntec, 2016c) and are designated as the uppermost aquifer at the site in accordance with 40 CFR §257.40.

Historical groundwater elevation measurements in the surficial aquifer at the site were influenced by the water levels in the slurry ponds and ash ponds. In recent years, two ponds have been closed. Once the new landfill is operational and the remaining ponds are dewatered and closed, the effect of the ponds on recharge to the water table will be eliminated. For these reasons, a modeled seasonal high water table representing conditions after closure of the slurry ponds and ash ponds was developed (Geosyntec, 2016c). A map of the seasonal high water table conditions used for this location restrictions evaluation is included in this report as Figure 3.

2 LOCATION RESTRICTIONS EVALUATION

The location restrictions under §257.60 through §257.64 include: (1) placement above the uppermost aquifer; (2) wetlands; (3) fault areas; (4) seismic impact zones; and (5) unstable areas. Each of these locations is generally recognized as having the potential to impact the structure of any disposal unit.

2.1 Placement Above the Uppermost Aquifer

40 CFR §257.60(a) states that existing CCR surface impoundments "*must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table).*" The "uppermost aquifer" is defined by §257.40 as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. This definition includes a shallow, deep, perched, confined or unconfined aquifer, provided it yields usable water.

As mentioned, the uppermost aquifer at the site is the surficial aquifer, which is an unconfined aquifer consisting of mixtures of predominantly sand and minor amounts of silt and clay. A map of the modeled seasonal high water table is included in Figure 3 of this report. As shown, the groundwater elevations across Ash Pond A are 20 to 21 feet NGVD 29. The measured seasonal high water level at well WAP-9 was 21.47 feet NGVD 29, confirming the modeled results (Geosyntec, 2016c).

The bottom of Ash Pond A was estimated to be approximately 20 feet NGVD 29 in the central portion of Ash Pond A to less than 20 feet NGVD 29 in the northeastern portion of Ash Pond A. This information was estimated from historical borings and field investigations performed by Geosyntec in 2013 and 2014 (Figures 3 and 4 of Geosyntec, 2016a).

For the foregoing reasons, Ash Pond A is not in compliance with the requirements of 40 CFR §257.60 for placement above the uppermost aquifer.

2.2 Wetlands

40 CFR §257.61(a) states that existing CCR surface impoundments "*must not be located in wetlands, as defined in §232.2 of this chapter, unless the owner or operator demonstrates… that the CCR unit meets the requirements of paragraph (a)(1) through (5) of this section.*" Wetlands, as defined in 40 CFR §232.2, means "*those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of*

vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Waste treatment systems, including treatment ponds designed to meet the requirements of the Clean Water Act (CWA), are not waters of the United States and are exempt from permitting under Section 404 of the CWA. Any wetlands that may exist within these boundaries are exempt from permitting because the CCR ponds are considered part of the existing waste treatment system which is permitted and operated under National Pollutant Discharge Elimination System (NPDES) Permit No. SC0022471. A demonstration to show that Ash Pond A meets the requirements of paragraphs (a)(1) through (a)(5) of 40 CFR §257.61 is not necessary since the CCR unit is not located in areas delineated or defined as wetlands. Ash Pond A is considered to be in compliance with the requirements of 40 CFR §257.61 for wetlands.

2.3 Fault Areas

40 CFR §257.62(a) states that existing CCR surface impoundments "*must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit.*"

A summary of the structural features in South Carolina are summarized in Maybin (1998) and is provided in the *Site Hydrogeologic Characterization Study* (Geosyntec, 2016d). From an assessment of this information, it is concluded that no structural features indicative of recent (Holocene-age) faulting have been identified within 20 miles of the WGS site. The lack of a nearby fault zone has been further confirmed through previous WGS site-specific subsurface investigations documented in Geosyntec (2016), which have showed no evidence of recent faults (i.e., no linear features that could be indicative of surface expression of a fault and no evidence of any stratigraphic offsets at depth which could be suggestive of faulting).

For the foregoing reasons, Ash Pond A is considered to be in compliance with the requirements of 40 CFR §257.62 for fault areas.

2.4 Seismic Impact Zones

40 CFR §257.63(a) states that existing CCR surface impoundments must not be located in seismic impact zones unless the owner or operator makes certain demonstrations. A seismic impact zone is defined as "*an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10 g in 50 years.*" While United States Geological Survey (USGS) national seismic hazard maps are the most commonly used resources for the selection of Peak Ground Acceleration (PGA), regional seismic hazard maps developed by local experts consider regional geologic setting and seismicity and are often the preferred alternatives.

The WGS site is located in a seismic impact zone. Accordingly, 40 CFR §257.63(a) requires a demonstration that "*all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.*" This demonstration is made through the engineering analyses and design presented in Attachment 6 of the *2016 Surface Impoundment Periodic Safety Factor Assessment Report –Ash Pond A* (Geosyntec, 2016b), and is further evaluated in the remainder of this section.

The target spectrum for "geologically realistic" site conditions was selected using the South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (SCDOT, 2010) seismic hazard maps as described in the Attachments 6 and 8 of the *2016 Surface Impoundment Periodic Safety Factor Assessment Report – Ash Pond A* (Geosyntec, 2016b). The Site PGA is 0.16g for "geologically realistic" conditions. The "geologically realistic" target acceleration response spectrum has a PGA (represented by a spectral period of 0.01 seconds) of 0.16g and a peak spectral acceleration of 0.48g at a spectral period of 0.2 seconds. Site response analyses were performed to evaluate the effect of local site conditions on the expected ground motions at the Site. The objective of the site response analysis is to calculate accelerations and shear stresses within the Site soil profiles. Shear stresses are examined to evaluate the seismic stability analysis (Attachment 6 of the Safety Factor Assessment Report) and liquefaction potential analysis (Attachment 7 of the Safety Factor Assessment Report).

Computed cyclic shear stresses were applied for the liquefaction potential analysis and were also utilized to evaluate the seismic safety factor as a part of the safety factor assessment using DEEPSOIL® (Hashash et al., 2015), a one-dimensional nonlinear site response analysis program. The site response analysis presented in Attachment 6 of the *2016 Surface Impoundment Safety Factor Assessment Report* (Geosyntec, 2016b) considers the full depth of soil columns (i.e., 500 feet bgs), but results are presented for soil columns to a depth of 100 feet bgs to emphasize the near-surface response. The calculated FS for each of the cross sections exceed the respective target FS for static and seismic FS.

For the foregoing reasons, Ash Pond A is considered to be in compliance with the requirements of 40 CFR §257.63 for seismic impact zones.

2.5 Unstable Areas

40 CFR §257.64(a) indicates that existing CCR surface impoundments "*must not be located in an unstable area unless the owner or operator demonstrates… that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.*" An unstable area means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity, including structural components of some or all of the CCR unit that are responsible for preventing releases from such unit. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains. To assess whether Ash Pond A may be situated in an unstable area, the following factors were considered:

- On-site or local soil conditions that may result in differential settlements;
- On-site or local soil conditions that may constitute poor foundation conditions;
- On-site or local geologic or geomorphologic features; and
- On-site or local human-made features or events (both surface and subsurface).

Potentially liquefiable zones were encountered in the subsurface soils adjacent and downstream to the perimeter dikes in some areas. The "Safety Factor Assessment - Ash Pond A" calculation package, provided as Attachment 8 to the *2016 Periodic Safety Factor Assessment Report –Ash Pond A* (Geosyntec, 2016b) presents analyses to address on-site or local soil conditions in and around Ash Pond A. The liquefaction potential was evaluated for soil borings and cone penetration test (CPT) soundings advanced through Ash Pond A perimeter dike based on geotechnical information collected during Geosyntec's 2013 and 2016 geotechnical subsurface investigations. Borings and soundings located at the perimeter dike toe were analyzed during an evaluation of "Unstable Areas" in accordance with the CCR Rule. The liquefaction analyses were performed on both the CPT soundings and SPT borings. The methodology to compute the potential of soils to liquefy and the factor of safety against liquefaction are described below.

Global slope stability analyses were performed using Spencer's method (Spencer, 1973), as implemented in the computer program SLIDE®, version 6.037 (Rocscience, 2015). The Factors of Safety values calculated for static conditions under static maximum normal storage pool, static maximum surcharge pool, and seismic maximum normal storage pool exceeded the target FS. The dike fill and foundation soils directly underlying Ash Pond A were not found to be susceptible to liquefaction during the design earthquake, and thus the liquefaction safety factor of the perimeter dike is not required to be evaluated during the periodic safety factor assessment (Attachment 8, Geosyntec, 2016b).

For the foregoing reasons, Ash Pond A is considered to be in compliance with the requirements of §257.64 for unstable areas.

3 CONCLUSIONS

A compliance summary of the CCR Rule location restrictions requirements addressed in this document are provided in Table 1 below.

Table 1 Location Restriction Compliance Summary

Winyah Ash Pond A		Compliant?	
Regulation	**CCR Location Restriction**	**YES**	**NO**
257.60	Placement Above Uppermost Aquifer		X
257.61	Wetlands	X	
257.62	Fault Areas	X	
257.63	Seismic Impact Zones	X	
257.64	Unstable Areas	X	

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FIGURES

Legend

----- Approximate Limit of Pond

— Approximate Property Boundary

1. Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
2. The WGS includes 2,527.47 acres zoned as Heave Industrial.
3. WGS boundary shown provided by Thomas & Hutton Dated 10 January 2014.

0 4,000 8,000 16,000 Feet

Vicinity Map

Santee Cooper Winyah Generation Station
Georgetown, South Carolina

Geosyntec consultants

Figure 1

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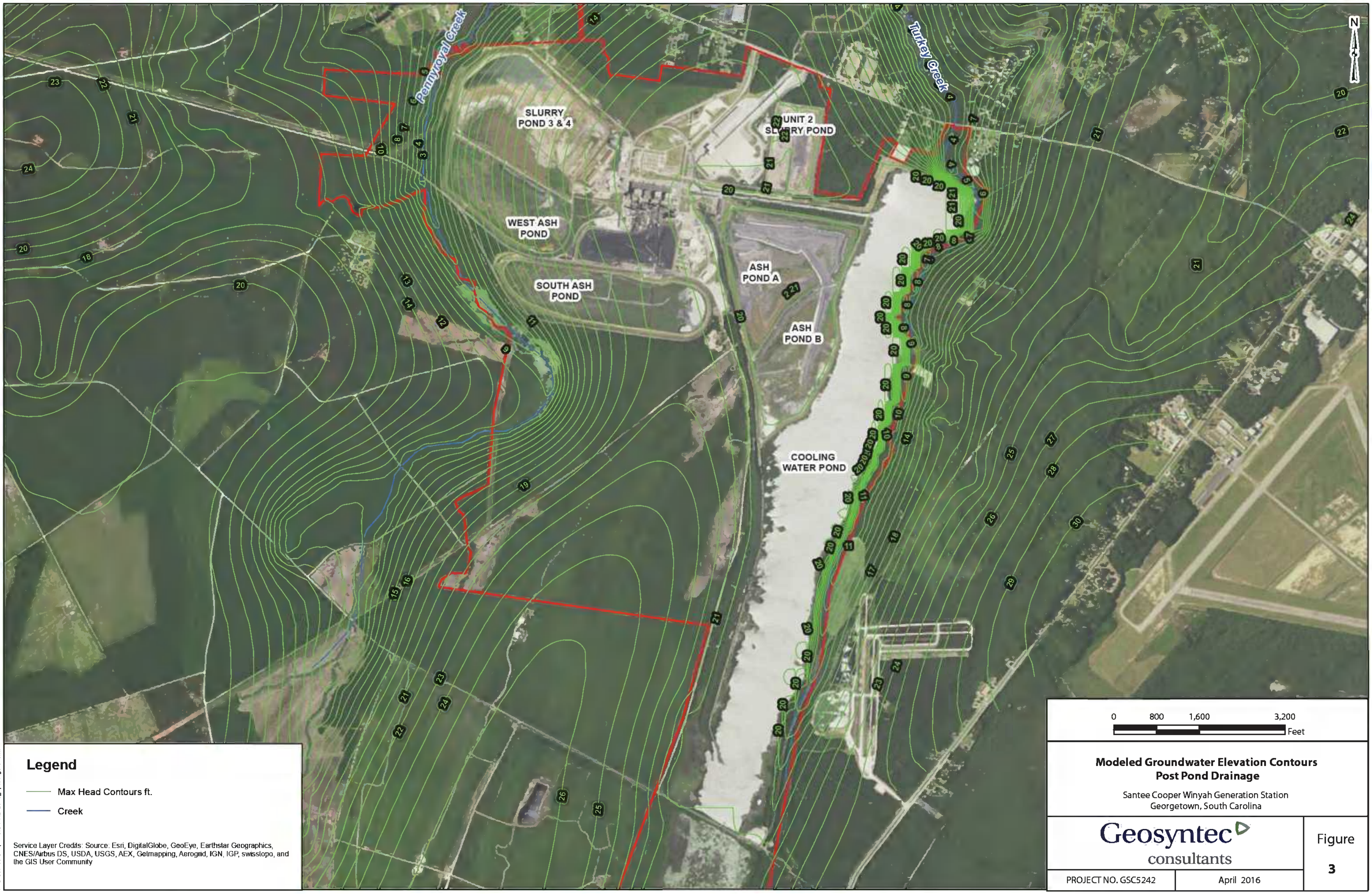
Site Layout Map

Santee Cooper Winyah Generation Station
Georgetown, South Carolina

Geosyntec consultants

Greenville, SC | February 2016

Figure 2



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Modeled Groundwater Elevation Contours
Post Pond Drainage

Santee Cooper Winyah Generation Station
Georgetown, South Carolina

Geosyntec consultants

Figure 3

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