Prepared for

Santee Cooper
One Riverwood Drive
Moncks Corner, SC 29461

INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN – SLURRY POND 3 AND 4

WINYAH GENERATING STATION

Prepared by

Geosyntec consultants

engineers | scientists | innovators

104 South Main Street, Suite 115
Greenville, SC 29601

Project Number: GSC5242

October 2016

INTRODUCTION

Winyah Generating Station (WGS or the Site) is a 1,260 megawatt coal-fired steam electric generating facility owned and operated by South Carolina Public Service Authority (Santee Cooper). The Site is situated between Pennyroyal and Turkey Creeks and is located at 661 Steam Plant Drive in Georgetown, South Carolina. Coal combustion residuals (CCR) generated at WGS have been historically managed in existing CCR surface impoundments.

In response to the recently published CCR Rule (40 Code of Federal Regulations (CFR) Part 257), South Carolina Public Service Authority (Santee Cooper) retained Geosyntec Consultants, Inc. (Geosyntec) to prepare documentation for existing surface impoundments (SIs) at WGS. Pursuant to Section 257.82(c) of the CCR Rule, Geosyntec Consultants (Geosyntec) prepared this Inflow Design Flood Control System Plan for the Slurry Pond 3 & 4 (Slurry Pond) at WGS.

Section § 257.82(a) of the Rule states that "*The owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (2) of this section.*" The Preamble to the CCR Rule provides guidance on the documentation that should be provided for the Inflow Design Flood Control System Plan.

The inflow design flood control system for the Slurry Pond at the Site consists of maintaining minimum operating freeboards for the SI. Justification and documentation of the adequacy of the inflow design flood control systems are presented in the sections below.

The work presented in this report was performed under the direction of Mr. Fabian Benavente, P.E., of Geosyntec in accordance with §257.82(c).

SURFACE IMPOUNDMENT DESCRIPTION

The Slurry Pond, encompassing approximately 106 acres (ac), is situated near the northwest corner of the Site, directly adjacent to Pennyroyal Creek. The Slurry Pond is bounded by perimeter dikes which are approximately 30 feet (ft) in height to the north, 26 ft in height to the west, and 18 ft in height to the east (Thomas and Hutton, 2012). The Slurry Pond is separated from the West Ash Pond by a divider dike which forms the southern boundary of the Slurry Pond. Under the CCR Rule, the West Ash Pond is an inactive landfill. A Site Map depicting the Slurry Pond boundary and hydraulic features associated with the Slurry Pond is provided in **Figure 1**.

The Slurry Pond receives Flue Gas Desulfurization (FGD) residuals that do not meet specifications for use as wallboard grade gypsum or which contain gypsum fines discharged from the Dewater Plant. Typically, the Slurry Pond received 2,888,000 gallons per day (GPD) of FGD process water (Santee Cooper, 2013). The Slurry Pond also receives process water and stormwater from the Limestone Slurry/Ball Mill area and stormwater from Detention Pond No. 2.

Stormwater is collected in Detention Ponds No. 1 and No. 2 located along the outside perimeter of the Slurry Pond. These Detention Ponds were designed to manage the 25 yr, 24 hour (hr) storm event (Santee Cooper, 2004). Pump Station No. 2 receives water from Detention Pond No. 2 and discharges to the Slurry Pond. Detention Pond No. 2 is equipped with a spillway to Pennyroyal Creek which may only be activated during storm events greater than the 25 yr, 24 hr storm. Stormwater from the West Ash Pond gravity drains to the Slurry Pond through two (2) 36 inch (in.) diameter culverts. There are also four (4) 22 in. diameter culverts with higher invert elevations and an emergency spillway that hydraulically connects the Slurry Pond and West Ash Pond. Additionally, piping exists to route flow from the Coal Pile Runoff Pump Station to the Slurry Pond. However, Coal Pile runoff is currently routed to the South Ash Pond

A Floating Pump Station equipped with two (2) Tsurumi GSZ-4-45-4 submersible pumps, installed in the Slurry Pond in 2015, normally conveys water from the Slurry Pond directly to the Discharge Canal. The capacity of these pumps operating in parallel is 3,100 gallons per minute (gpm) at the maximum head, normal pool operating elevation of 19.6 ft NGVD 29 when pumping directly to the Discharge Canal (Geosyntec, 2014). Piping is valved such that the Floating Pump Station may convey water to the Pump Station No. 1 sump located immediately east of the Slurry Pond. Pump Station No. 1

conveys water to the Discharge Canal, which is connected to and flows into the Cooling Pond.

CATCHMENT AREAS AND DESIGN STORM EVENT

The contributing watershed areas for the West Ash Pond and Slurry Pond are 64.4 ac and 107.2 ac, respectively. These areas were delineated using the dike crests to correspond to the ponds' direct drainage areas. A description of drainage areas is included in the Hydrologic and Hydraulic Analysis report, provided in Appendix A. Since the Slurry Pond is classified as a high hazard potential surface impoundment (Geosyntec, 2016), the inflow design flood is the Probable Maximum Flood (PMF) storm event.

STORAGE CAPACITIES

The available stormwater storage volume in the Slurry Pond between elevations 12 ft (pond bottom per bathymetric survey) and 35.67 ft NGVD 29 was calculated by developing an area-volume curve based on topographic and bathymetric data (Thomas and Hutton, 2012) (Thomas and Hutton, 2016). The lowest available contour within the Slurry Pond is 12 ft NGVD 29. The minimum crest elevation of the Slurry Pond perimeter dikes is 35.67 ft NGVD 29. The surface area of each contour was measured and tabulated at each elevation. Next, the available surface water volume in each depth increment was calculated by averaging the surface area of the upper and lower contour and multiplying by the change in elevation between each contour. The cumulative storage volume of Slurry Pond between these elevations is 510.2 ac-ft. The available cumulative storage volume between 19.6 ft and 35.67 ft NGVD 29 is 469.9 ac-ft. The area-volume data are presented in Appendix A.

Similarly, the available stormwater storage volume of the West Ash Pond between elevations 26 ft and 37 ft National Geodetic Vertical Datum of 1929 (NGVD 29) (approximate crest) was calculated by developing an area-volume curve based on the closure design grading plan (Geosyntec, 2015). The lowest available contour within the West Ash Pond is 26 ft NGVD 29. The minimum crest elevation of the West Ash Pond perimeter dikes is 37 ft NGVD 29. The surface area of each contour was measured and tabulated at each elevation. The available surface water volume in each depth increment was calculated by averaging the surface area of the upper and lower contour and multiplying by the change in elevation between each contour. The cumulative storage volume of the West Ash Pond between these elevations is 98.9 acre-feet (ac-ft). The area-volume data are presented in Appendix A.

HYDROLOGIC AND HYDRAULIC ANALYSIS

Geosyntec performed a hydrologic and hydraulic analysis of the Slurry Pond. Stormwater runoff volumes and associated discharges to the Slurry Pond were modeled using *HydroCAD Version 10.0* software (HydroCAD, 2011). In addition to stormwater, FGD process inflows were input to the model. The model also assumed that the Floating Pump Station is non-operational due to temporary loss of power during the PMF storm event. Appendix A presents the Hydrologic and Hydraulic analysis report and documents assumptions, rainfall abstractions, and drainage areas.

ROUTING RESULTS

The *HydroCAD* model results are presented in Appendix A. During the PMF storm event, the Slurry Pond and the West Ash Pond will effectively operate as a single pond as the intermediary culverts and spillway allow flow between both areas. To ensure that these ponds are not over-topped during the design storm event, the following operational modifications to the Slurry Pond inflows are recommended –

a. Pump Station No. 2, located just north of the Slurry Pond, shall be shut off during storm events greater than the 25 yr, 24 hr storm. Detention Pond No. 2 and Pump Station No. 2 are designed to manage the 25 yr storm. The Site is permitted to discharge over the Detention Pond No. 2 emergency spillway to Pennyroyal Creek during larger storm events.

b. The Coal Pile Runoff Pump Station shall not pump stormwater to the Slurry Pond.

c. Activation of the Detention Pond No. 2 spillway shall serve as a trigger for the plant to shut down Pump Station No. 2 to eliminate this stormwater flow from entering the Slurry Pond.

The resulting peak water surface elevation at the Slurry Pond and West Ash Pond during the PMF storm event based on the hydraulic and hydrologic analysis are shown in **Table 2**. The SlurryPond will effectively contain the PMF storm event and maintain a freeboard of 0.3 feet. Detailed results are presented in Appendix A.

Table 2 – Peak Elevations and Freeboard

Event	*Slurry Pond*		*West Ash Pond*	
	Elevation (NGVD 29) (ft)	*Freeboard (ft)*	*Elevation (NGVD 29) (ft)*	*Freeboard (ft)*
Normal Operating Condition	19.6	16.1	-	-
PMF, 72-Hr	35.37	0.30	36.67	0.33

CERTIFICATION

This inflow design flood control system plan meets the requirements of this section (§257.82 Hydrologic and hydraulic capacity requirements for CCR impoundments.) 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 did evaluate it to determine whether it was consistent with other information that we developed in the course of our performance of the scope of services.

Certified by:

Carlos F. Benavente Date 10/12/2016

C. Fabian Benavente, P.E. South Carolina License Number 32067
Senior Engineer

REFERENCES

Geosyntec. (2014). *Mitigation Drawdown Design for Increased Seismic Stability, Slurry Pond 3 & 4 and West Ash Pond.*

Geosyntec. (2015). *Wastewater Construction Permit Request - Phase I West Ash Pond Closure.*

Geosyntec. (2016). *Hazard Potential Classification Assessment - Slurry Pond 3 and 4.*

HydroCAD. (2011). *HydroCAD Stormwater Modeling.* HydroCAD Software Solutions, LLC.

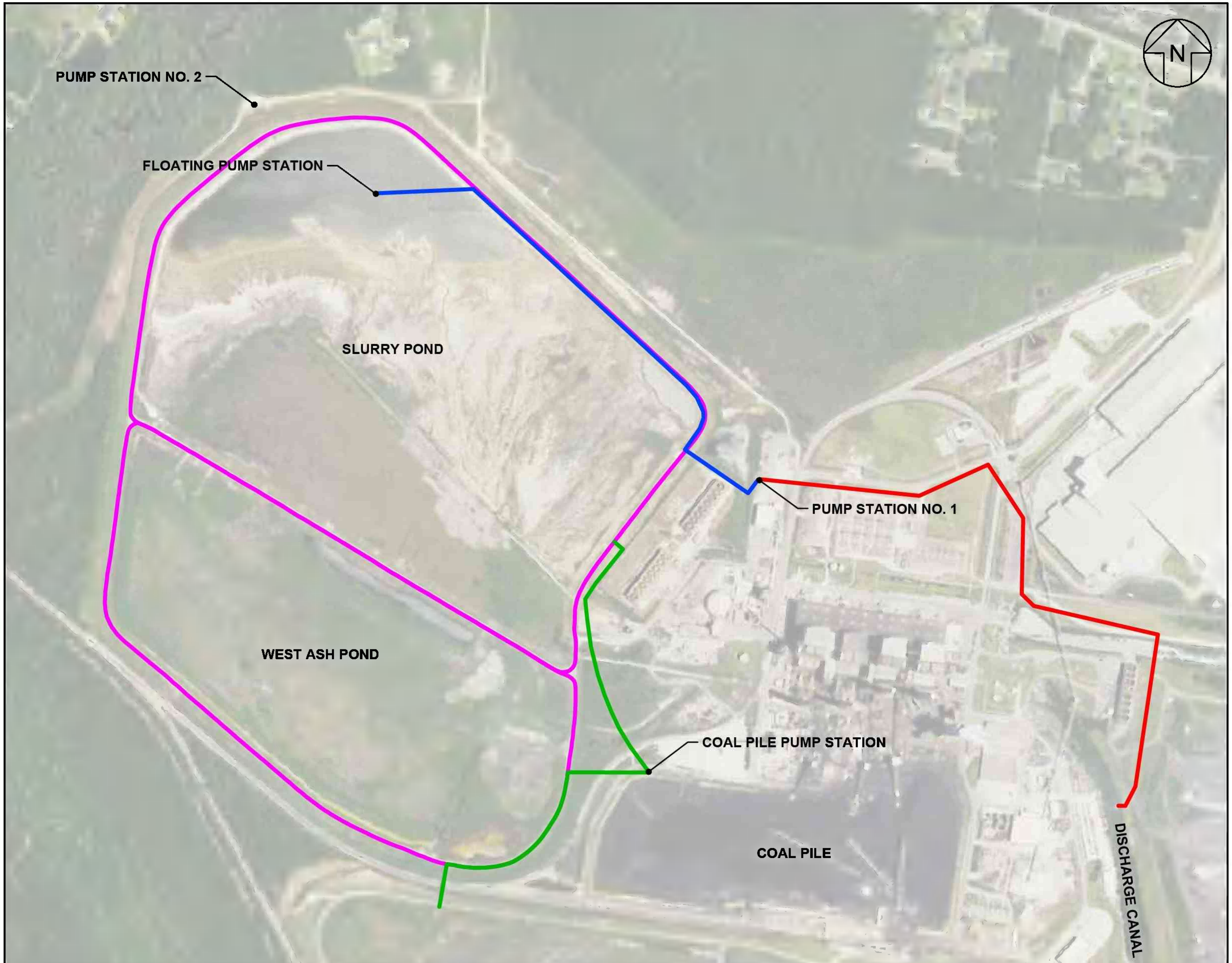
Santee Cooper. (2004). *Pump Station Design Report - Winyah Generating Station Redirect Drainage Project.*

Santee Cooper. (2013). *Inter-Office Communication - Winyah Generating Station Construction Report, Hydrologic Remediation of West Ash Pond and Unit 3 & 4 Slurry Pond.*

Thomas and Hutton. (2012). *Topographic Survey of a Portion of Santee Cooper Winyah Generating Station.*

Thomas and Hutton. (2016). *Topographic Survey of the Dike Crests at Santee Cooper Winyah Generating Station.*

FIGURES



LEGEND

- POND BOUNDARY
- APPROXIMATE PIPE ALIGNMENT FROM COAL PILE PUMP STATION
- PIPE ALIGNMENT FROM FLOATING PUMP STATION TO PUMP STATION NO. 1
- PIPE ALIGNMENT FROM PUMP STATION NO. 1 TO DISCHARGE CANAL

0 500' 1000'
SCALE IN FEET

WINYAH GENERATING STATION
SITE MAP

Geosyntec consultants

FIGURE 1

PROJECT NO: GSC5242 | OCTOBER 2016

M:\S\SANTEE COOPER\SANTEE COOPER-WINYAH\0028-WINYAH H&H ANALYSES\FIGURES\F-0-SC-585-00-F0028-013

APPENDIX A

Hydrologic and Hydraulic Analysis – Slurry Pond

Geosyntec consultants

COMPUTATION COVER SHEET

Client:	**Santee Cooper**	Project:	**Winyah Generating Station**	Project/ Proposal No.:	**GSC5242**
				Task No.	**01**

Title of Computations: **Hydrologic and Hydraulic Analysis: Slurry Pond 3 and 4**

Computations by:	Signature	Sarah M. Herr	2/10/16
	Printed Name	Sarah Herr	Date
	Title	Senior Staff Engineer	
Assumptions and Procedures Checked by: (senior reviewer)	Signature	Brianna L. Wallace	10/7/16
	Printed Name	Brianna Wallace	Date
	Title	Senior Engineer	
Computations, Assumptions, and Procedures Checked by: (peer reviewer)	Signature	[signature]	10/7/16
	Printed Name	Hari Parthasarathy	Date
	Title	Senior Staff Engineer	
Computations backchecked by: (originator)	Signature	Sarah M. Herr	10/7/16
	Printed Name	Sarah Herr	Date
	Title	Senior Staff Engineer	
Approved by: (pm or designate)	Signature	Brianna L. Wallace	10/7/16
	Printed Name	Brianna Wallace	Date
	Title	Senior Engineer	

Approval notes:

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

Written by:	S. Herr	Date:	10/7/16	Reviewed by:	B. Wallace	Date:	10/7/16
Client:	Santee Cooper	Project:	Winyah Generating Station	Project/ Proposal No.:	GSC5242	Task No.:	01

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Written by:	S. Herr	Date:	10/7/16	Reviewed by:	B. Wallace	Date:	10/7/16
Client:	Santee Cooper	Project:	Winyah Generating Station	Project/ Proposal No.:	GSC5242	Task No.:	01

PURPOSE AND BACKGROUND

Winyah Generating Station (WGS or the Site) is a coal-fired, electric generating facility located in Georgetown County, South Carolina. The Site is located between Pennyroyal and Turkey Creeks, tributaries to the Sampit River, and is approximately four miles southwest of Georgetown.

The purpose of this computation package is to evaluate the hydraulic capacity of Slurry Pond 3 and 4 (Slurry Pond) to support spillway capacity assessment requirements, static factor of safety analyses, and hazard rankings required by the United States Environmental Protection Agency's (USEPA's) Coal Combustion Residuals (CCR) Rule. The Slurry Pond is regulated by the CCR Rule as an existing CCR surface impoundment. Under the CCR Rule, a high hazard ranking classification is associated with the Probable Maximum Flood (PMF) precipitation event. Since the Slurry Pond is a high hazard surface impoundment, the PMF storm frequency is analyzed herein.

The Slurry Pond, encompassing approximately 107 acres (ac), is situated near the northwest corner of the Site, directly adjacent to Pennyroyal Creek. (Note that 107 ac is the area contained within the dike crest boundary. The area of the limits of CCR is slightly less at approximately 106 ac.) The Slurry Pond is bounded by perimeter dikes which are approximately 30 feet (ft) in height to the north, 26 ft in height to the west, and 18 ft in height to the east (Thomas and Hutton, 2012). The Slurry Pond is separated from the West Ash Pond by a divider dike which forms the southern boundary of the Slurry Pond. Under the CCR Rule, the West Ash Pond is an inactive landfill. A Site Map depicting the Slurry Pond boundary and hydraulic features associated with the Slurry Pond is provided in **Figure 1**.

The Slurry Pond receives Flue Gas Desulfurization (FGD) residuals that do not meet specifications for use as wallboard grade gypsum or which contain gypsum fines discharged from the Dewater Plant. The Slurry Pond also receives process water and stormwater from the Limestone Slurry/Ball Mill area and stormwater from Detention Pond No. 2. A Floating Pump Station, installed in the Slurry Pond in 2015, normally conveys water from the Slurry Pond directly to the Discharge Canal. Piping is valved such that the Floating Pump Station may convey water to the Pump Station No. 1 sump located immediately east of the Slurry Pond. Pump Station No. 1 conveys water to the Discharge Canal. The Discharge Canal is connected to and flows into the Cooling Pond.

Stormwater is collected in Detention Ponds No. 1 and No. 2 (shown as catchments 1S, 2S, and 3S and 4S, respectively, in **Appendix A**) located along the outside perimeter of the Slurry Pond. These Detention Ponds were designed to manage the 25 yr, 24 hour (hr) storm event (Santee Cooper, 2004). Pump Station No. 1 (labeled in **Figure 1**) receives water from Detention Pond No. 1, as well as Cooling Tower blowdown, and discharges to the Discharge Canal. Pump Station No. 2 receives water from Detention Pond No. 2 and discharges to the Slurry Pond. Detention Pond No. 2 is equipped with a spillway to Pennyroyal Creek which may only be activated during storm events greater than the 25 yr, 24 hr storm.

The West Ash Pond gravity drains to the Slurry Pond through two (2) 36 inch (in.) diameter culverts. There are also four (4) 22 in. diameter culverts with higher invert elevations and an emergency spillway that hydraulically connects the Slurry Pond and West Ash Pond. The West Ash Pond is not subject to the CCR Rule, because it has not impounded water since before the effective date of the CCR Rule.

METHODOLOGY

Stormwater runoff volumes and associated discharges to the Slurry Pond were modeled using *HydroCAD Version 10.0* software (HydroCAD, 2011). *HydroCAD* utilizes frequency-based precipitation events, in conjunction with watershed properties, to calculate peak runoff by several accepted methods. The Soil Conservation Service (SCS) Technical Release 20 (TR-20) method was applied in *HydroCAD* to calculate stormwater runoff volumes (SCS, 1982).

The following parameters and assumptions were selected for calculating stormwater runoff volumes to the West Ash Pond and Slurry Pond.

Rainfall

The 72 hr duration precipitation event was used in this analysis. It is the maximum duration precipitation event for which the National Oceanic and Atmospheric Agency (NOAA) provides isopluvial maps for PMF events. The rainfall depth corresponding to the 72 hr duration precipitation event for the PMF frequency return period for the Site is 53.0 in. (NOAA, 1978). The design storm hyetograph was developed using SCS Type III rainfall distribution and was directly input to the *HydroCAD* model.

Written by:	S. Herr	Date:	10/7/16	Reviewed by:	B. Wallace	Date:	10/7/16
Client:	Santee Cooper	Project:	Winyah Generating Station	Project/ Proposal No.:	GSC5242	Task No.:	01

Drainage Areas and Curve Numbers

The contributing watershed areas for the West Ash Pond and Slurry Pond are 64.4 ac and 107.2 ac, respectively. These areas were delineated using the dike crests to correspond to the ponds' direct drainage areas. Each pond was assigned a curve number (CN) based on guidance provided in Technical Release 55 (TR-55) (SCS, 1986) representing the type of ground cover in that area. The West Ash Pond closure plan includes placement of a cover, consisting of seamed geomembrane panels, to limit infiltration into the underlying CCR material. As a result, the West Ash Pond ground cover was assumed to be impervious (CN = 98). Alternatively, Slurry Pond ground cover was assumed to be 90% FGD material and 10% water (Weighted CN = 87) (Santee Cooper, 2013). The contributing watershed areas and CNs are summarized in **Table 1** and were directly input to the *HydroCAD* model.

Times of Concentration Calculations

The time of concentration represents the time required for runoff to flow from the most hydraulically remote point of the drainage area to the point under investigation. The flow path from the most remote point within the West Ash Pond is characterized entirely as open channel flow (shown in **Figure 2**). Open channel flow travel times were calculated as:

$$T_t = \frac{L}{V}$$

where: T_t = travel time (seconds [s]);

L = flow length (ft); and

V = average velocity (feet per second [ft/s]).

Open channel flow velocities were calculated using Manning's equation. The average velocities were computed assuming bank-full elevation as:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where: V = average velocity (ft/s);

n = Manning's roughness coefficient;

R = hydraulic radius (ft); and

S = slope of hydraulic grade line (or longitudinal channel slope for normal flow conditions) (feet per feet [ft/ft]).

A Manning's roughness coefficient of 0.013 was used to represent open channel flow across the geomembrane cover for the West Ash Pond. The open channels were designed with trapezoidal configurations per Phase I of the West Ash Pond closure plan (Geosyntec, 2015). Channel dimensions are summarized in **Table 2**. The hydraulic radii were computed as:

$$R = \frac{A}{P_w}$$

where: R = hydraulic radius (ft);

A = cross sectional flow area (square feet [sq ft]); and

P_w = wetted perimeter (ft).

The cross sectional flow areas were calculated by:

$$A = (B + DZ)D$$

where: A = cross sectional flow area (sq ft);

B = bottom width of the channel (ft);

D = depth of the channel (ft); and

Z = side slope of the channel (horizontal run divided by vertical rise) (ft/ft).

The wetted perimeters were calculated by:

$$P_w = B + 2D\sqrt{1 + Z^2}$$

where: P_w = wetted perimeter (ft);

B = bottom width of the channel (ft);

D = depth of the channel (ft); and

Z = side slope of the channel (horizontal run divided by vertical rise (ft/ft).

The parameters used to describe open channel flow in the West Ash Pond are presented in **Table 3**. The computed times of concentration for the West Ash Pond channels are summarized in **Table 4**.

The flow path from the most remote point within the Slurry Pond is characterized by sheet flow, shallow concentrated flow, and channel flow (shown in **Figure 3**). *HydroCAD* applied the Overton and Meadows formulation to calculate travel time for sheet flow for distances less than 300 ft (NRCS, 2010):

$$T_t = \frac{0.007(n\mathrm{L})^{0.8}}{P_{2-24}^{0.5} S^{0.4}}$$

where: T_t = travel time for overland sheet flow (hr);

n = Manning's roughness coefficient for sheet flow (--);

L = flow length (ft);

$P_{2\text{-}24}$ = 2 yr, 24 hr rainfall (in.); and

S = slope of hydraulic grade line (or land slope) (ft/ft).

A Manning's roughness coefficient of 0.020 was used to represent sheet flow in the Slurry Pond. The sheet flow length was limited to 100 ft, because sheet flow beyond 100 ft typically transitions to shallow concentrated flow. The rainfall depth for the 2 yr, 24 hr

Written by:	S. Herr	Date:	10/7/16	Reviewed by:	B. Wallace	Date:	10/7/16
Client:	Santee Cooper	Project:	Winyah Generating Station	Project/ Proposal No.:	GSC5242	Task No.:	01

frequency storm event is 4.38 in. (NOAA, 2006). The parameters used to model sheet flow within the Slurry Pond are shown in **Table 3**.

Shallow concentrated flow travel time was computed using the Upland Method (NRCS, 2010).

$$T_t = \frac{L}{V}$$

where: T_t = travel time (s);

L = flow length (ft); and

V = average velocity (ft/s).

The average velocity was computed using the following equation (NRCS, 2010).

$$V = K_v S^{0.5}$$

where: V = average velocity (ft/s);

K_v = velocity factor (ft/s); and

S = slope of hydraulic grade line (or land slope) (ft/ft).

A velocity factor of 16.1 ft/s, representing flow across an unpaved surface, was used to calculate shallow concentrated flow travel time within the Slurry Pond. The parameters used to describe shallow concentrated flow within the Slurry Pond are presented in **Table 3**.

Open channel flow within the Slurry Pond is characterized using the method previously described for open channel flow within the West Ash Pond. The open channel flow velocities were calculated using Manning's equation. A Manning's roughness coefficient of 0.020 was selected to represent open channel flow across the FGD residuals present within the Slurry Pond. The open channels were designed with trapezoidal configurations per Phase I of the West Ash Pond closure plan (Geosyntec, 2015). Channel dimensions are summarized in **Table 2**. The parameters used to describe open channel flow within the Slurry Pond are presented in **Table 3**. The resulting times of concentration for sheet flow, shallow concentrated flow, and open channel flow are presented in **Table 4**.

Inflows

In the *HydroCAD* model, stormwater inflow generated from the West Ash Pond and Slurry Pond is modeled as Sub-Catchments 1S and 2S, respectively. Stormwater inflow generated from Sub-Catchment 1S is routed into Pond 3P (the West Ash Pond), while stormwater inflow generated from Sub-Catchment 2S flows into Pond 4P (the Slurry Pond). The *HydroCAD* model routing diagram is provided in **Appendix B**.

In addition to stormwater inflow, FGD process water is discharged to the Slurry Pond. This base flow is represented by Node 5L in the *HydroCAD* model and contributes to the inflow to Pond 4P, the Slurry Pond. The base process water inflow when all four units are operational is modeled as 2,880,000 gallons per day (gpd) (4.46 cubic feet per second [cfs]) (Santee Cooper, 2013).

The Slurry Pond normally receives flow from Pump Station No. 2. This pump station must be shut down during storm events greater than the 25 yr, 24 hr event to ensure no overtopping of the Slurry Pond. Additionally, piping exists to route flow from the Coal Pile Runoff Pump Station to the Slurry Pond. However, Coal Pile runoff is currently routed to the South Ash Pond. This analysis assumes no inflows from the Coal Pile Runoff Pump Station.

Storage Capacities

In *HydroCAD*, Ponds 3P and 4P model the available storage volumes within the West Ash Pond and Slurry Pond, respectively.

The available stormwater storage volume of the West Ash Pond between elevations 26 ft and 37 ft National Geodetic Vertical Datum of 1929 (NGVD 29) (approximate crest) was calculated by developing an area-volume curve based on the closure design grading plan (Geosyntec, 2015). The lowest available contour within the West Ash Pond is 26 ft NGVD 29. The minimum crest elevation of the West Ash Pond perimeter dikes is 37 ft NGVD 29. The surface area of each contour was measured and tabulated at each elevation. The available surface water volume in each depth increment was calculated by averaging the surface area of the upper and lower contour and multiplying by the change in elevation between each contour. The cumulative storage volume of the West Ash Pond between these elevations is 98.9 acre-feet (ac-ft). The area-volume data are presented in **Table 5**.

Similarly, the available stormwater storage volume in the Slurry Pond between elevations 12 ft (pond bottom per bathymetric survey) and 35.67 ft NGVD 29 was calculated by developing an area-volume curve based on topographic and bathymetric data (Thomas and Hutton, 2012; Thomas and Hutton, 2016). The lowest available contour within the Slurry Pond is 12 ft NGVD 29. The minimum crest elevation of the Slurry Pond perimeter dikes is 35.67 ft NGVD 29. The surface area of each contour was measured and tabulated at each elevation. Next, the available surface water volume in each depth increment was calculated by averaging the surface area of the upper and lower contour and multiplying by the change in elevation between each contour. The cumulative storage volume of Slurry Pond between these elevations is 510.2 ac-ft. Per the weekly inspection reports, the Slurry Pond is maintained at a normal operational pool elevation of 19.6 ft NGVD 29 by the Floating Pump Station. As a result, the starting elevation of Pond 4P is set to 19.6 ft NGVD 29. The available cumulative storage volume between 19.6 ft and 35.67 ft NGVD 29 is 469.9 ac-ft. The area-volume data are presented in **Table 5**.

<u>Outlet Structures</u>

The outlet structures between the West Ash Pond to the Slurry Pond include two (2) 36 in. diameter smooth interior, corrugated exterior, high density polyethylene (HDPE) pipe culverts with upstream inverts at 25.96 and 25.90 ft NGVD 29 (Thomas and Hutton, 2016). An existing 200 ft wide spillway with an invert elevation of 36.25 ft NGVD 29 is provided in the divider dike (Santee Cooper, 2013). These outlet structures allow water to drain from the West Ash Pond to Slurry Pond. Additionally, four (4) 22 in. diameter HDPE pipe culverts from historical operations (upstream invert elevations at 33.40 ft, 33.25 ft, 33.42 ft, and 33.32 ft NGVD 29) also hydraulically connect the Slurry Pond to the West Ash Pond (Santee Cooper, 2013; Thomas and Hutton, 2016).

The Slurry Pond is equipped with two (2) Tsurumi GSZ-4-45-4 submersible pumps, housed in the Floating Pump Station located over the deepest area of the Slurry Pond. The capacity of these pumps operating in parallel is 3,100 gallons per minute (gpm) at the maximum head, normal pool operating elevation of 19.6 ft NGVD 29 when pumping directly to the Discharge Canal (Geosyntec, 2014). Normally, the Floating Pump Station discharges directly to the Discharge Canal. However, for this analysis, the Floating Pump Station is assumed to be nonoperational due to temporary loss of power during a large storm event.

Since Pump Station No. 1 is designed to manage the 25 yr, 24 hr storm event, it will be inundated during the 100 yr, 24 hr and greater storm events. If the Detention Pond No. 2 spillway is activated (indicating a storm event greater than the 25 yr, 24 hr storm event), Santee Cooper will check the valves on the piping to ensure they are adjusted such that the Floating Pump Station will pump directly to the Discharge Canal. To allow Pump Station No. 1 to be completely dedicated to pumping stormwater flowing during a large storm event, Santee Cooper will pump Units 3 and 4 Cooling Tower blowdown directly to the Discharge Canal to allow Pump Station No. 1 to be fully committed to managing stormwater flows. Santee Cooper will also shut down Pump Station No. 2 that discharges to the Slurry Pond during storm events greater than the 25 yr, 24 hr storm event.

RESULTS

The resulting peak water surface elevations and storage volumes for the PMF storm event are shown in **Table 6**. During this storm event, the West Ash Pond and Slurry Pond will effectively operate as a single pond as the intermediate dike culverts and spillway allow flow between both storage areas. This hydrologic and hydraulic analysis demonstrates that the West Ash Pond and Slurry Pond contain the 72 hr duration precipitation event for the PMF frequency return period given the following assumptions and operating conditions:

- The normal maximum operating pool elevation for the Slurry Pond is 19.6 ft NGVD 29. This allows an additional 6.4 ft of storage capacity for operational flexibility during storm events. The maximum water elevation to maintain seismic stability is 26 ft NGVD 29.
- The Floating Pump Station is not operational due to temporary loss of power during a large storm event.
- Pump Station No. 2, located just north of the Slurry Pond, shall be shut off during storm events greater than the 25 yr, 24 hr storm. Detention Pond No. 2 and Pump

Station No. 2 are designed to manage the 25 yr storm. The Site is permitted to discharge over the Detention Pond No. 2 emergency spillway to Pennyroyal Creek during larger storm events.

- The Coal Pile Runoff Pump Station shall not pump stormwater to the Slurry Pond.
- Activation of the Detention Pond No. 2 spillway shall serve as a trigger for the plant to shut down Pump Station No. 2 to eliminate this stormwater flow from entering the Slurry Pond.

Written by:	**S. Herr**	Date:	**10/7/16**	Reviewed by:	**B. Wallace**	Date:	**10/7/16**
Client:	**Santee Cooper**	Project:	**Winyah Generating Station**	Project/ Proposal No.:	**GSC5242**	Task No.:	**01**

REFERENCES

Geosyntec. (2014). *Mitigation Drawdown Design for Increased Seismic Stability, Slurry Pond 3 & 4 and West Ash Pond.*

Geosyntec. (2015). *Wastewater Construction Permit Request - Phase I West Ash Pond Closure.*

HydroCAD. (2011). *HydroCAD Stormwater Modeling.* HydroCAD Software Solutions, LLC.

NOAA. (1978). *Probable Maximum Precipitation Estimates, United States East of the 105th Meridian.* Hydrometeorological Report No. 51. National Oceanic and Atmospheric Adminatration.

NOAA. (2006). *Precipitation-Frequency Atlas of the United States.* Atlas 14, Volume 2, Version 3.0, National Oceanic and Atmospheric Administration.

NRCS. (2010). National Engineering Handbook, Part 630: Hydrology.

Santee Cooper. (2004). *Pump Station Design Report - Winyah Generating Station Redirect Drainage Project.*

Santee Cooper. (2013). *Inter-Office Communication - Winyah Generating Station Construction Report, Hydrologic Remediation of West Ash Pond and Unit 3 & 4 Slurry Pond.*

SCS. (1982). *Technical Release Number 20 (TR-20).* National Technical Information Service.

SCS. (1986). *Technical Release Number 55 (TR-55).* Soil Conservation Service. National Technical Information Service.

Thomas and Hutton. (2012). *Topographic Survey of a Portion of Santee Cooper Winyah Generating Station.*

Thomas and Hutton. (2016). *Topographic Survey of the Dike Crests at Santee Cooper Winyah Generating Station.*

TABLES

Table 1 – Watershed Areas and Curve Numbers

Drainage Basin	Area (ac)	Weighted Curve Number (--)
West Ash Pond	64.4	98
Slurry Pond	107.2	87

Table 2 – Open Channel Dimensions (Geosyntec, 2015)

Flow Path	Channel Configuration	Side Slope Ratio (H:V) (ft:ft)	Bottom Width of the Channel (ft)	Depth of the Channel (ft)
West Ash Pond				
Channel A	Trapezoidal	3:1	4	3
Channel B	Trapezoidal	3:1	4	3
Channel C	Trapezoidal	3:1	14	3
Slurry Pond				
Channel A	Trapezoidal	3:1	14	4
Channel B	Trapezoidal	3:1	14	4

Table 3 – Input Parameters Describing Open Channel Flow, Sheet Flow, and Shallow Concentrated Flow

Flow Path	Open Channel Flow					Sheet Flow				Shallow Concentrated Flow		
	Cross Sectional Area (sq ft)	*Wetted Perimeter (ft)*	*Channel Slope (ft/ft)*	*Manning's Roughness Coefficient (--)*	*Flow Length (ft)*	*Land Slope (ft/ft)*	*Manning's Roughness Coefficient (--)*	*Flow Length (ft)*	*2 Yr, 24 Hr Rainfall (in.)*	*Flow Length (ft)*	*Land Slope (ft/ft)*	*Velocity Factor (ft/s)*
West Ash Pond												
Channel A	39	23.0	0.0025	0.013	302	--	--	--	--	--	--	--
Channel B	39	23.0	0.0025	0.013	1,022	--	--	--	--	--	--	--
Channel C	69	33.0	0.0025	0.013	2,222	--	--	--	--	--	--	--
Slurry Pond												
Sheet	--	--	--	--	--	0.0005	0.020	100	4.38	--	--	--
Shallow Concentrated	--	--	--	--	--	--	--	--	--	2,290	0.0009	16.1
Channel A	104	39.3	0.0025	0.020	656	--	--	--	--	--	--	--
Channel B	104	39.3	0.0169	0.020	674	--	--	--	--	--	--	--

Table 4 – Times of Concentration

Flow Path	Time of Concentration (minutes [min])
West Ash Pond	
Channel A	0.6
Channel B	2.1
Channel C	4.0
Slurry Pond	
Sheet	7.3
Shallow Concentrated	79.0
Channel A	1.5
Channel B	0.6

Table 5 – Stage Storage Table (Thomas and Hutton, 2012; Thomas and Hutton, 2016)

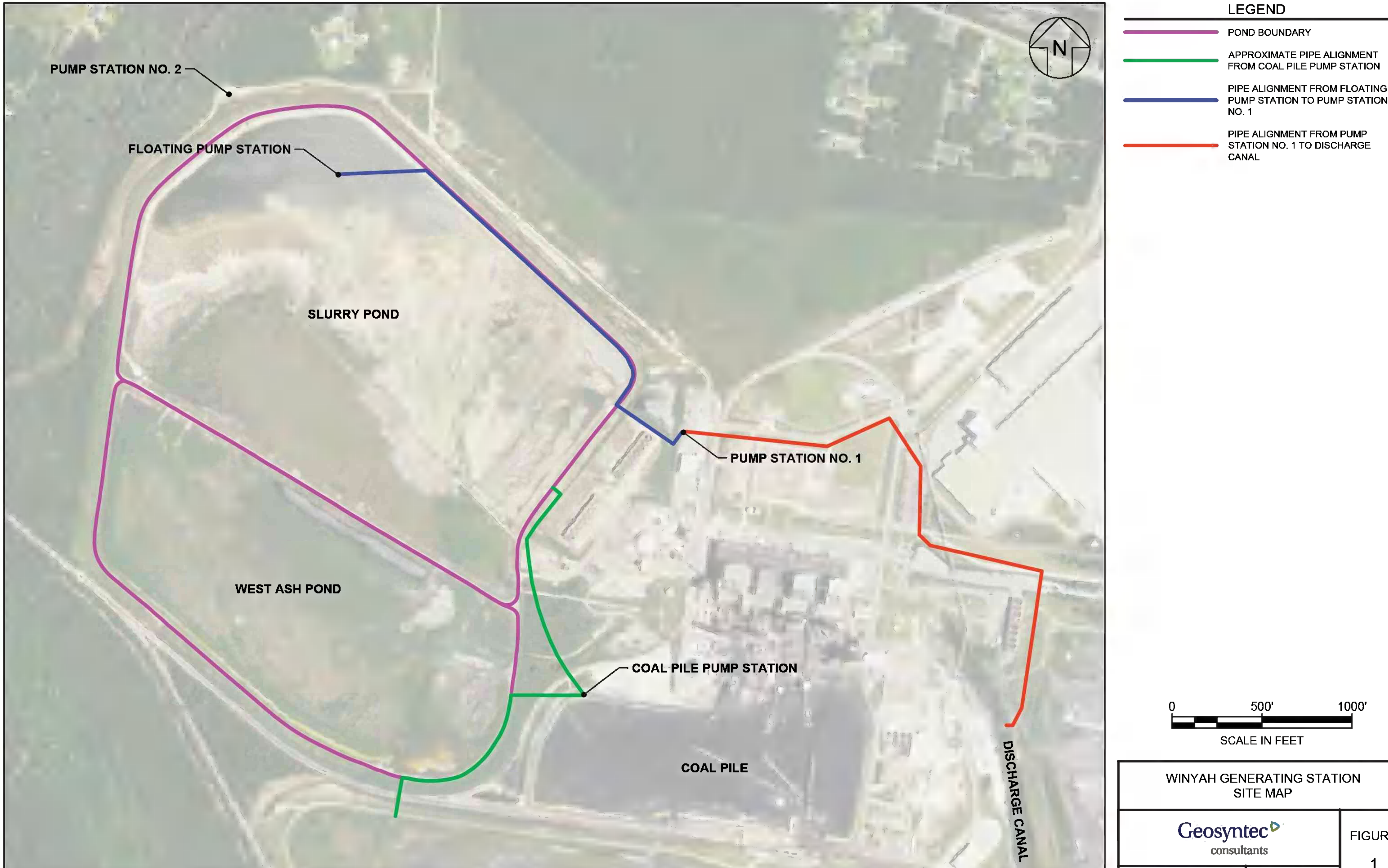
Slurry Pond				West Ash Pond			
Elevation (NGVD 29) (ft)	*Area (ac)*	*Volume (ac-ft)*	*Cumulative Volume (ac-ft)*	*Elevation (NGVD 29) (ft)*	*Area (ac)*	*Volume (ac-ft)*	*Cumulative Volume (ac-ft)*
35.67	77.2	103.9	510.2	37	36.6	32.0	98.9
34	47.2	83.6	406.3	36	27.4	23.4	66.9
32	36.4	67.5	322.7	35	19.4	16.4	43.5
30	31.0	57.5	255.3	34	13.4	11.1	27.1
28	26.5	49.0	197.7	33	8.9	7.1	16.0
26	22.5	41.3	148.7	32	5.4	4.2	8.9
24	18.8	34.3	107.5	31	3.0	2.3	4.7
22	15.5	28.0	73.2	30	1.6	1.3	2.4
20	12.6	22.2	45.2	29	0.9	0.7	1.1
18	9.6	14.7	23.0	28	0.5	0.3	0.4
16	5.0	6.7	8.3	27	0.2	0.1	0.1
14	1.6	1.7	1.7	26	0.0	0.0	0.0
12	0.0	0.0	0.0	--	--	--	--

Note: The *HydroCAD* model uses the normal operating pool elevation of 19.6 ft NGVD 29 as the starting water surface elevation for the Slurry Pond.

Table 6 – Peak Elevations and Volumes

Storm Event	West Ash Pond			Slurry Pond		
	Elevation (NGVD 29) (ft)	*Volume (ac-ft)*	*Time (hr)*	*Elevation (NGVD 29) (ft)*	*Volume (ac-ft)*	*Time (hr)*
PMF, 72 Hr	36.67	87.215	37.21	35.37	488.118	47.66

FIGURES



WINYAH GENERATING STATION
SITE MAP

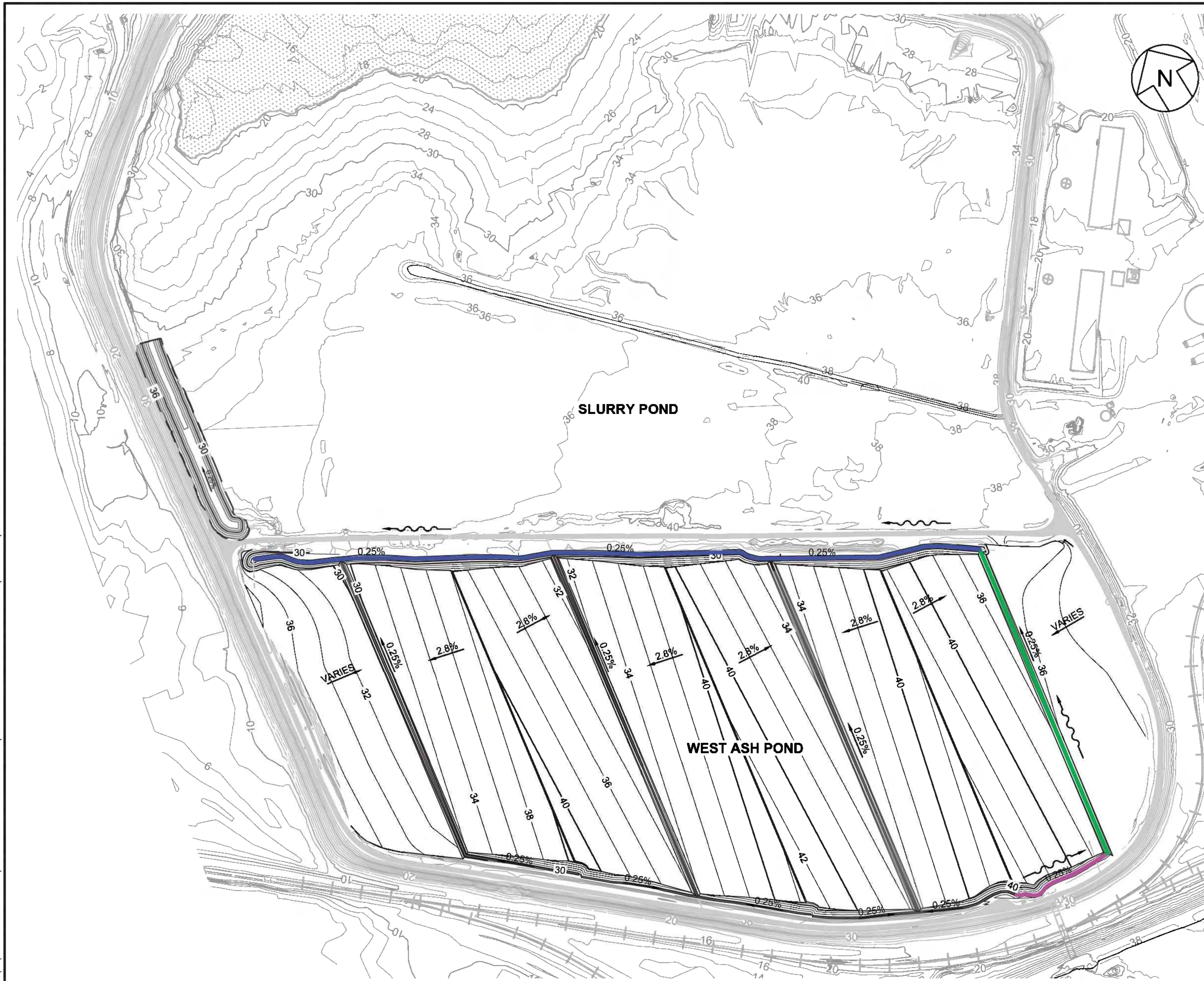
Geosyntec consultants

FIGURE 1

PROJECT NO: GSC5242 | OCTOBER 2016

M:\S\SANTEE COOPER\SANTEE COOPER-WINYAH\0028-WINYAH H&H ANALYSES\FIGURES\F-0-SC-585-00-F0028-013

M:\S\SANTEE COOPER\SANTEE COOPER-WINYAH\0028-WINYAH H&H ANALYSES\FIGURES\F-0-SC-585-00-F0028-014



LEGEND

- CHANNEL A FLOW
- CHANNEL B FLOW
- CHANNEL C FLOW
- NORMAL POOL OPERATING ELEVATION
- GENERAL FLOW DIRECTION

0 300' 600'

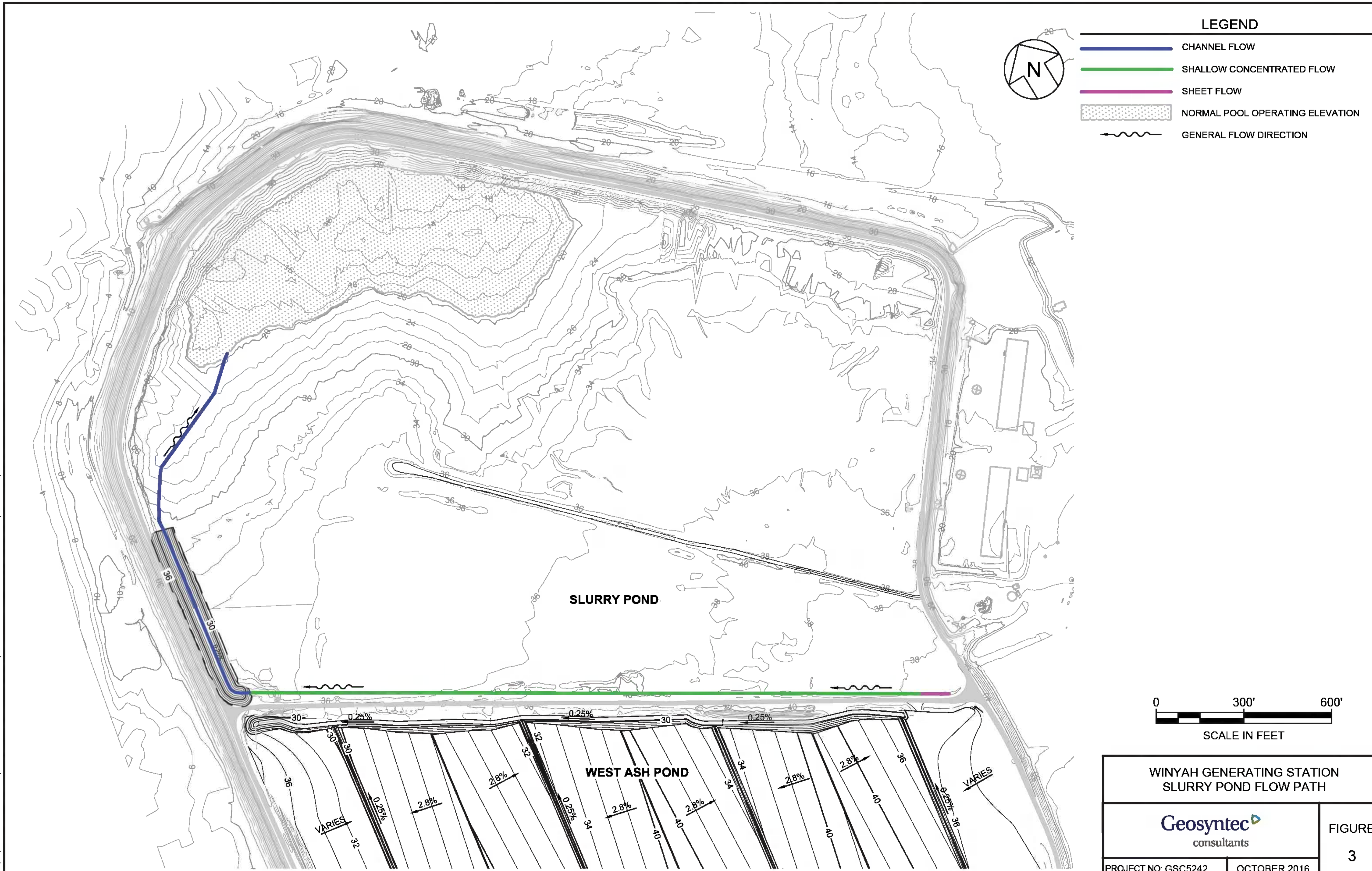
SCALE IN FEET

WINYAH GENERATING STATION
WEST ASH POND FLOW PATH

Geosyntec consultants

FIGURE 2

PROJECT NO: GSC5242 | OCTOBER 2016



WINYAH GENERATING STATION
SLURRY POND FLOW PATH

Geosyntec consultants

FIGURE 3

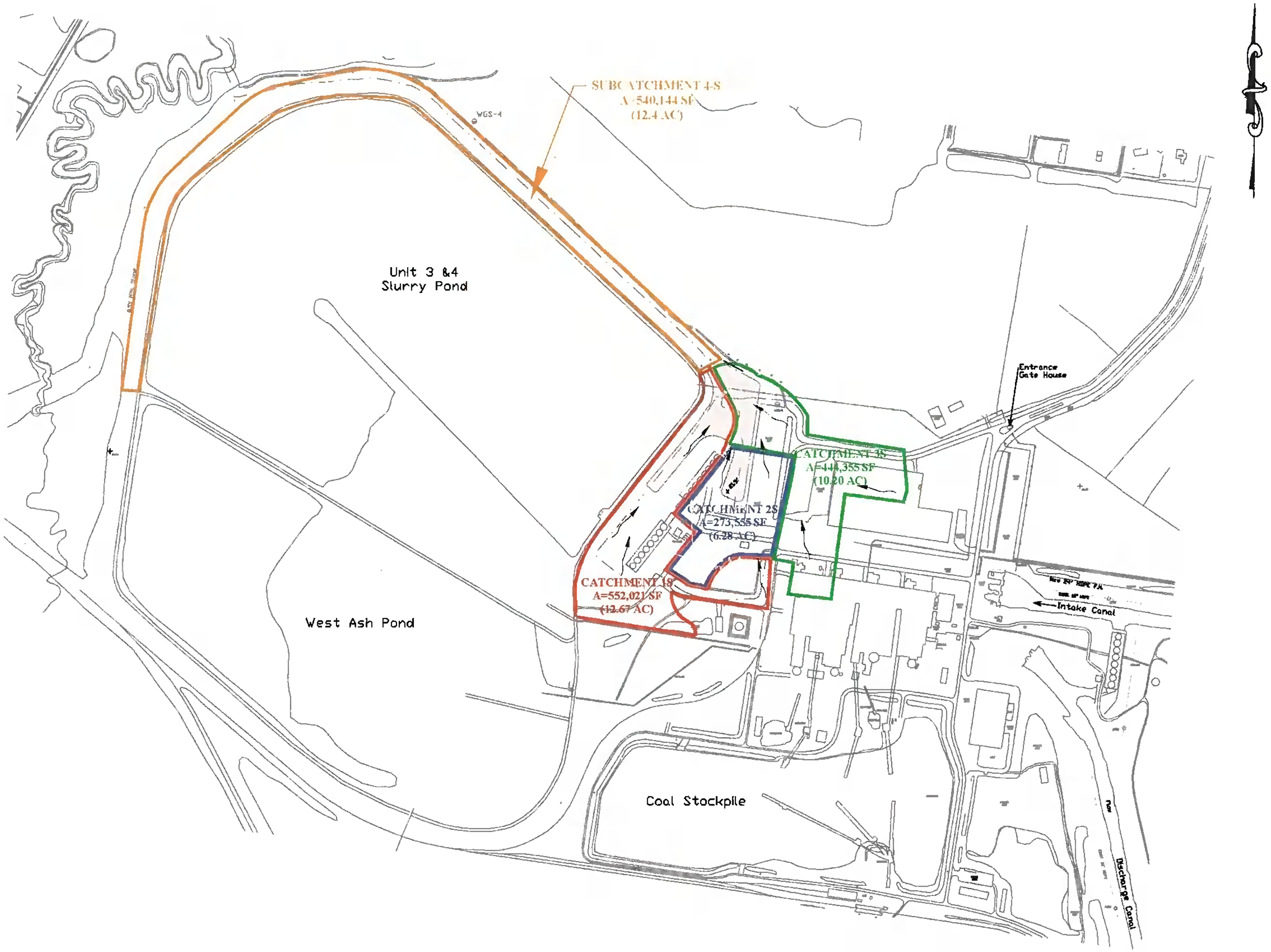
PROJECT NO: GSC5242

OCTOBER 2016

M:\S\SANTEE COOPER\SANTEE COOPER-WINYAH\0028-WINYAH H&H ANALYSES\FIGURES\F-0-SC-585-00-F0028-015

APPENDICES

APPENDIX A



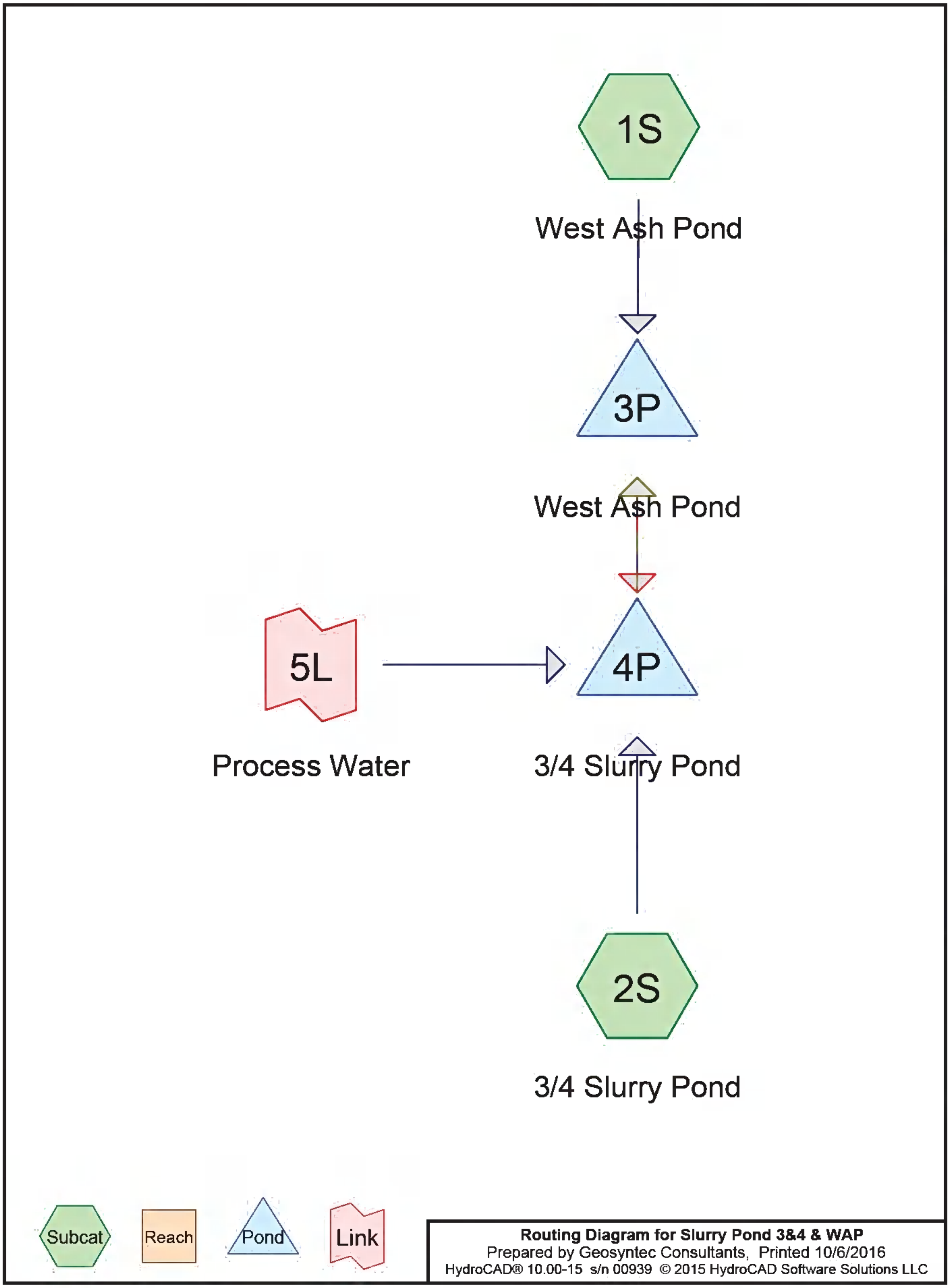
300 0 300 600 900

Scale 1" = 300'

REDUCED SCALE

GENERAL CONSTRUCTION			DRAINAGE AREAS
CIVIL PROJECTS			WINYAH GENERATION STATION DRAINAGE IMPROVEMENTS PROJECT GEORGETOWN, SOUTH CAROLINA
DRAFTER W. J. SMITH	CHECKED B. WILLIAMS		
DATE 10-30-03	AUTH. NO. 106741	SCALE: AS NOTED	
FILENAME:			SHEET 1 OF 1 — DWG. NO.

APPENDIX B


1S
West Ash Pond
3P
West Ash Pond
5L
Process Water
4P
3/4 Slurry Pond
2S
3/4 Slurry Pond
Subcat
Reach
Pond
Link
Routing Diagram for Slurry Pond 3&4 & WAP
Prepared by Geosyntec Consultants, Printed 10/6/2016
HydroCAD® 10.00-15 s/n 00939 © 2015 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
107.205	87	90% FGD + 10% Water (2S)
64.385	98	Exposed Geomembrane (1S)

Time span=0.00-600.00 hrs, dt=0.010 hrs, 60001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment1S: West Ash Pond Runoff Area=64.385 ac 100.00% Impervious Runoff Depth=52.76"
Flow Length=3,546' Slope=0.0025 '/' Tc=6.7 min CN=98 Runoff=1,282.84 cfs 283.057 af

Subcatchment2S: 3/4 Slurry Pond Runoff Area=107.205 ac 0.00% Impervious Runoff Depth=51.25"
Flow Length=3,720' Tc=88.4 min CN=87 Runoff=1,074.34 cfs 457.838 af

Pond 3P: West Ash Pond Peak Elev=36.67' Storage=87.215 af Inflow=1,282.84 cfs 283.057 af
mary=100.39 cfs 206.020 af Secondary=42.17 cfs 56.538 af Tertiary=140.83 cfs 20.496 af Outflow=270.20 cfs 283.053 af

Pond 4P: 3/4 Slurry Pond Peak Elev=35.37' Storage=488.118 af Inflow=1,209.40 cfs 923.126 af
Primary=119.39 cfs 810.254 af Secondary=0.00 cfs 0.000 af Tertiary=0.00 cfs 0.000 af Outflow=119.39 cfs 810.254 af

Link 5L: Process Water Manual Hydrograph Inflow=4.46 cfs 202.731 af
Primary=4.46 cfs 202.731 af

Summary for Subcatchment 1S: West Ash Pond

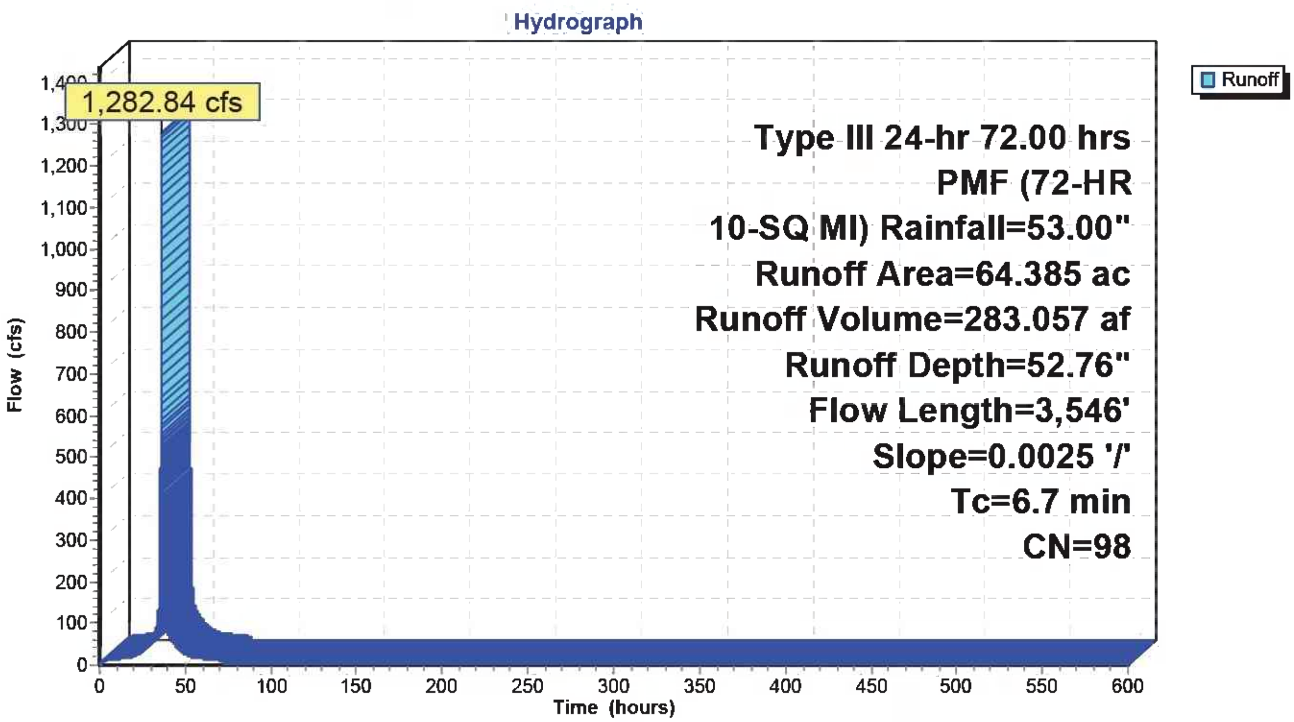
Runoff = 1,282.84 cfs @ 36.10 hrs, Volume= 283.057 af, Depth=52.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-600.00 hrs, dt= 0.010 hrs
Type III 24-hr 72.00 hrs PMF (72-HR, 10-SQ MI) Rainfall=53.00"

Area (ac)	CN	Description
64.385	98	Ex osed Geomembrane
64.385		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	302	0.0025	8.13	316.96	**Channel Flow, Channel A Flow** Area= 39.0 sf Perim= 23.0' r= 1.70' n= 0.013
2.1	1,022	0.0025	8.13	316.96	**Channel Flow, Channel B Flow** Area= 39.0 sf Perim= 23.0' r= 1.70' n= 0.013
4.0	2,222	0.0025	9.35	644.84	**Channel Flow, Channel C Flow** Area= 69.0 sf Perim= 33.0' r= 2.09' n= 0.013
6.7	3,546	Total			

Subcatchment 1S: West Ash Pond



Summary for Subcatchment 2S: 3/4 Slurry Pond

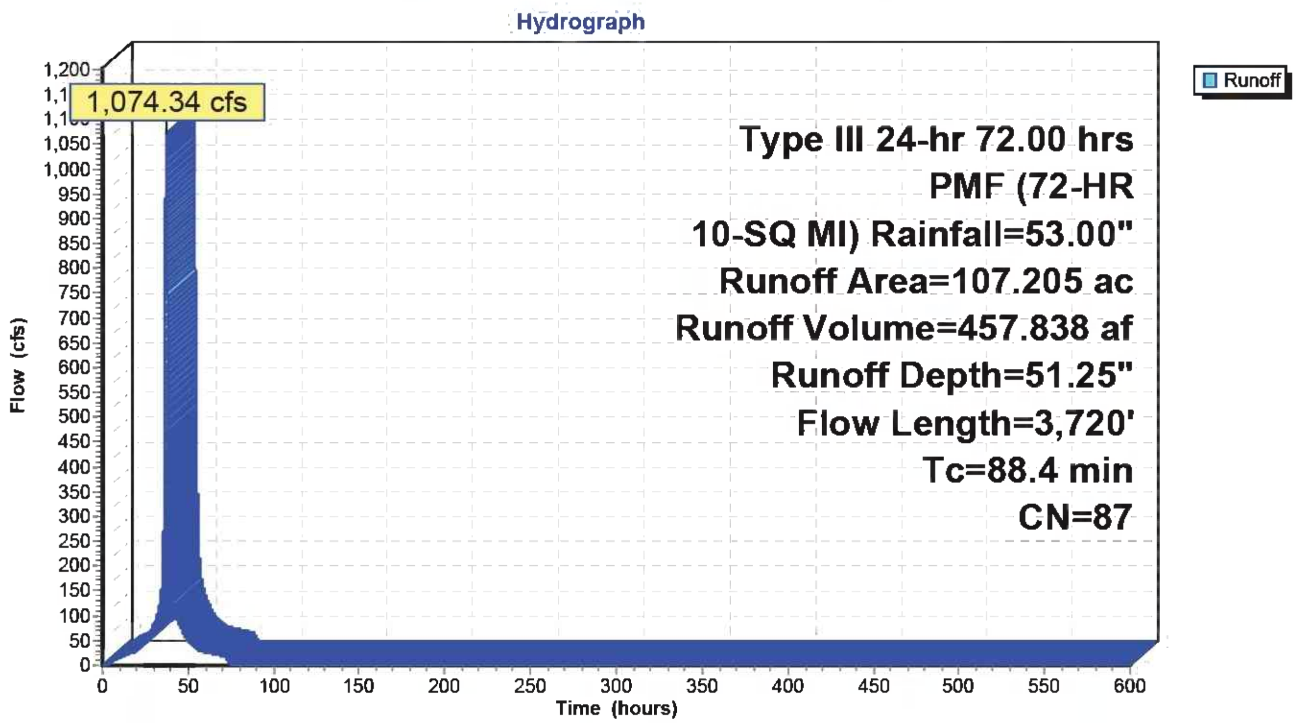
Runoff = 1,074.34 cfs @ 37.13 hrs, Volume= 457.838 af, Depth=51.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-600.00 hrs, dt= 0.010 hrs
Type III 24-hr 72.00 hrs PMF (72-HR, 10-SQ MI) Rainfall=53.00"

	Area (ac)	CN	Description
*	107.205	87	90% FGD + 10% Water
	107.205		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0005	0.23		**Sheet Flow, Sheet Flow** n= 0.020 P2= 4.38"
79.0	2,290	0.0009	0.48		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
1.5	656	0.0025	7.11	739.18	**Channel Flow, Channel A Flow** Area= 104.0 sf Perim= 39.3' r= 2.65' n= 0.020
0.6	674	0.0169	18.48	1,921.88	**Channel Flow, Channel B Flow** Area= 104.0 sf Perim= 39.3' r= 2.65' n= 0.020
88.4	3,720	Total			

Subcatchment 2S: 3/4 Slurry Pond



Summary for Pond 3P: West Ash Pond

Inflow = 1,282.84 cfs @ 36.10 hrs, Volume= 283.057 af
Outflow = 270.20 cfs @ 37.16 hrs, Volume= 283.053 af, Atten= 79%, Lag= 63.7 min
Primary = 100.39 cfs @ 36.34 hrs, Volume= 206.020 af
Secondary = 42.17 cfs @ 37.21 hrs, Volume= 56.538 af
Tertiary = 140.83 cfs @ 37.21 hrs, Volume= 20.496 af

Routing by Sim-Route method, Time Span= 0.00-600.00 hrs, dt= 0.010 hrs
Peak Elev= 36.67' @ 37.21 hrs Surf.Area= 33.519 ac Storage= 87.215 af

Plug-Flow detention time= 498.3 min calculated for 283.048 af (100% of inflow)
Center-of-Mass det. time= 498.7 min (2,673.6 - 2,175.0)

Volume	Invert	Avail.Storage	Storage Description
#1	26.00'	98.929 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
26.00	0.004	0.000	0.000
27.00	0.182	0.093	0.093
28.00	0.481	0.331	0.425
29.00	0.932	0.706	1.131
30.00	1.599	1.265	2.397
31.00	2.978	2.288	4.685
32.00	5.395	4.186	8.872
33.00	8.851	7.123	15.995
34.00	13.446	11.149	27.143
35.00	19.354	16.400	43.543
36.00	27.418	23.386	66.929
37.00	36.582	32.000	98.929

Device	Routing	Invert	Outlet Devices
#1	Primary	25.96'	**30.0" Round Culvert 1** L= 99.1' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 25.96' / 24.87' S= 0.0110 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf
#2	Primary	25.90'	**30.0" Round Culvert 2** L= 98.7' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 25.90' / 24.64' S= 0.0128 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf
#3	Secondary	33.40'	**17.8" Round Existing Culvert 1** L= 50.7' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 32.87' / 33.40' S= -0.0105 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.73 sf
#4	Secondary	33.25'	**17.8" Round Existing Culvert 2** L= 51.4' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 32.77' / 33.25' S= -0.0093 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.73 sf
#5	Secondary	33.42'	**17.8" Round Existing Culvert 3** L= 50.5' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 32.81' / 33.42' S= -0.0121 '/' Cc= 0.900

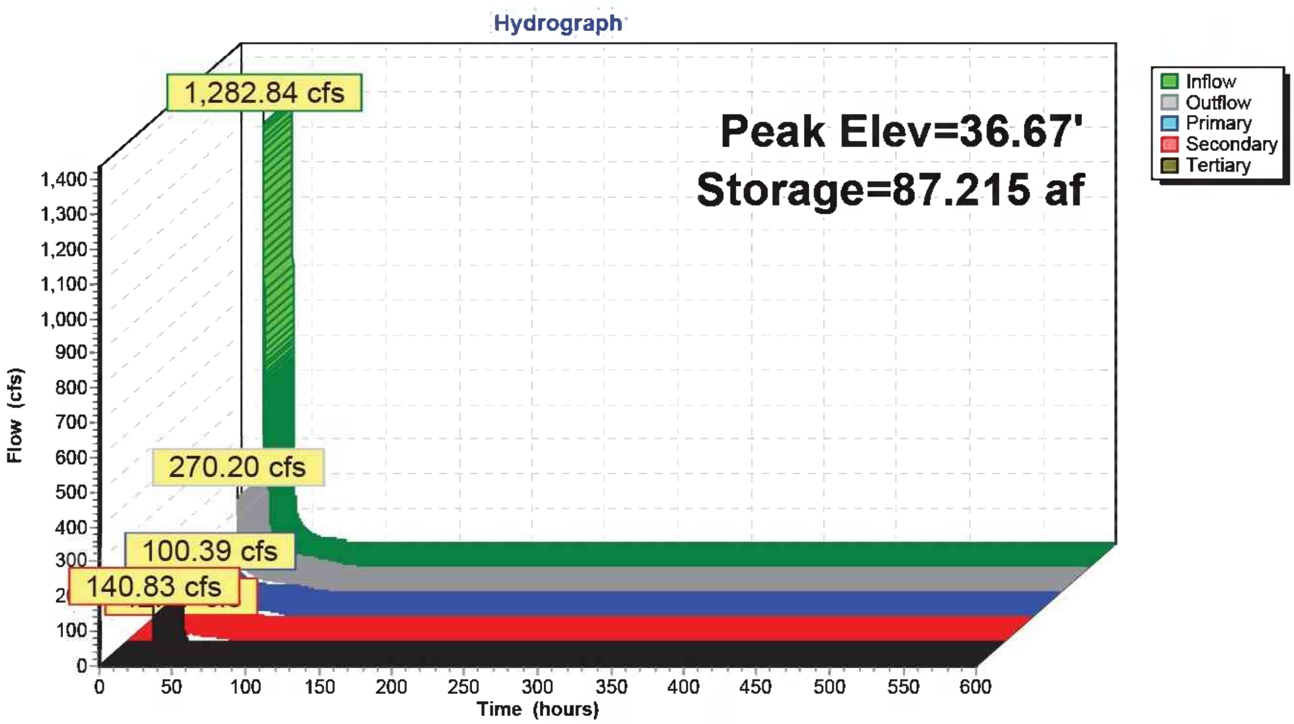
			n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.73 sf
#6	Secondary	33.32'	**17.8" Round Existing Culvert 4** L= 50.8' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 32.75' / 33.32' S= -0.0112 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.73 sf
#7	Tertiary	36.25'	**200.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64
#8	Tertiary	36.75'	**30.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64

Primary OutFlow Max=100.24 cfs @ 36.34 hrs HW=36.20' TW=30.42' (Dynamic Tailwater)
1=Culvert 1 (Inlet Controls 50.12 cfs @ 10.21 fps)
2=Culvert 2 (Inlet Controls 50.12 cfs @ 10.21 fps)

Secondary OutFlow Max=42.17 cfs @ 37.21 hrs HW=36.67' TW=32.39' (Dynamic Tailwater)
3=Existing Culvert 1 (Inlet Controls 10.44 cfs @ 6.04 fps)
4=Existing Culvert 2 (Inlet Controls 10.74 cfs @ 6.22 fps)
5=Existing Culvert 3 (Inlet Controls 10.40 cfs @ 6.02 fps)
6=Existing Culvert 4 (Inlet Controls 10.60 cfs @ 6.13 fps)

Tertiary OutFlow Max=140.82 cfs @ 37.21 hrs HW=36.67' (Free Discharge)
7=Broad-Crested Rectangular Weir (Weir Controls 140.82 cfs @ 1.69 fps)
8=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 3P: West Ash Pond



Summary for Pond 4P: 3/4 Slurry Pond

Inflow	=	1,209.40 cfs @	37.13 hrs,	Volume=	923.126 af
Outflow	=	119.39 cfs @	47.66 hrs,	Volume=	810.254 af, Atten= 90%, Lag= 631.6 min
Primary	=	119.39 cfs @	47.66 hrs,	Volume=	810.254 af
Secondary	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af
Tertiary	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af

Routing by Sim-Route method, Time Span= 0.00-600.00 hrs, dt= 0.010 hrs
Starting Elev= 19.60' Surf.Area= 11.970 ac Storage= 40.293 af
Peak Elev= 35.37' @ 47.66 hrs Surf.Area= 71.884 ac Storage= 488.118 af (447.824 af above start)

Plug-Flow detention time= 5,395.1 min calculated for 769.960 af (83% of inflow)
Center-of-Mass det. time= 2,120.8 min (7,651.1 - 5,530.3)

Volume	Invert	Avail.Storage	Storage Description
#1	12.00'	510.207 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
12.00	0.029	0.000	0.000
14.00	1.643	1.672	1.672
16.00	5.029	6.672	8.344
18.00	9.636	14.665	23.009
20.00	12.553	22.189	45.198
22.00	15.458	28.011	73.209
24.00	18.807	34.265	107.474
26.00	22.466	41.273	148.747
28.00	26.497	48.963	197.710
30.00	31.046	57.543	255.253
32.00	36.416	67.462	322.715
34.00	47.197	83.613	406.328
35.67	77.209	103.879	510.207

Device	Routing	Invert	Outlet Devices
#1	Primary	25.96'	**30.0" Round Culvert 1** L= 99.1' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 24.87' / 25.96' S= -0.0110 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#2	Primary	25.90'	**30.0" Round Culvert 2** L= 98.7' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 24.64' / 25.90' S= -0.0128 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#3	Secondary	33.40'	**17.8" Round Existing Culvert 1** L= 50.7' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 33.40' / 32.87' S= 0.0105 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.73 sf
#4	Secondary	33.25'	**17.8" Round Existing Culvert 2** L= 51.4' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 33.25' / 32.77' S= 0.0093 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.73 sf
#5	Secondary	33.42'	**17.8" Round Existing Culvert 3**

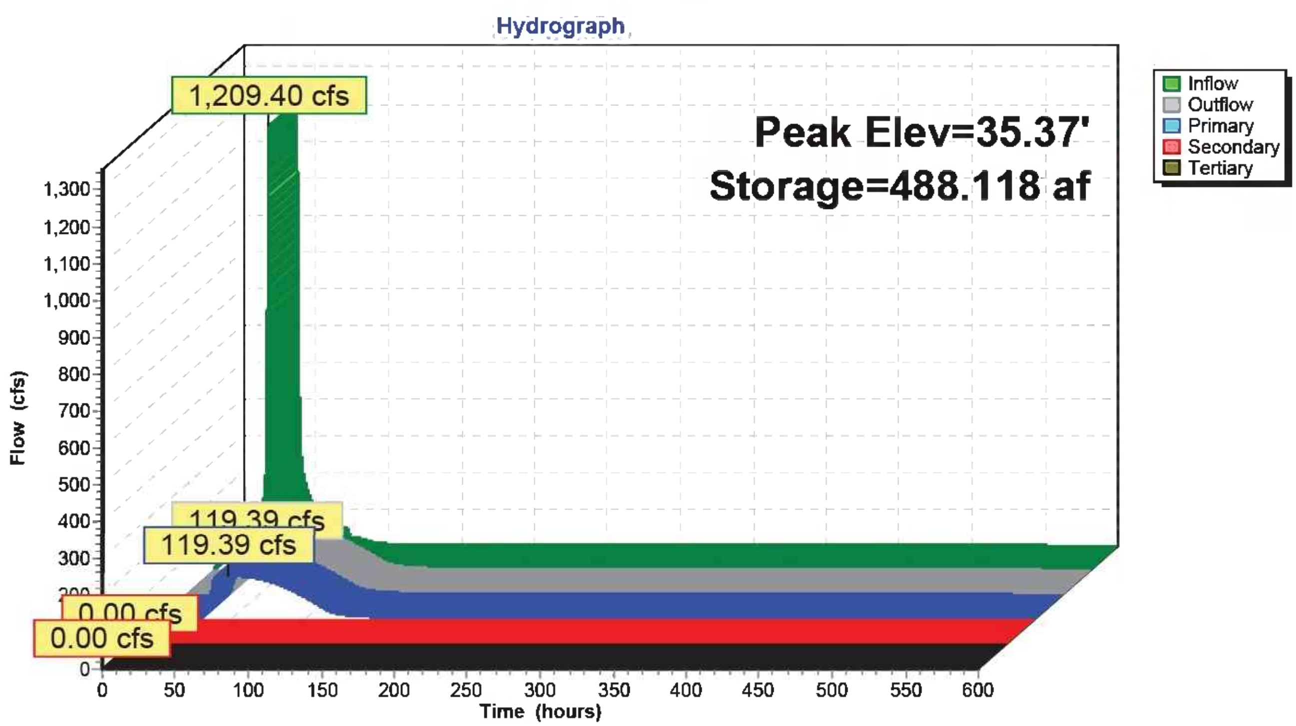
			L= 50.5' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 33.42' / 32.81' S= 0.0121 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.73 sf
#6	Secondary	33.32'	**17.8" Round Existing Culvert 4** L= 50.8' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 33.32' / 32.75' S= 0.0112 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.73 sf
#7	Tertiary	36.25'	**200.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64
#8	Tertiary	36.75'	**30.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64

Primary OutFlow Max=119.39 cfs @ 47.66 hrs HW=35.37' (Free Discharge)
↑—**1=Culvert 1** (Inlet Controls 59.59 cfs @ 12.14 fps)
└—**2=Culvert 2** (Inlet Controls 59.81 cfs @ 12.18 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=19.60' TW=26.00' (Dynamic Tailwater)
↑—**3=Existing Culvert 1** (Controls 0.00 cfs)
├—**4=Existing Culvert 2** (Controls 0.00 cfs)
├—**5=Existing Culvert 3** (Controls 0.00 cfs)
└—**6=Existing Culvert 4** (Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=19.60' TW=26.00' (Dynamic Tailwater)
↑—**7=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
└—**8=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: 3/4 Slurry Pond



Summary for Link 5L: Process Water

Inflow	=	4.46 cfs @	0.00 hrs, Volume=	202.731 af
Primary	=	4.46 cfs @	0.01 hrs, Volume=	202.731 af, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-600.00 hrs, dt= 0.010 hrs

12 Point manual hydrograph, To= 0.00 hrs, dt= 50.00 hrs, cfs =

4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46
4.46	4.46								

Link 5L: Process Water