ENGINEERING REPORT

PLANT WANSLEY ASH POND 1 (AP-1) CLOSURE

HEARD AND CARROLL COUNTIES, GEORGIA

FOR

Georgia Power

MARCH 2023

No. PE043417
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LIST OF ACRONYMS

AP-1	Ash Pond 1
CCR	Coal Combustion Residuals
CQA	Construction Quality Assurance

1. INTRODUCTION

Plant Wansley Ash Pond 1 (AP-1) will be closed by removal of Coal Combustion Residuals (CCR) and placement in the onsite Existing CCR Landfill. This will minimize the need for future maintenance and eliminates the potential for the post-CCR removal release of contaminants to groundwater or surface water. Closure by removal will be performed by removing both the CCR and the additional 6-inches of soils that are in contact with the CCR within AP-1.

The Separator Dike, a Category II Dam that separates AP-1 from the Storage Water Pond, will remain following Closure by Removal to separate the future industrial water pond (closed AP-1) from the Storage Water Pond. As part of AP-1 closure a riprap buttress and stability and seepage berm will be added to the Separator Dike.

This document provides an engineering narrative that presents a compilation of the engineering documents (drawings, calculation packages, and narrative plans) used to present and support the AP-1 closure.

2. ENGINEERING REPORT CALCULATION PACKAGES

The Engineering Report (Section 2 of Part B of the permit application package) includes calculation packages that contain analyses and computations to address design criteria and support design decisions for the AP-1 Closure Plan. The following calculation packages are included as subsections to Section 2 (The Engineering Report):

- Section 2.1 – Material Properties Data Package
- Section 2.2 – Closure Stability Calculation Package
- Section 2.3 – Material Balance Package
- Section 2.4 – Stormwater and Contact Water Management Package
- Section 2.5 – Final Closure Stormwater Management Package

3. CLOSURE DRAWINGS

Section 8 of Part A of this permit application contains a set of Closure Drawings showing plan views, engineering details, and cross sections of the AP-1 Closure Plan. Included are drawings of the groundwater monitoring plan, existing site conditions (topography and AP-1 bathymetry), CCR removal plan, site restoration grading plan, site cross sections, phasing plans, final surface-water management system and erosion and sediment control plans, and surface-water management system and erosion and sediment control details.

4. NARRATIVE PLANS

The permit application package includes the following narrative plans addressing operations and closure, including related closure construction activities (with references given to the permit application part and section):

- Section 5 of Part A – Construction Quality Assurance (CQA) Plan
- Section 6 of Part A – Groundwater Monitoring Plan
- Section 7 of Part A – Closure Plan
- Section 1 of Part B – Hydrogeological Assessment Report

CALCULATION
PACKAGES

MATERIAL PROPERTIES
DATA PACKAGE

Geosyntec consultants

CALCULATION PACKAGE COVER SHEET

Client: Georgia Power Company **Project:** Plant Wansley CCR Permitting **Project #:** GW9155

TITLE OF PACKAGE: MATERIAL PROPERTIES DATA PACKAGE

PREPARATION	**CALCULATION PREPARED BY:** (Calculation Preparer, CP)	Signature Matthew Chartier	Name Matthew Chartier	09/28/2022 Date
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REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
1	Submittal to Georgia EPD	03/10/2023	MC	CG	CG	JG

CP: **MC** Date: **09/28/22** APC: **CG** Date: **09/29/22** CA: **JG** Date: **11/14/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

MATERIAL PROPERTIES DATA PACKAGE

PURPOSE

This *Material Properties and Major Design Parameters* package (herein referred to as the Data Package) was prepared in support of the Coal Combustion Residual (CCR) Closure Permit for the permanent closure of Ash Pond 1 (AP-1, CCR Pond) at Plant Wansley (Site). This Data Package establishes the selected geotechnical design parameters used to develop the permit level design for closure. Specifically, this Data Package presents the interpreted geotechnical material properties: (i) index properties, (ii) shear strength parameters, (iii) compressibility parameters, and (iv) hydraulic conductivities for different subsurface units.

This Data Package includes: (i) summary of the available data from the field and laboratory investigations; (ii) discussion of the observed trends in the material properties of the subsurface units; and (iii) selected geotechnical parameters for general use with the closure design development. The format of the Data Package is as follows: (i) geotechnical field and laboratory testing program; (ii) subsurface stratigraphy; (iii) laboratory test results and parameter development; and (iv) selected design geotechnical material parameters.

GEOTECHNICAL FIELD AND LABORATORY TESTING PROGRAM

The geotechnical material properties and design parameters established in this Data Package are primarily based upon results from the field investigation conducted during the Spring 2017 Pre-Design Study. The following activities were performed during that investigation:

- advancement of twelve (12) soil borings (S-series, S-1 to S-12) along the proposed containment structure alignment into the bedrock, using rotosonic drilling methods;
- of these borings, six (6) were logged using downhole borehole geophysical methods including caliper, natural gamma, and acoustic televiewer logging and eight (8) were tested using an "Iso-Flow" packer system to evaluate horizontal hydraulic conductivity in various lithologic units;
- collection of bulk samples at each of the S-series soil borings;
- advancement of twelve (12) soil borings (M-series, M-1 to M-12) along the proposed containment structure alignment to the top of the partially weathered rock, using the mud-rotary drilling technique;

- Standard Penetration Tests (SPT) and collection of disturbed split spoon samples at each of the M-series soil borings (drill rig hammer efficiency of 92 percent); and

- Collection of 26 undisturbed Shelby tube samples from across the M-series soil borings.

A geotechnical laboratory testing program for the samples collected from the geotechnical field investigation was conducted by Excel Geotechnical Testing (Excel) in Roswell, Georgia. **Attachment 1** summarizes the tests conducted. The list of geotechnical laboratory tests performed on the soil samples are listed below.

- 120 particle-size distribution analyses (per ASTM D422);

- 120 water (or moisture) content tests (per ASTM D2216);

- 43 Atterberg limits tests (per ASTM D4318);

- four (4) specific gravity tests (per ASTM D854);

- 20 flexible wall permeability tests (per ASTM D5084);

- 18 Consolidated Undrained (CU) triaxial tests (single point) (per ASTM D4767); and

- five (5) one-dimensional (1-D) consolidation tests (per ASTM D2435).

In-situ blow count data were collected while advancing split spoon samplers during the SPT. The blow counts were measured as the “number of blows” needed to advance the split spoon sampler over a 6-inch interval. The sum of the blow counts required to drive the sampler the second and third 6-inch interval represents the raw N-value. The N-values were corrected for energy and depth (i.e., N_{60} and $(\mathrm{N}_1)_{60}$) as discussed in **Attachment 2**.

The soil boring logs and monitoring well installation logs from the 2017 Field Investigation are included in the *Hydrogeological Assessment Report, Revision 03* [Geosyntec, 2022].

In addition to the 2017 field investigations, the following data sources were used in the preparation of this Data Package:

- SPT boring labeled as SPT-16 was drilled inside Gypsum Cell No.1 by Southern Company Services (SCS) in 2015 and provided as a pdf file [*final logs 3-11-15.pdf*]. SPT blow counts (N-values) were recorded for this boring.

- three seismic Cone Penetration Tests (sCPTs) (sCPTu-1a [on the gypsum cell dike], sCPTu-2 [inside Gypsum Cell No.1], and sCPT-3 [on the separator dike]) were conducted by Thomson Engineering in 2016 as part of Geosyntec's 2016 Field Investigation at the Site. CPT results are presented in the *Hydrogeological Assessment Report, Revision 3* [Geosyntec, 2022].
- four SPT borings (B-1, B-2, B-2a [replacement for B-2] and B-3) were drilled as part of Geosyntec's 2016 Field Investigation. SPT blow counts were recorded and disturbed and undisturbed samples were collected during this investigation. Summary of the laboratory test results are presented in the *Hydrogeological Assessment Report* [Geosyntec, 2018].
- 30 CPTs were conducted in the CCR delta by Mid Atlantic Drilling between April and May 2019 to further refine the subsurface stratigraphy, particularly the depth of the CCR, along the revised containment structure alignment. Results of the investigation are presented in the *Ash Pond 1 CPT Report* [Geosyntec, 2019b].
- aquifer test data reported in the *Hydrogeological Assessment Report, Revision 3* [Geosyntec, 2022], *Ash Pond Closure Pre-Design Study, Phase B-2 Final Draft Report* [Geosyntec, 2017], and *Ash Pond Closure Feasibility Study, Phase II Summary Report* [Geosyntec, 2016].
- in-situ dewatering pilot test results reported in the *Ash Pond Closure Pre-Design Study, Phase B-2 Final Draft Report* [Geosyntec, 2017].

A map of the exploration locations is shown in **Figure 1**.

SUBSURFACE STRATIGRAPHY

Subsurface stratigraphy at the Site was developed based on information collected from existing Site data including boring logs, geologic maps, and investigation reports, in addition to the geotechnical field investigation and the soil boring logs produced by Geosyntec in 2016, 2017, and 2019, as discussed in the previous section. Six primary lithologic units were encountered at the Site: (i) Coal Combustion Residuals (CCRs); (ii) native soil (saprolitic soils and alluvial deposits); (iii) dike; (iv) gypsum; (v) partially weathered rock (PWR) and (vi) metamorphic crystalline bedrock. The *Hydrological Assessment Report, Revision 3* [Geosyntec, 2022] discusses these lithologic layers in more detail and provide the elevations of the interfaces of these layers across the Site. A brief description of these lithologic units is provided below.

Coal Combustion Residuals (CCR)

The CCR layer ranges in thickness from less than one foot to nearly 100 feet. CCR are concentrated in the delta area in the southeastern portion of AP-1, adjacent to the Separator Dike. CCR at the

Site consist of both fly ash, as well as coarser bottom ash in thin, discontinuous lenses throughout the unit. The fly ash material is generally dark to medium gray, soft and loose to very loose fine sand and silts with some clay. Bottom ash is generally dark gray, well graded, fine to coarse sand and fine gravel.

Native Soil

For this Data Package, native soil comprises of alluvial deposits and saprolite for which the geotechnical material properties were established.

- Alluvial deposits related to historical stream and drainage processes were observed in few isolated borings across the Site (M-3, S-3, S-4, and S-8). These lenses ranged in thickness from 8 to 12 feet and consisted of organic silt and fine sand over-bank deposits and fine to coarse sand channel deposits.

- Saprolitic soils, which are Piedmont residual soils, resulting from the in-situ weathering of the parent bedrock material make up a majority of the Site subsurface and were generally encountered across the Site. Saprolite tends to display relict structures and properties of the parent bedrock but has the consistency of a soil (unconsolidated). The thickness of this unit is highly variable, ranges from two to 130 feet, and is described primarily as sandy silt, silty sand, sandy clay, and silty clay.

Dike

An earthen Separator Dike (dike) separates AP-1 from an adjacent Storage Water Pond used to supply the plant with fresh water (e.g., cooling and process water). The dike has a maximum height of 105 feet and is approximately 3,000 feet long. It is classified as a Category II structure according to Georgia Safe Dams Program guidelines. The dike generally consists of lean clays and silts with no known seepage or stability issues, but the dike does not include a clay (i.e., low permeability) core.

Gypsum

Two temporary gypsum cells (Cell No. 1 and Cell No. 2) were built on top of the CCR delta in 2007. The two gypsum cells contain approximately one million cubic yards of material, including mostly gypsum but also CCR and soil dike material.

Partially Weathered Rock (PWR)

As the saprolite transitions to more rock-like material approaching the bedrock surface, the PWR unit is the hard, semi-consolidated weathered to intensely fractured rock interface. This unit ranges in thickness from one to 55 feet and was generally encountered across the Site. PWR accounts for a majority of the "transition zone" that lies between the saprolite and the competent bedrock. For geotechnical borings in which SPTs were performed, saprolite that exceeds 50 blows per six inches may be considered PWR. No laboratory tests were performed on PWR given that no Shelby tubes could be collected from this unit. As a result, the engineering parameters presented in Table 1 were estimated based on literature and empirical correlations.

Bedrock

The bedrock at the site is composed primarily of graphitic schist, muscovite schist, biotite schist, schist with interlayered mafic units, amphibolite/hornblende gneiss, granitic gneiss (Long Island Creek Gneiss), and feldspathic quartzite. The ridges to the northwest and southeast of the CCR pond are underlain by muscovite schist and Long Island Creek Gneiss, respectively, both of which are relatively resistant to weathering, and thus, the bedrock is closer to the ground surface. AP-1 and Storage Water Pond, however, are underlain by schist with interlayered mafic units and feldspathic quartzite, which are more susceptible to weathering, and thus, the layer of residual soil and partially weathered rock is thicker.

LABORATORY TEST RESULTS AND PARAMETER DEVELOPMENT

Soil Index Properties and Classification

Index properties are useful in the classification of soils and provide a general understanding of the physical characteristics of the soils. The index properties evaluated in this Data Package include: (i) moisture content; (ii) Atterberg limits; (iii) grain size distribution; (iv) specific gravity; and (v) unit weight. The index properties were measured using laboratory tests performed on the samples obtained from the geotechnical field investigation. Measured index properties (e.g., grain size distribution and Atterberg limits) were used to classify the samples following the Unified Soil Classification System (USCS) (ASTM D2487). Index properties were also used in empirical equations to obtain estimates for shear strength and compressibility parameters.

The total unit weight was calculated using the dry unit weight provided from the triaxial, consolidation, and permeability tests combined with the moisture content test results. The total unit weight (γ_T) was computed as:

$$\gamma_T = \gamma_d \left(1 + \frac{w_o}{100}\right) \quad (1)$$

where:

γ_d = dry unit weight (pounds per cubic foot [pcf]); and

w_o = initial moisture content, in percent, prior to testing.

The total unit weight calculated using Equation 1 is termed “measured total unit weight.”

The total unit weight was also estimated using phase relationships and the results from the moisture content test. The degree of saturation was assumed to be 100 percent since the borings were drilled below the water surface.

$$\gamma_T = \frac{G_s \gamma_w}{1+G_s \frac{w_o}{100}}\left(1+\frac{w_o}{100}\right) \quad (2)$$

where:

γ_w = unit weight of water = 62.4 pcf;

G_s = specific gravity; and

w_o = moisture content, in percent, measured in the laboratory tests.

The total unit weight calculated using Equation 2 is termed “calculated total unit weight.”

The moisture contents and Atterberg limits for CCR and native soil are plotted versus depth on **Figure 2**. The moisture contents for CCR vary between 14.8 and 52.4 percent but appear to generally be around the average value of 37.3 percent. The native soil moisture contents have larger variability (vary between 8.9 and 73.9 percent) but appear to generally decrease with depth. The moisture contents for dike are presented in Figure 5 and vary between 18.3 and 33.7 percent.

Specific gravity for both CCR and native soil were estimated based via laboratory testing. **Figure 3** presents the laboratory testing results. The selected specific gravities of CCR and native soil are 2.33 and 2.8, respectively.

The measured and calculated total unit weights for CCR and native soil are plotted versus depth on **Figure 4**. The average calculated total unit weights (assumed to equal the saturated unit weights due to the borings being drilled below the water surface) for CCR and native soil are 107.2 and

127.9 pounds per cubic feet (pcf), respectively. The average measured total unit weights for CCR and native soil are 104.6 and 111.2 pcf, respectively.

The total unit weights for dike and gypsum were estimated from CPT results using the correlation developed by Robertson [2010]:

$$\gamma/\gamma_w = 0.27(\log R_f) + 0.36\left(\log\left(\frac{q_t}{p_a}\right)\right) + 1.236 \tag{3}$$

where:

R_f = CPT friction ratio = $(f_s/q_t) \times 100\%$;

γ_w = unit weight of water;

q_t = tip resistance (pounds per square foot [psf]);

f_s = sleeve friction (psf); and

p_a = atmospheric pressure (psf).

Figures 5 and **6** present the calculated total unit weights based on Equation 3 for dike and gypsum, respectively. The selected total unit weights for dike and gypsum are 125 and 120 pcf, respectively.

The total unit weight for PWR is estimated to be 125 pcf. Figures 4, 5 and 6 and Table 1 show the selected design total unit weights for CCR, native soil, dike, gypsum and PWR.

The fines content for dike is presented in Figure 5 and varies between 26.6 and 71.9 percent. The fines content for CCR and native soil is presented in **Figure 7**. The fines content for CCR vary between 28.6 and 99.8 percent with most of the samples (36 out of 41) containing more than 90 percent fines. The fines contents for the native soil have larger variability (6.3 to 94.9 percent) but appear to generally decrease with depth.

The plasticity chart for native soil samples is presented in **Figure 8**. Native soil generally consists of lean clays and silts with some elastic silts and high plasticity clays.

Drained Shear Strength Parameters

Laboratory Triaxial Test Results

Consolidated Undrained (CU) triaxial tests per ASTM D4767 with pore pressure measurements were performed on extruded thin-walled Shelby tube samples from the CCR, native soil, and dike. The results from the CU triaxial tests were used to estimate the peak drained (i.e., effective friction angle, ϕ', and effective cohesion, c') shear strength parameters (from undrained tests) for CCR, native soil, and dike and undrained (s_u) shear strength for the native soil and dike.

The shear stress and mean effective stress at failure from the triaxial test results for CCR, native soil, and dike are plotted on **Figure 9** along with the corresponding estimated failure envelope. The selected effective shear strength parameters (ϕ' and c') also shown on **Figure 9** and presented in **Table 1**.

Empirical Correlation with Index Properties

Multiple empirical correlations were also used to estimate the effective friction angle of the native soil using the index properties. The correlation developed by Mitchell [1978] in Equation 4 relates the plasticity index (PI) to the critical void ratio friction angle (ϕ'_{cv}), which is approximately equal to peak effective friction angle for insensitive, uncemented, normally-consolidated clays.

$$\phi'_{cv} = \sin^{-1}[0.8 - 0.094\ln(\text{PI})] \tag{4}$$

Bjerrum and Simons [1960] used a similar data set to develop the relationship between the peak effective friction angle and normally consolidated clays shown in Table 2. The effective friction angles estimated by the Bjerrum and Simons [1960] and Mitchell [1978] correlations are plotted on **Figure 10** along with the CU triaxial test results for the native soil. Both correlations show a relatively narrow range of scatter. The average effective friction angles estimated by the Bjerrum and Simons [1960] and Mitchell [1978] correlations are 32 and 33 degrees.

CPT Results

CPT tip resistance [Kulhawy and Mayne, 1990] was used to estimate the effective friction angle of gypsum:

$$\phi' \;= 17.6 + 11\log(Q_{tn}) \quad \text{(in degrees)} \tag{5}$$

where:

Q_{tn} = normalized tip resistance = $\frac{q_t}{\sigma'_{vo}}$;

q_t = cone tip resistance (psf); and

σ'_{vo} = in-situ effective vertical stress (psf).

The effective friction angles for the gypsum estimated from CPT data are plotted on **Figure 6**.

Saprolite with SPTs that exceed 50 blows per six inches was considered PWR. Assuming a minimum SPT N-value of 100 for PWR, the calculated effective friction angle using Equation 5 is approximately 59 degrees. For design, the effective friction angle for PWR was conservatively assumed to be 40 degrees.

Figures 9 and **10** and **Table 1** show the selected design drained shear strength parameters for CCR, native soil, gypsum, and PWR.

Undrained Shear Strength Parameters

Laboratory Triaxial Test Results

The peak undrained shear strengths were obtained from the CU triaxial test results on native soil specimens. The undrained shear strength ratios ($\frac{s_u}{\sigma'_c}$), where σ'_c is the consolidation pressure, were calculated and presented in **Figure 11**. As shown on **Figure 11**, $\frac{s_u}{\sigma'_c}$ tends to decrease with increasing $\frac{\sigma'_c}{\sigma'_p}$, where σ'_p is the preconsolidation pressure and reaches a relatively constant value of 0.4. For design, the undrained shear strength ratio ($\frac{s_u}{\sigma'_v}$), where σ'_v or σ'_{vo} is the effective vertical stress, is assumed to be equal to $\frac{s_u}{\sigma'_c}$ since the range of consolidation pressures used in the CU triaxial tests was selected to approximately cover the estimated current in-situ conditions. Thus, the undrained shear strength ratio ($\frac{s_u}{\sigma'_v}$) is selected to be 0.4 with a minimum undrained shear strength of 1,200 pounds per square foot (psf). For comparison, regression analyses on 22 CU triaxial tests performed by Mayne and Brown [2003] on Piedmont residual soil samples indicated a $\frac{s_u}{\sigma'_{vo}}$ of 0.65.

The calculated undrained shear strengths for dike obtained from CU triaxial tests are presented in Figure 5. For design, the selected undrained shear strength ratio ($\frac{s_u}{\sigma'_v}$) for dike is 0.5 with a minimum undrained shear strength of 1,000 psf.

CCR at the Site is classified as an ML material (silt and sandy silt) based on the laboratory test results. At low-to-moderate confining pressures, CCR tend to dilate during shear, resulting in negative excess pore pressures at failure. In such cases, Brandon et al. [2006] indicates that the undrained shear strength can be conservatively represented by the drained shear strength.

Empirical Correlation with SPT N-value

In this Data Package, the Hara et al. [1974] correlation was used to estimate the undrained shear strength when SPTs were performed in the native soil and dike.

$$s_u = 0.29((N_1)_{60})^{0.72} \times 2{,}000 \quad \text{(in psf)} \tag{6}$$

Figure 12 shows the undrained shear strength ratios (left plot) and the undrained shear strengths (right plot) estimated by the SPT N-value correlations for native soil. The calculated undrained shear strengths from SPT N-values for dike are presented in **Figure 5**.

Figure 12 and **Table 1** show the selected design undrained shear strength parameters for the native soil. For comparison, the undrained shear strengths with respect to depth were calculated (assuming total unit weights of 105 and 115 pcf CCR and native soil, respectively, and the bottom of CCR at a depth of 20 feet). As shown on **Figure 12**, the undrained shear strengths predicted by the SPT N-value correlation are generally significantly larger than the strengths calculated using the ratio of 0.4.

Stress History and Compressibility Parameters

Laboratory Consolidation Test Results

Consolidation tests were performed on CCR and native soil to estimate their stress history, modified compression index ($C_{c\varepsilon}$), modified recompression index ($C_{r\varepsilon}$), modified secondary compression index ($C_{\alpha\varepsilon}$), and coefficient of consolidation (c_v). Preconsolidation pressures (σ'_p), and modified compression and recompression indices were calculated using the Casagrande [1936] procedure. CCR is considered to be in a normally-consolidated state as it is sluiced and deposited in AP-1 (i.e., the current vertical effective stresses are the maximum stresses that this material has experienced). Residual soils, such as the native soil, typically exhibit an apparent preconsolidation pressure, possibly due to the weathering related volume changes, residual bonds between particles, and residual lateral tectonic stresses [Sowers, 1994]. This apparent preconsolidation pressure typically ranges between 1,000 and 5,000 pounds per square feet (psf) as indicated by Sowers [1994] and between 2,000 and 4,000 psf as reported by Barksdale et al. [1982]. The preconsolidation pressure for the native soil, as calculated from the 1-D consolidation tests, varies between 2,000 psf and 6,000 psf as presented on **Figure 13**. For design, the selected minimum preconsolidation pressure for native soil is 2,500 psf as shown in **Figure 13** and **Table 1**.

The modified compression and recompression indices were calculated from the consolidation test curves and are presented on **Figure 14**. Plots of deformation against the logarithm and square root of time for each increment (i.e., consolidating pressure) were used to calculate the modified secondary compression indices and coefficients of consolidation [Coduto, 2011] which are presented on **Figures 15** and **16**, respectively.

Empirical Correlation with Void Ratio

An empirical correlation (Equation 8) from Sowers and Richardson [1983], specific to Piedmont residual soils, was used to estimate the compressibility parameters of the native soil as described below:

$$C_c = 0.75\,(e - 0.55) \tag{7}$$

where:

e = in-situ void ratio.

The in-situ void ratio was calculated from phase relationships as shown in Equation 8.

$$e = \frac{G_s\, w_o}{S} \tag{8}$$

where:

G_s = specific gravity of the soil;

w_o = moisture content of the soil measured in the laboratory tests; and

S = degree of saturation (assumed to be 100 percent).

The moisture content of the soil was measured from disturbed grab samples as well as undisturbed CU triaxial, permeability, and 1-D consolidation samples.

The modified compression index ($C_{c\varepsilon}$) was then calculated using Equation (9) and is shown in **Figure 14**.

$$C_{c\varepsilon} = \frac{C_c}{1+e} \tag{9}$$

From Holtz and Kovacs [1981], the modified recompression index is approximately 0.05 to 0.1 times the modified compression index. In this Data Package, the modified recompression index was empirically predicted using 0.075 times the modified compression index, and then compared to the modified recompression index directly calculated from 1-D consolidation curves as shown on **Figure 14**.

Figure 14 and **Table 1** show the selected design stress history and compressibility parameters for CCR and native soil.

Figure 15 presents the calculated modified secondary indices and Figure 16 presents the calculated coefficient of consolidation for both native soil and CCR from the 1-D consolidation tests. Selected design parameters are shown in Figures 15 and 16 and presented in Table 1.

For gypsum, Young's modulus of elasticity (E) was calculated from CPT results as:

$$E = \alpha_E\ (q_t - \sigma_{v0}) \tag{11}$$

where:

q_t = cone tip resistance (psf);

σ_{vo} = in-situ total vertical stress; and

α_E = $0.015\ [10^{(0.55Ic+1.68)}]$

where:

I_c = soil behavior type index and calculated as below from Robertson and Cabal [2015]:

$$I_c = ((3.47 - \ logQ_t)^{\ 2} + \ (\ logF_r + 1.22)^2)^{0.5}$$

where:

Q_t = normalized cone penetration resistance; and

F_r = normalized friction ratio, in % = $\frac{f_s}{(q_t-\sigma_{vo})} \times 100\%$.

The Young's moduli of elasticity calculated based on CPT data and Equation 11 are plotted on Figure 6.

For PWR, Young's modulus of elasticity (E) was conservatively estimated based on a correlation developed by Kulhawy and Mayne [1990] for clean normally-consolidated sand as shown in Equation 12.

$$\frac{E}{p_a} = 10(N_{60}) \tag{12}$$

where:

E = Young's modulus of elasticity;

p_a = atmospheric pressure (e.g., 2,116 psf); and

N_{60} = assumed to be equal to 100 for PWR.

Thus, Young's modulus of elasticity for PWR is calculated to be approximately 2.1×10^6 psf.

Hydraulic Conductivity

Vertical and horizontal hydraulic conductivity values were estimated based on the field and laboratory test data, respectively. The selected design hydraulic conductivity parameters for each subsurface layer are provided in **Table 1**. A summary of the hydraulic conductivity data and selected parameters for each subsurface layer is provided in **Figure 17** through **Figure 20**. Field and laboratory hydraulic conductivity test data are tabulated in **Attachment 3**.

Vertical Hydraulic Conductivity, k_v

Vertical hydraulic conductivity (k_v) values were estimated from flexible wall permeability testing conducted in the lab on nominally undisturbed samples of CCR, native soil, and separator dike. For the flexible wall permeability tests, specimens were saturated and consolidated to pressures within the range of the approximate current in-situ and future (after the construction of the containment structure) effective stresses. Most specimens were tested at two consolidation pressures. First, the k_v value was measured at a pressure approximately equal to the estimated in-situ vertical effective stress. Once the first test was completed, the specimen was consolidated to a higher consolidation pressure before taking a second measurement of the vertical hydraulic conductivity. The measured vertical hydraulic conductivities are plotted versus elevation on **Figure 17** and **Figure 18** for the CCR and Native soil, respectively. The geometric mean of vertical hydraulic conductivities measured for CCR and native soil are approximately 1.6×10^{-5} cm/s and 5.7×10^{-5} cm/s, respectively, both within the respective typical range for CCR [EPRI, 2012] and Piedmont residual soils [Sowers and Richardson, 1983]. The vertical hydraulic conductivity of the separator dike was selected based on the calibrated model value presented in the *Hydrogeological Assessment Report, Revision 3* [Geosyntec, 2022].

Horizontal Hydraulic Conductivity, k_h

Horizontal hydraulic conductivity (k_h) values were estimated based on aquifer testing and pore pressure dissipation (PPD) testing performed at the Site. Aquifer testing included slug testing and iso-flow packer testing conducted within the CCR, native soil, PWR and bedrock. The Bouwer-Rice method, implemented in AQTESOLV software by Hydrosolve, Inc., was used to estimate k_h values based on a curve fit for the aquifer response test data. Additional information on this methodology is presented in the *Hydrogeological Assessment Report, Revision 3* [Geosyntec, 2022]. A summary of the calculated k_h values is provided in **Attachment 3**.

The geometric mean k_h values were calculated from aquifer testing for the CCR, native soil, PWR and bedrock to be 3.8×10^{-4} cm/s, 1.9×10^{-4} cm/s, 1.5×10^{-4} cm/s, and 1.3×10^{-4} cm/s, respectively. Aquifer tests that spanned more than one stratigraphic unit were not included in the calculated geometric mean.

PPD test data from sCPTu-1 and sCTPu-2 were also used to estimate k_h values within the CCR native soil based on the correlation in Equation 12 by Mayne [2007]. The calculated geometric mean values were 3.2×10^{-4} cm/s and 2.4×10^{-4} cm/s, respectively.

$$k_h \approx \left(\frac{1}{251 * t_{50}}\right)^{1.25} \qquad (1)$$

where:

k_h = horizontal hydraulic conductivity (cm/s)

t_{50} = time to 50 percent excess pore pressure dissipation (seconds)

Hydraulic Conductivity Design Parameters

Design k_h values for each subsurface layer were selected as the geometric mean from the in-situ aquifer testing discussed above. Design k_v values were computed by selecting anisotropy ratios (k_h/k_v) for similar depositional environments reported in literature [Jamiolkowski et al., 1985] and project experience in similar geology. The decision to prioritize field (k_h) data over the laboratory

(k_v) data was made by considering: (i) potential impacts of sample disturbance on k_v values measured in the lab and (ii) the superior spatial coverage afforded by in-situ hydraulic conductivity testing.

The depositional environment in CCR ponds provides for the presence of localized layering of more permeable fly ash and less permeable fly ash thereby resulting in relatively high anisotropy ratios compared to natural soils. As such, an anisotropy ratio of 20 was selected to calculate a design k_v value of 1.9×10^{-5} cm/s. The selected anisotropy ratio was benchmarked against a computed value of 23.7 using the geometric mean values for k_h and k_v discussed above.

For the native soil, an anisotropy ratio of 10 was selected to calculate a design k_v value of 1.9×10^{-5} cm/s. The selected anisotropy ratio was benchmarked against a computed value of 3.4 using the geometric mean values for k_h and k_v discussed above. The selected anisotropy ratio of 10 was based on statements in Sowers and Richardson [1983] indicating the native soils exhibit anisotropy and that a value of 10 is expected for the native soil's parent material, PWR.

An anisotropy ratio of 10 was selected for the PWR based on values reported for the partially weathered zone of the Piedmont residual soils in Sowers and Richardson [1983]. This value was used to calculate a design k_v value of 1.5×10^{-5} cm/s.

An anisotropy ratio of 10 was also selected for bedrock to be consistent with the value selected for PWR. This value was used to calculate a design k_v value of 1.3×10^{-5} cm/s.

SELECTED DESIGN GEOTECHNICAL MATERIAL PARAMETERS

The selected geotechnical parameters for the subsurface lithologic units encountered at the Site are summarized in **Table 1**. The design k_h values were selected based on the geometric mean of in-situ test results described above. Design k_v values were calculated based on the selected anisotropy ratios discussed above. For the CRR and native soil layers, the calculated k_v values were compared against those obtained from laboratory testing to benchmark the design values. Furthermore, the selected CCR k_h and k_v values were compared against, and were in general agreement with, the composite hydraulic conductivity value estimated from the in-situ dewatering pilot test results, reported in the Ash Pond Closure Pre-Design Study, Phase B-2 Final Draft Report [Geosyntec, 2017]. The hydraulic conductivity values for the dike were selected as those presented in the *Hydrogeological Assessment Report, Revision 3* [Geosyntec, 2022].

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TABLES

Table 1. Selected Design Geotechnical Material Parameters

Subsurface Stratigraphic Unit [(1)]	**Total Unit Weight (pcf)**	**Effective Shear Strength Parameters**		**Undrained Shear Strength Parameters** $\frac{s_u}{\sigma'_v}$	**Stress History and Compressibility Parameters**						**Vertical Hydraulic Conductivity, k_v (cm/s)**
		Effective Friction Angle, ϕ' (deg)	**Effective Cohesion, c' (psf)**		**Modified Compression Index, $C_{c\varepsilon}$**	**Modified Recompression Index, $C_{r\varepsilon}$**	**Modified Secondary Compression Index, $C_{\alpha\varepsilon}$**	**Coefficient of Consolidation, c_v (cm^2/min)**	**Preconsolidation Pressure, σ'_p, (psf)**	**Modulus of Elasticity, E (psf)**	
CCR	105	32	0	-	0.11	0.01	0.0015	1.25	-	-	2.1×10^{-5}
Native Soil	115	32	0	s_u/σ_v' =0.4 minimum s_u=1,200 psf	0.19	0.022	0.002	1.0	2500	-	1.1×10^{-5}
Dike	125	32	100	s_u/σ_v' =0.5 minimum s_u=1,000 psf	-	-	-	-	-	-	-
Gypsum	120	35	0	-	-	-	-	-	-	2.5×10^{5}	-
Partially Weathered Rock (PWR)	125	40	0	-	-	-	-	-	-	2.1×10^{6}	-

Notes:

1. The subsurface lithologic units are discussed in more detail in the *Hydrogeological Assessment Report, Revision 3* [Geosyntec, 2022]. Elevations of the interfaces of these stratigraphic units are also provided in the report.

Table 2. Typical Values of Peak Friction Angle for Normally Consolidated Clays (from Bjerrum and Simons [1960])

Plasticity Index	**Peak Effective Friction Angle (degrees)**
10	33 ± 5
20	31 ± 5
30	29 ± 5
40	27 ± 5
60	24 ± 5
80	22 ± 5

Note:

1. Effective cohesion equal to zero for these materials.

FIGURES

Figure 1. Boring Locations at the Site

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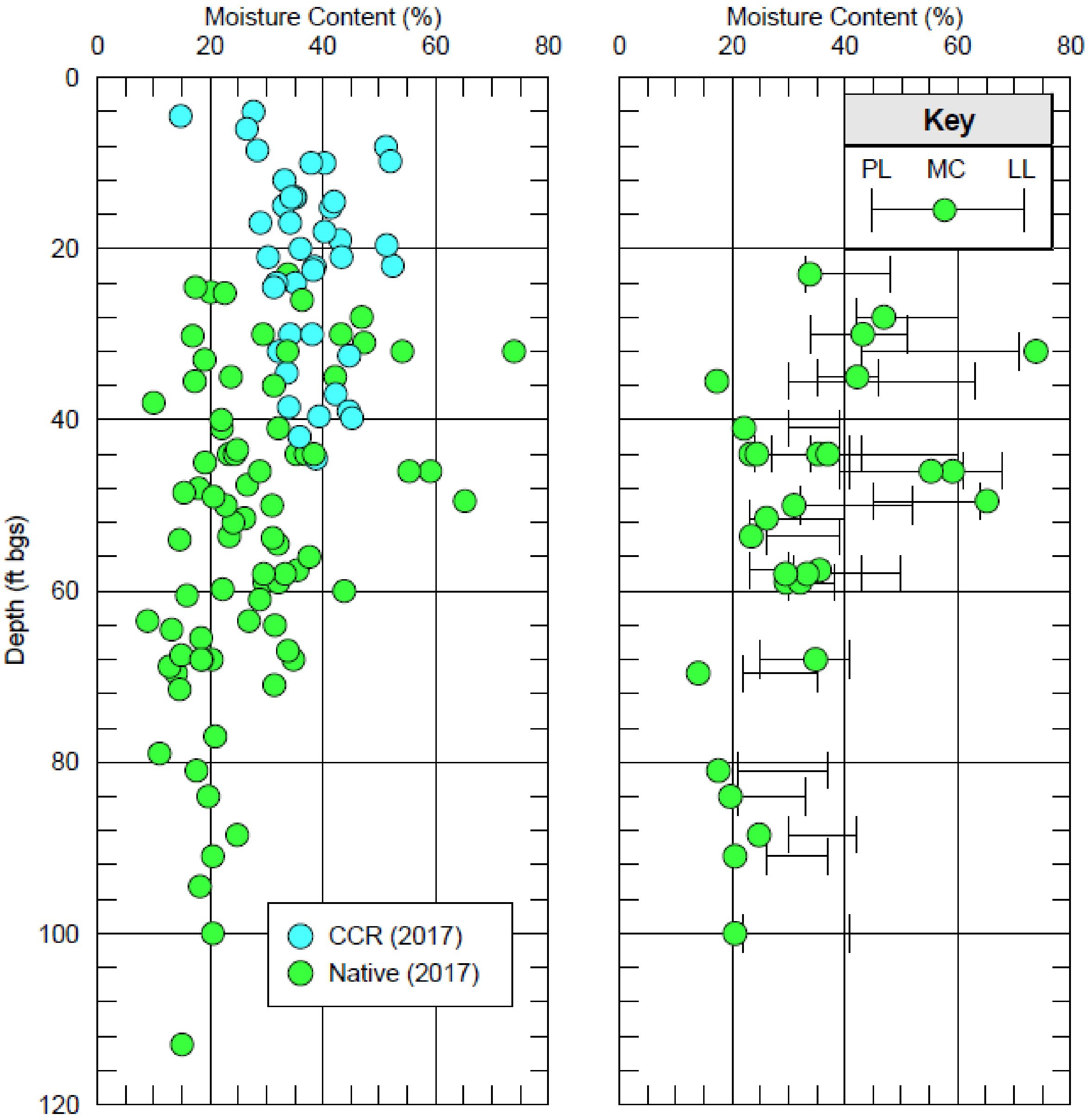

Figure 2. Moisture Contents and Atterberg Limits

Note:

1. LL – liquid limit; MS – moisture content; PL – plastic limit

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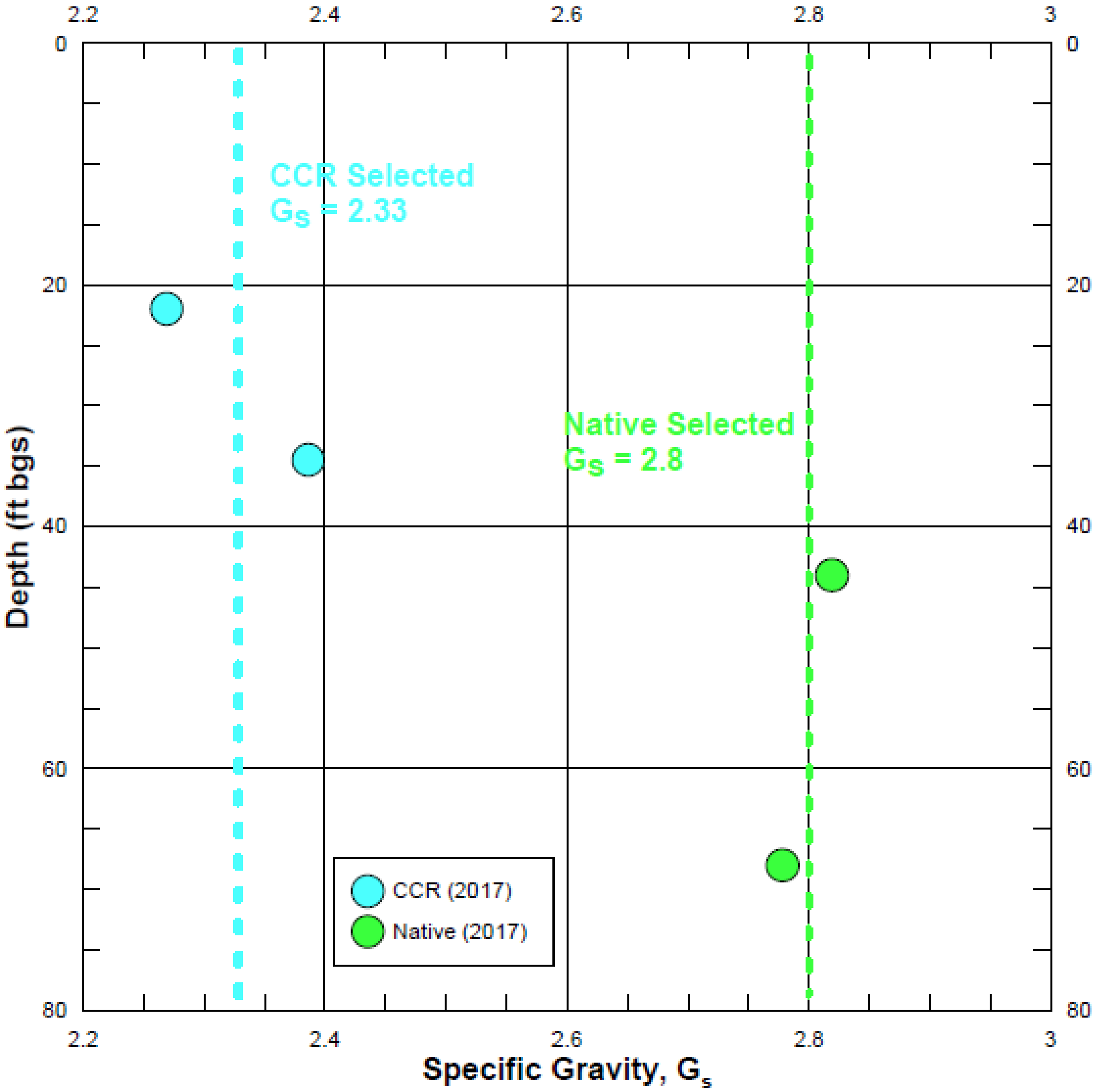

Figure 3. Specific Gravity for CCR and Native Soil

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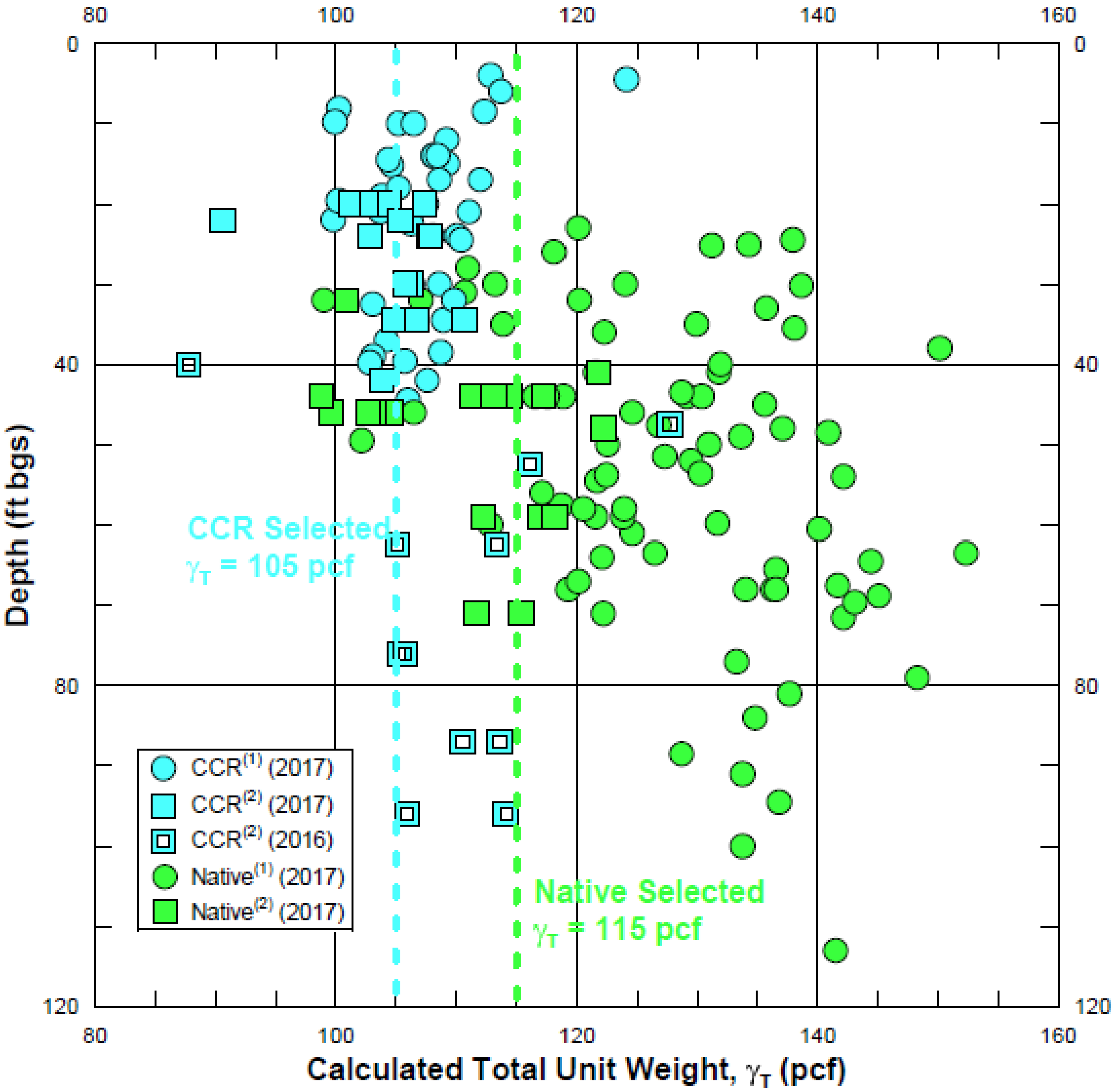

Figure 4. Calculated and Measured Total Unit Weight of CCR and Native Soil

Notes:

1. Total unit weights are calculated based on correlations with moisture content of disturbed grab samples.
2. Total unit weights are calculated from undisturbed CU triaxial, permeability, and 1-D consolidation samples.

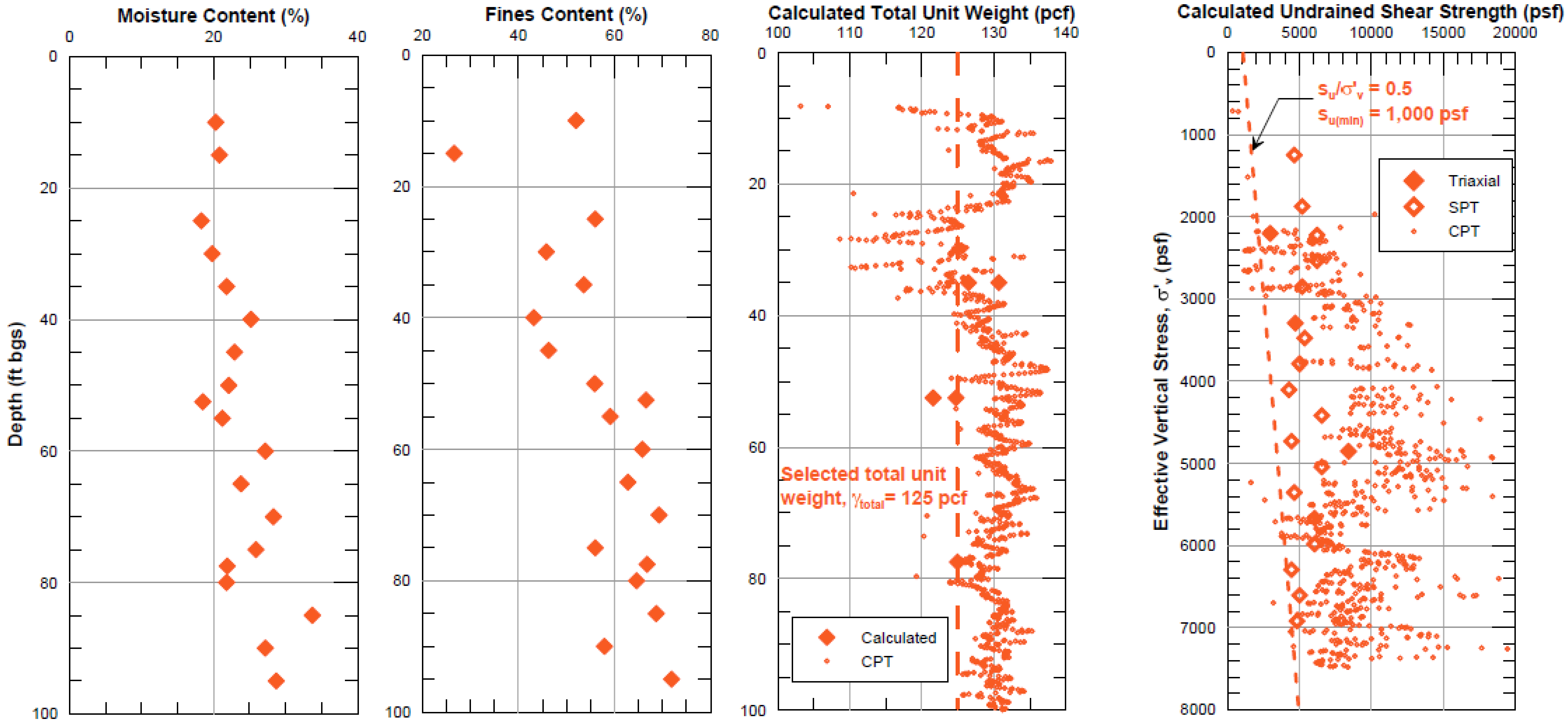

Figure 5. Calculated Moisture Content, Fines Content, Total Unit Weight, and Undrained Shear Strength of Dike

Notes:

1. Total unit weights are calculated based on undisturbed samples (triaxial, permeability, and consolidation samples) is termed "Calculated". Total unit weights are calculated from CPT data is termed "CPT".
2. ft bgs - feet below ground surface.
3. s_u - undrained shear strength.

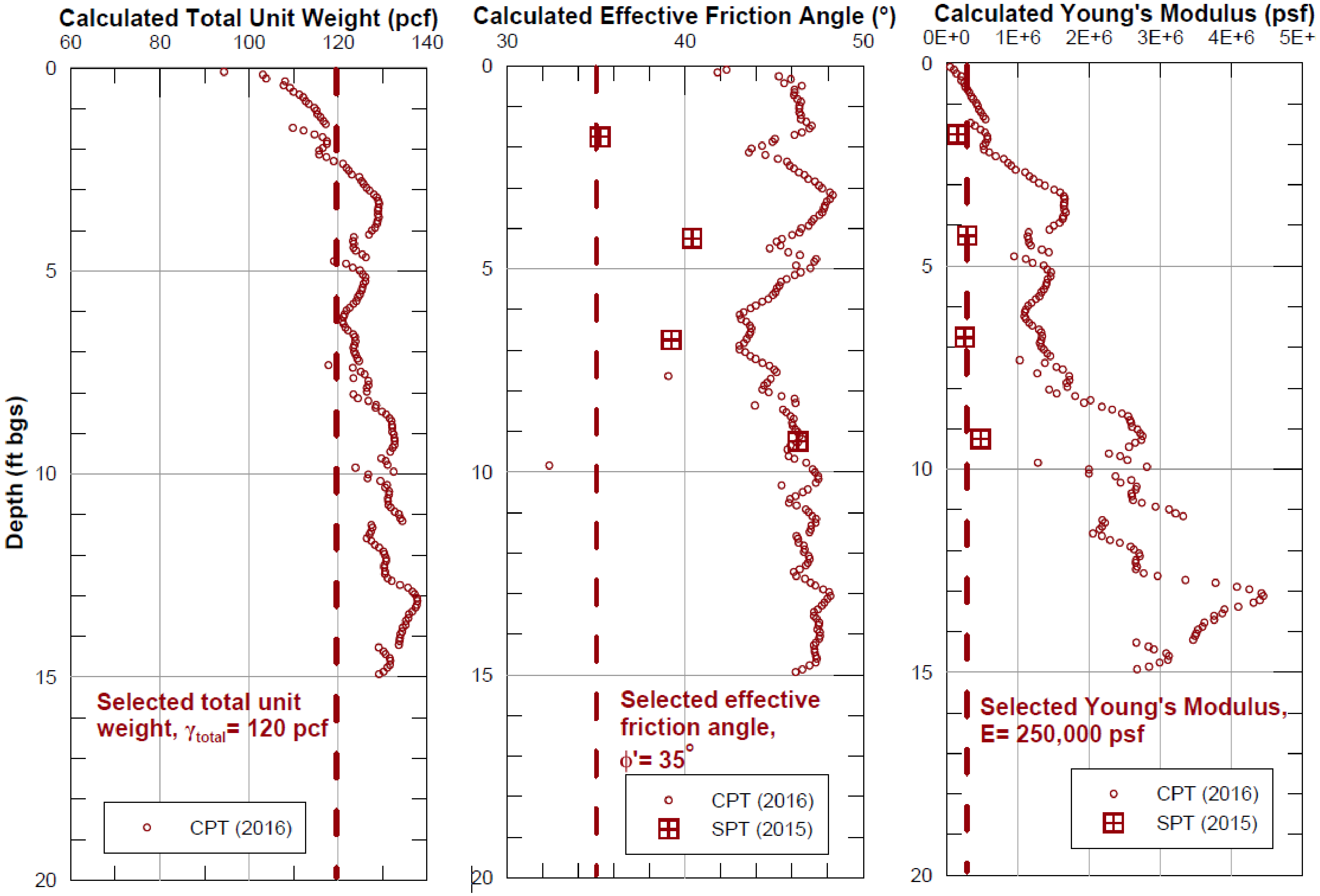

Figure 6. Total Unit Weight, Effective Friction Angle and Young's Modulus of Gypsum

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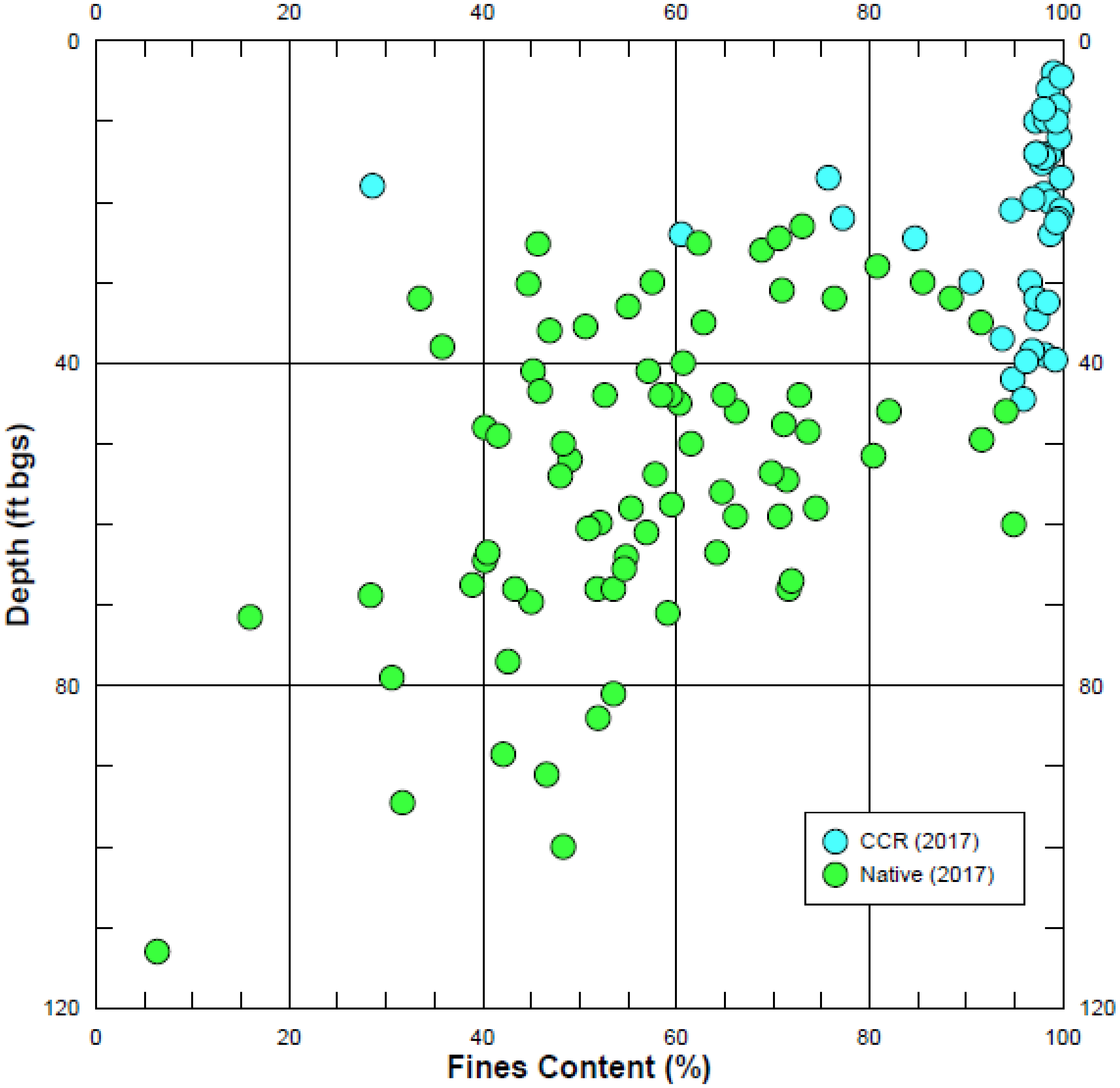

Figure 7. Fines Content for CCR and Native Soil

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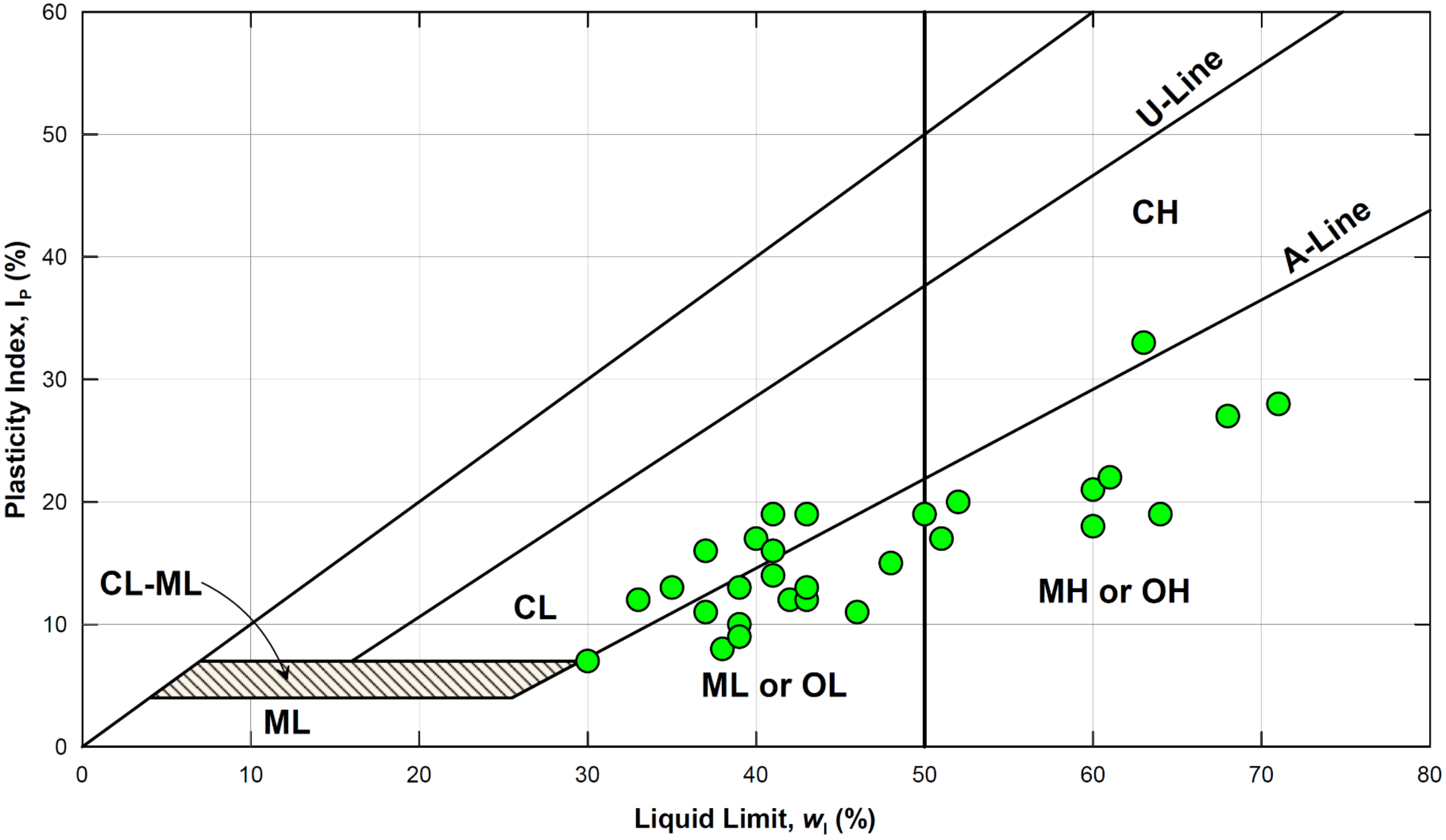

Figure 8. Plasticity Chart of Native Soil Samples

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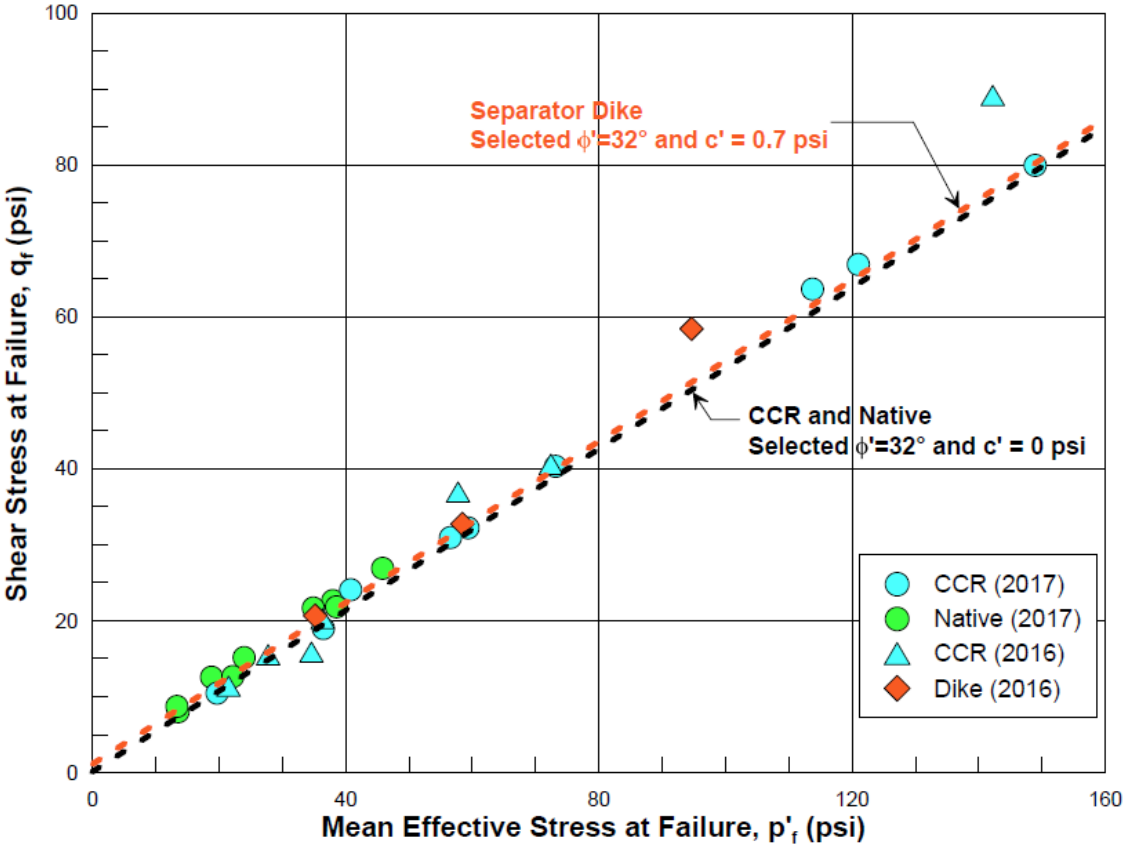

Figure 9. Shear Stress and Mean Effective Stress at Failure for CU Triaxial Tests

Notes:

1. Shear or Deviatoric Stress, q, is defined as: $q = \frac{\sigma_1' - \sigma_3'}{2}$, and

   Mean Effective Stress, p', is defined as: $p' = \frac{\sigma_1' + \sigma_3'}{2}$,

   where σ_1' and σ_3' are the effective major and minor principal stresses, respectively.

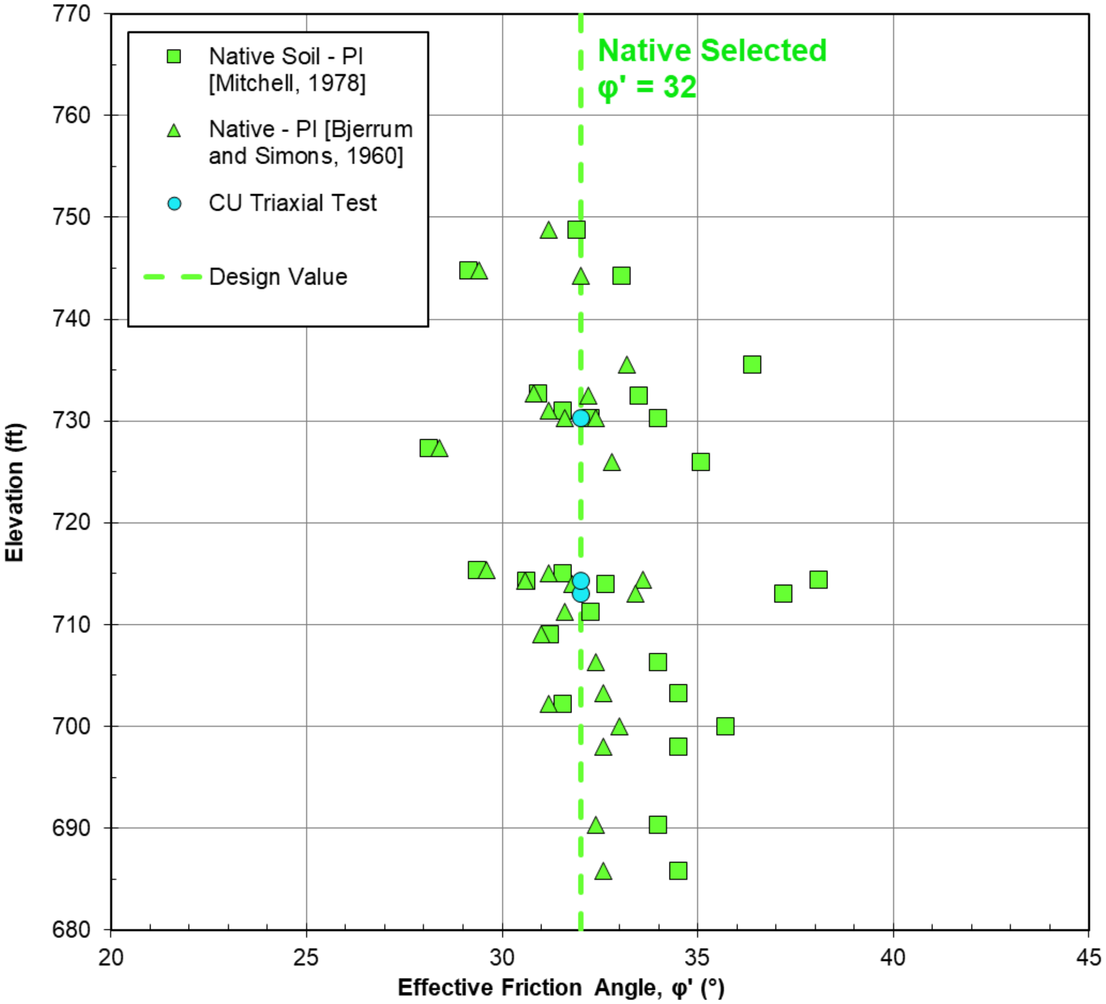

Figure 10. Calculated Effective Friction Angle of Native Soil

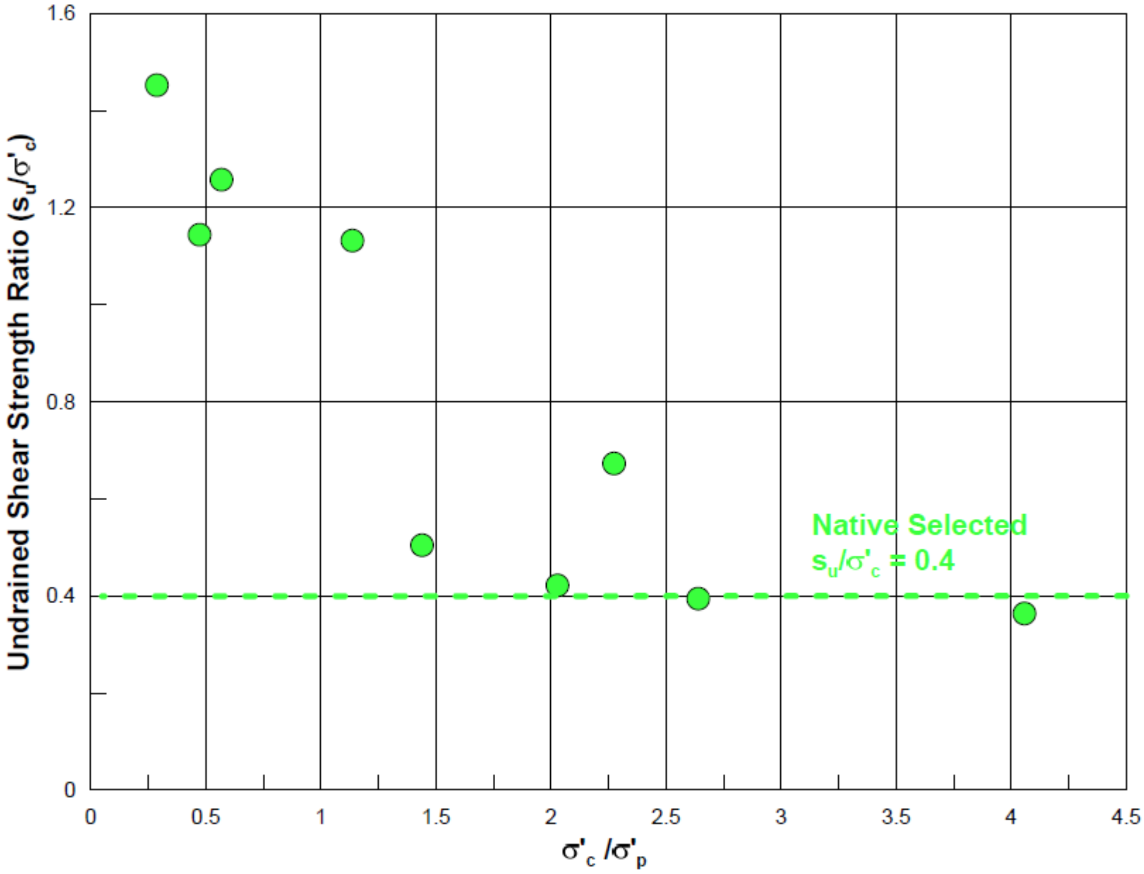

Figure 11. Undrained Shear Strength Ratio Calculated from CU Triaxial Tests on Native Soil

Notes:

1. Native soil is assumed to be normally consolidated, thus $\sigma'_p = \sigma'_v$.
2. S_u – Undrained Shear Strength; σ'_c – confining pressure;
   σ'_p – preconsolidation pressure; σ'_v – effective vertical stress.

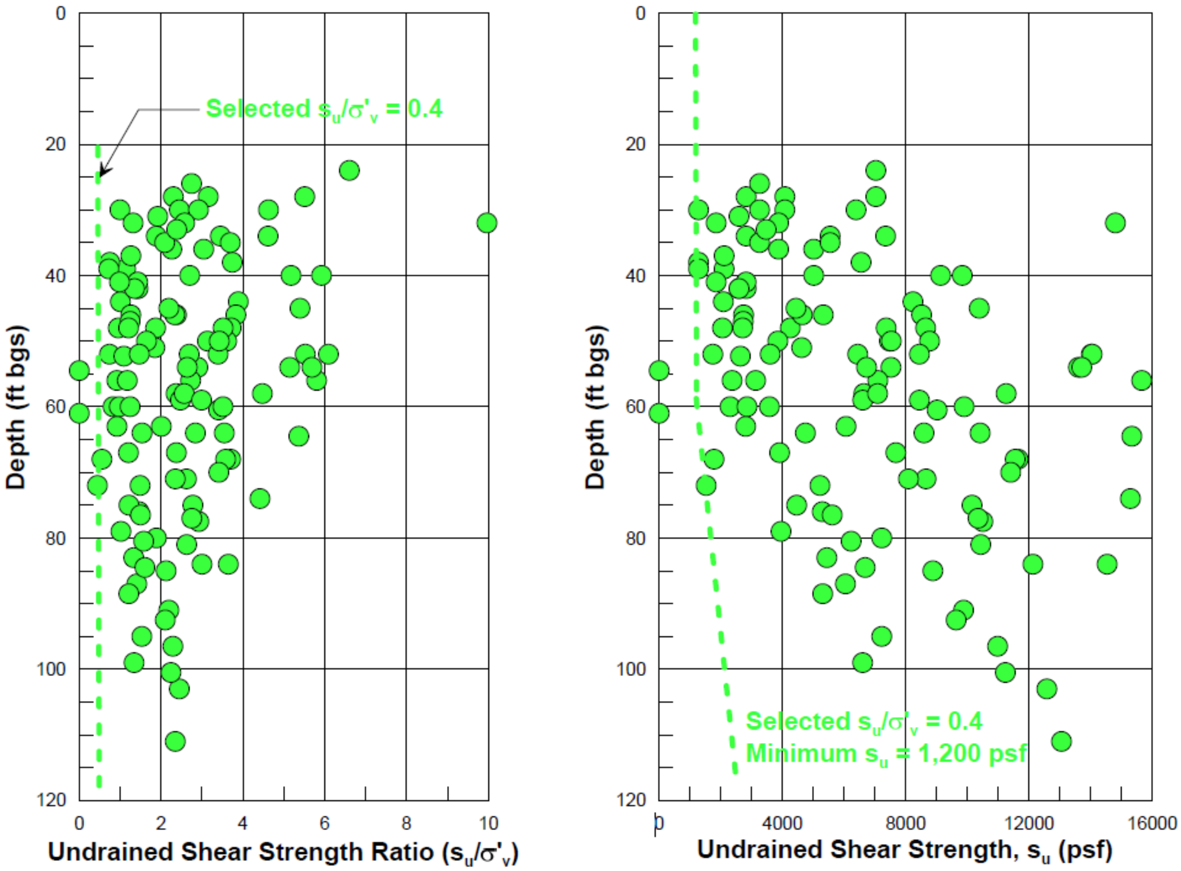

Figure 12. Calculated Undrained Shear Strength and Undrained Shear Strength Ratio from SPT on Native Soil

Notes:

1. SPTs that exceed 50 blows per 6 inches are not included in this figure.
2. σ_v' is the estimated effective vertical stress in the field.
3. ft: feet, psf: pounds per square foot.

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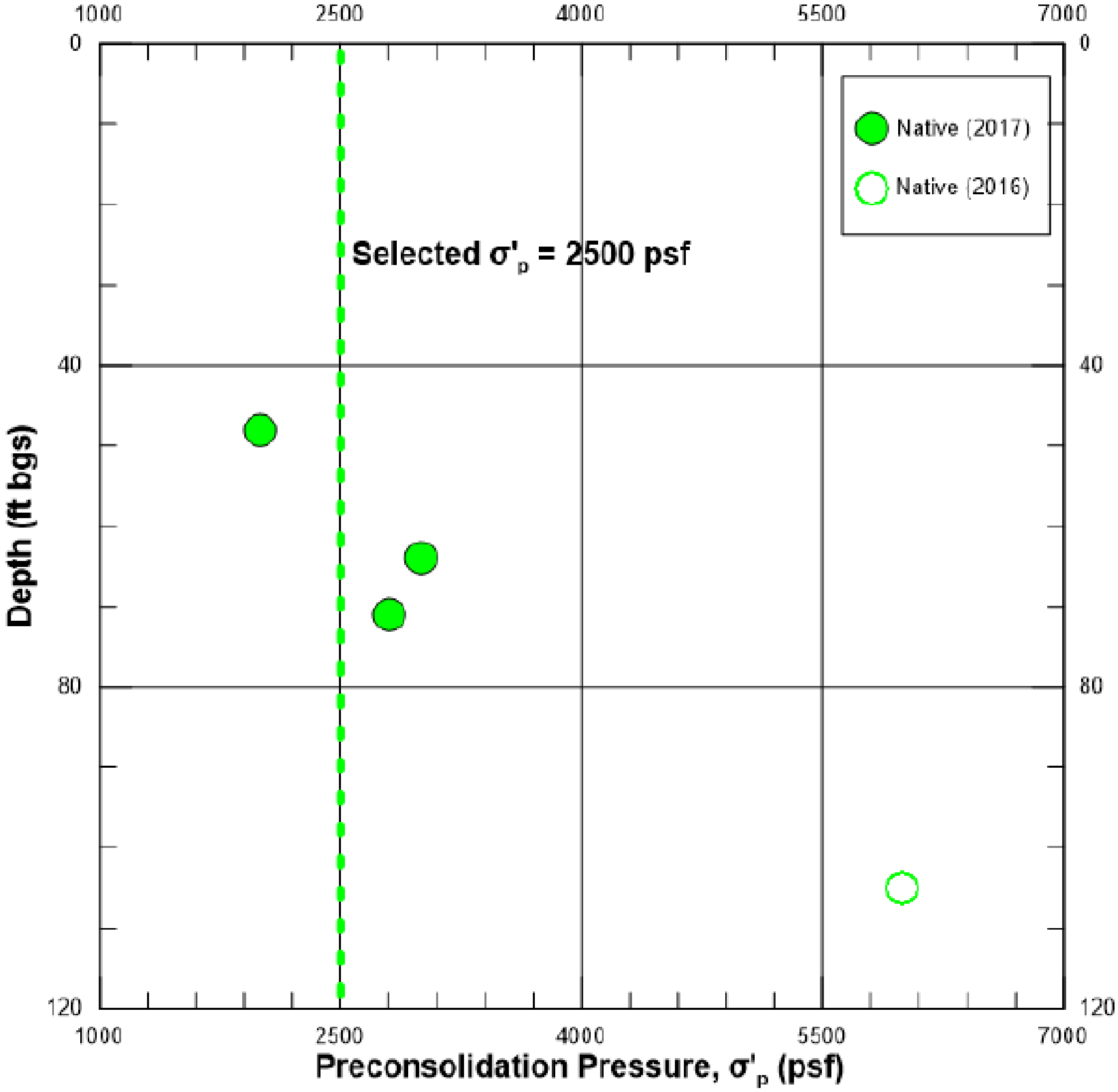

Figure 13. Calculated Preconsolidation Pressure for Native Soil

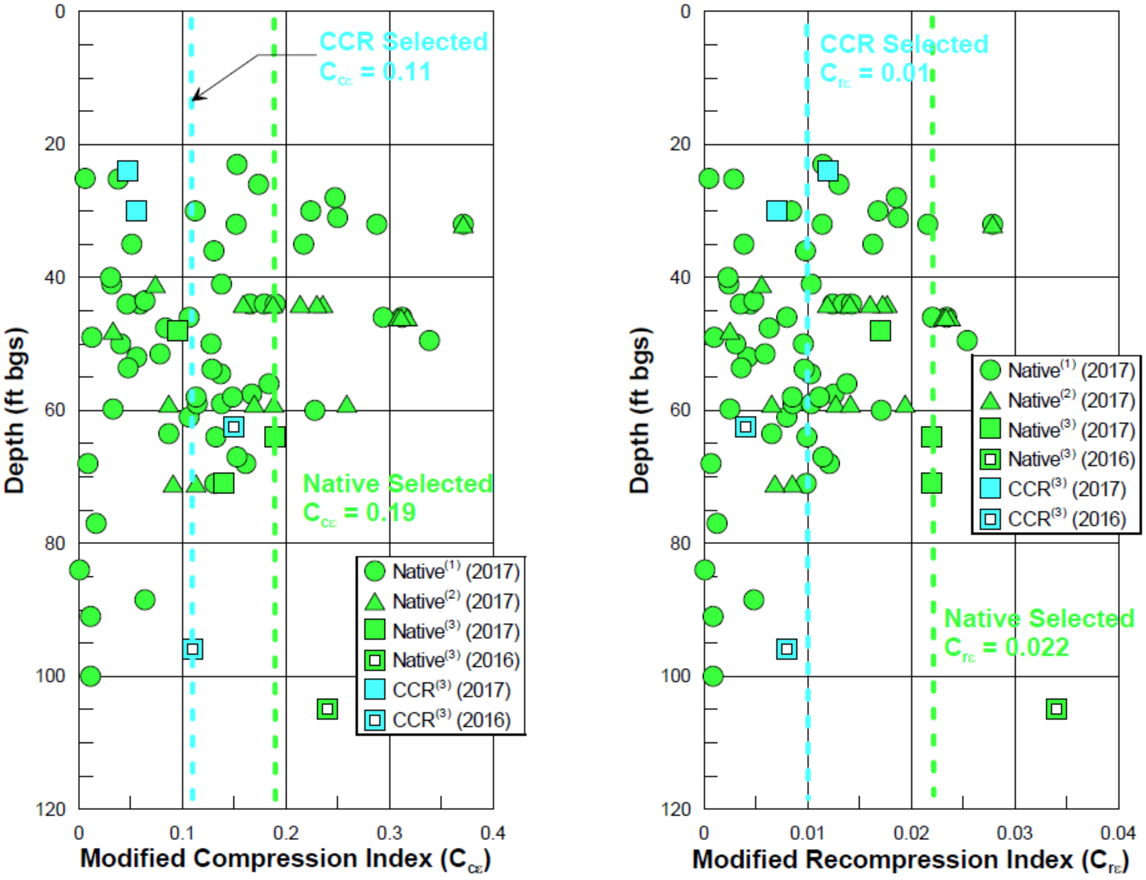

Figure 14. Calculated Modified Compression and Recompression Indices

Notes:

1. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ values based on correction with void ratio, where void ratios are calculated using moisture contents from disturbed grab samples.
2. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ values based on correction with void ratio, where void ratios are calculated using moisture contents from nominally undisturbed samples extruded in the laboratory for CU triaxial, permeability, and 1-D consolidation testing.
3. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ values calculated from 1-D consolidation test data.

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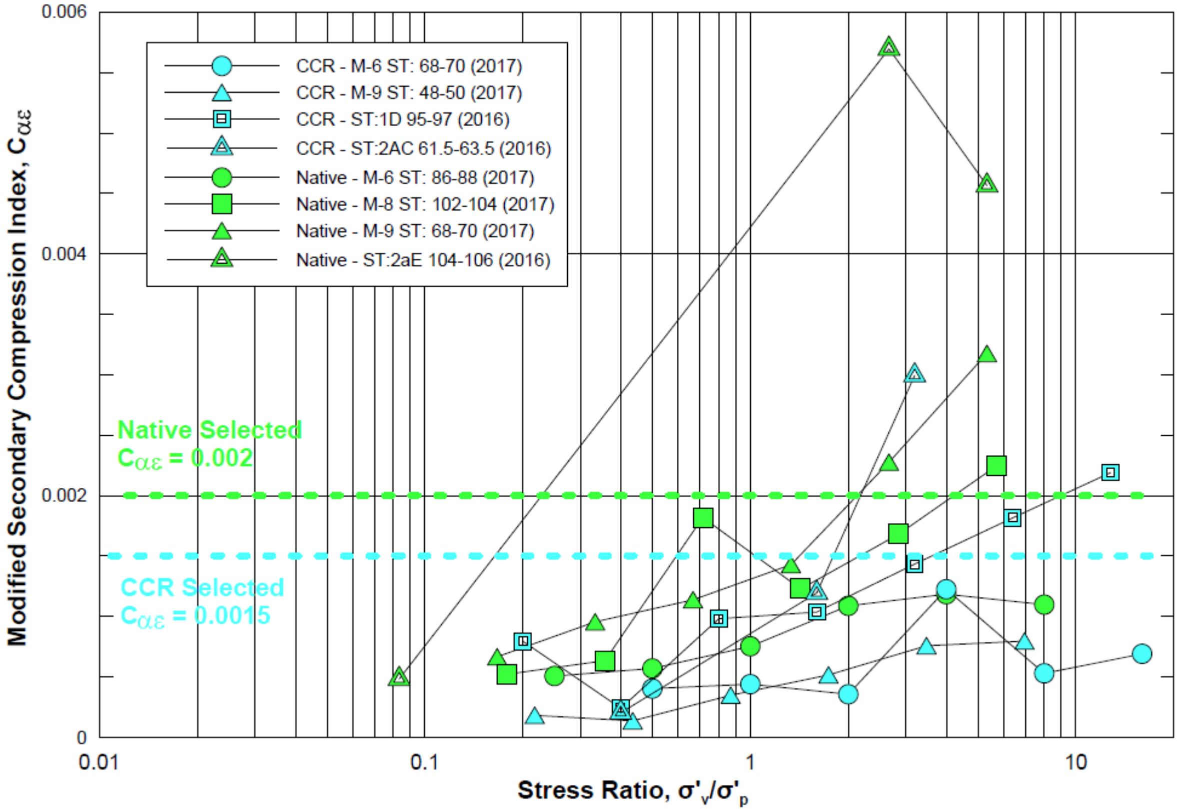

Figure 15. Calculated Modified Secondary Compression Index

Notes:

1. σ'_v – effective vertical stress; σ'_p – preconsolidation pressure.

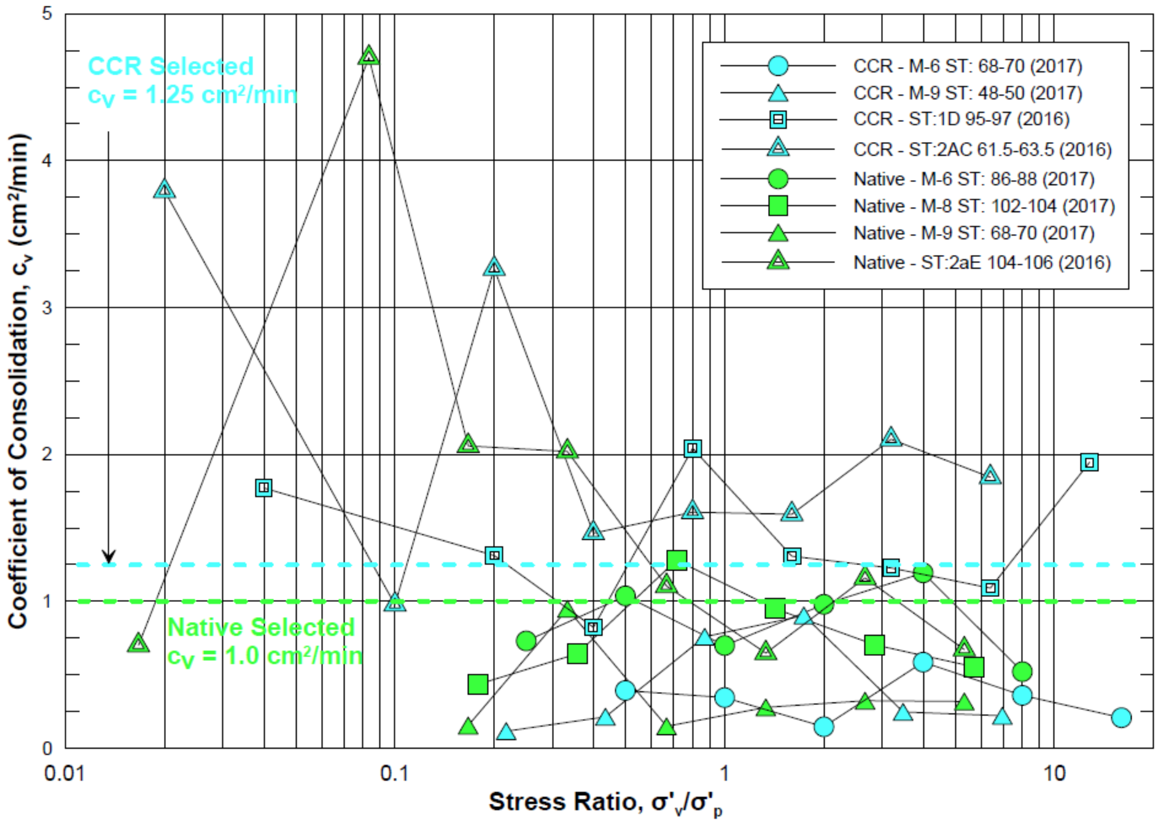

Figure 16. Calculated Coefficient of Consolidation

Notes:

1. σ'_v – effective vertical stress; σ'_p – preconsolidation pressure.

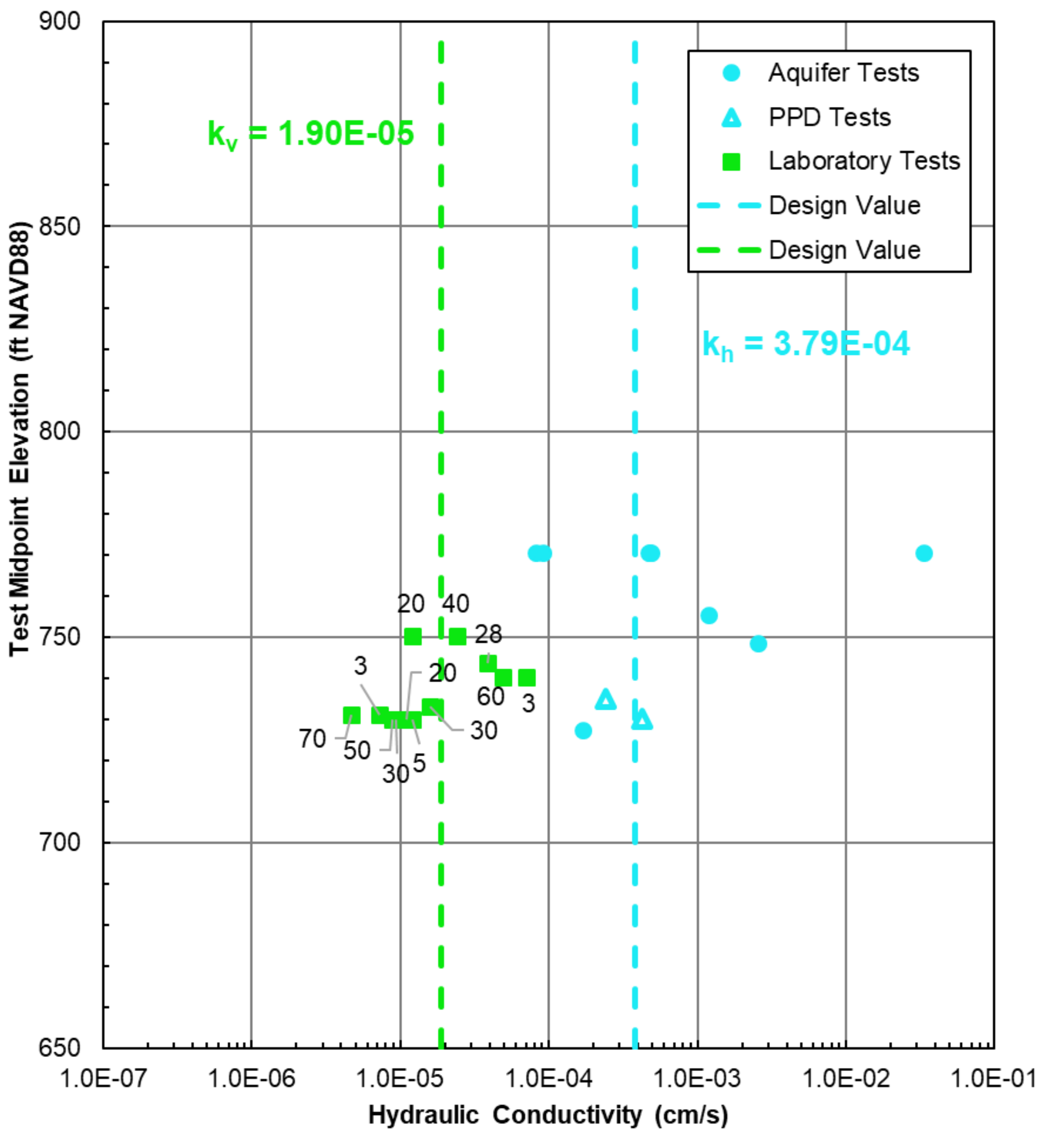

Figure 17. Measured Vertical Hydraulic Conductivity for CCR

Notes:

1. Data labels indicate the consolidation pressure, in pounds per square inch (psi), at which the permeability test was performed.
2. Blue data points indicate test results for horizontal hydraulic conductivity
3. Green data points indicate test results for vertical hydraulic conductivity

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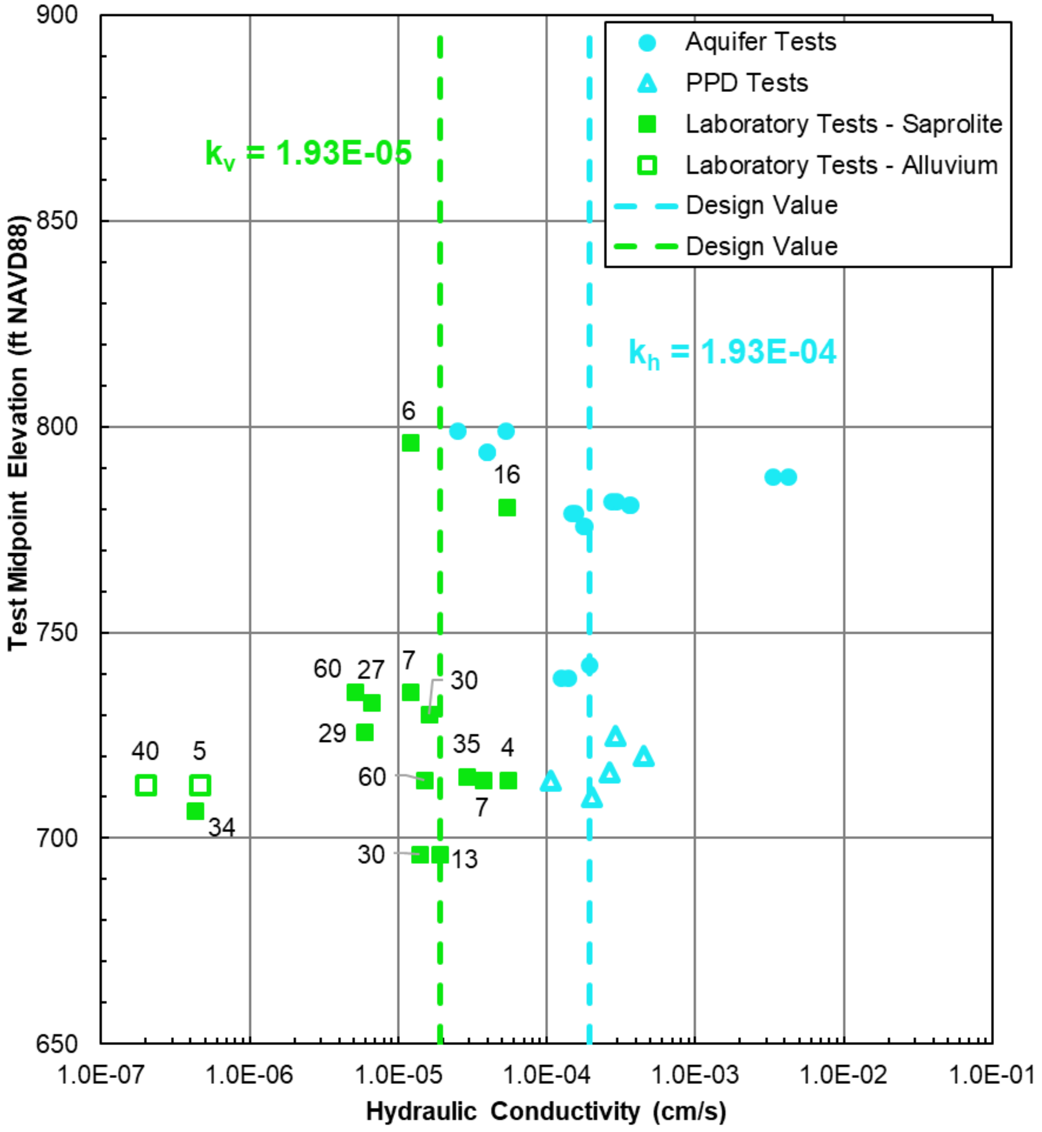

Figure 2. Measured Hydraulic Conductivity Parameters for Native Soil

Notes:

1. Data labels indicate the consolidation pressure, in pounds per square inch (psi), at which the permeability test was performed.
2. Blue data points indicate test results for horizontal hydraulic conductivity
3. Green data points indicate test results for vertical hydraulic conductivity

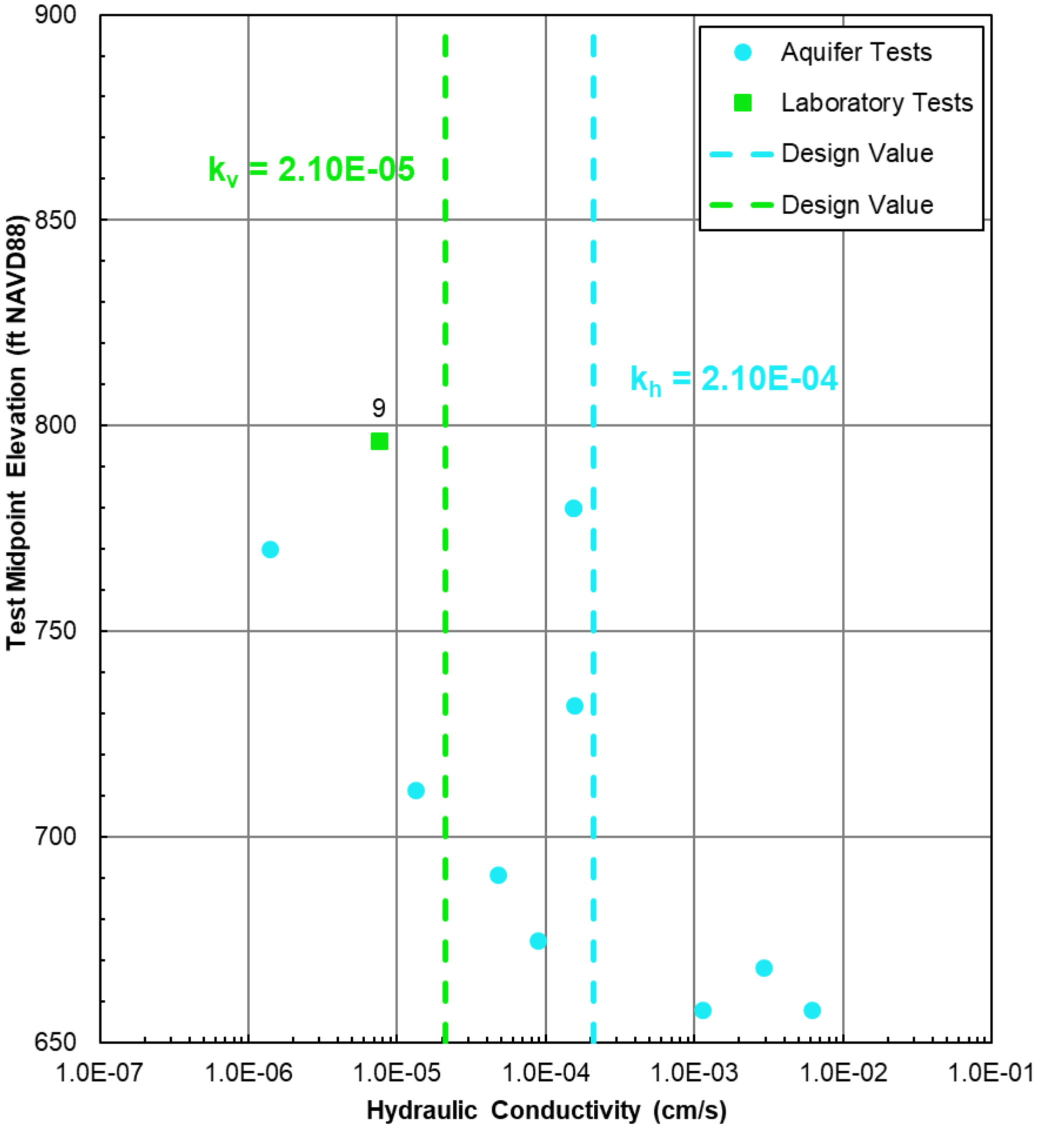

Figure 3. Measured Hydraulic Conductivity Parameters for PWR

Notes:
1. Data labels indicate the consolidation pressure, in pounds per square inch (psi), at which the permeability test was performed.
2. Blue data points indicate test results for horizontal hydraulic conductivity
3. Green data points indicate test results for vertical hydraulic conductivity

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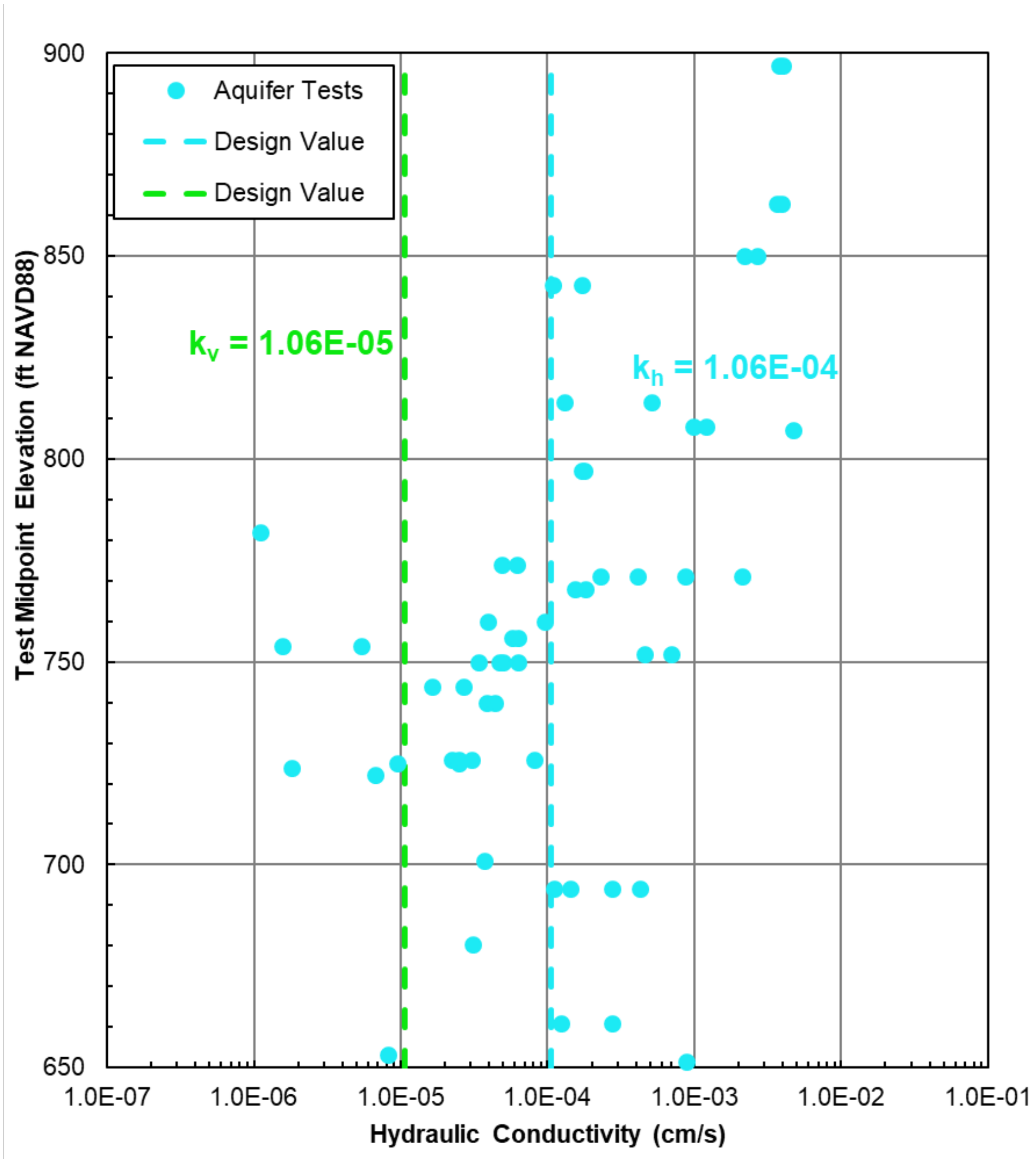

Figure 4. Measured Hydraulic Conductivity Parameters for Bedrock

Notes:

1. Blue data points indicate test results for horizontal hydraulic conductivity
2. Green data points indicate test results for vertical hydraulic conductivity

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ATTACHMENT 1

Laboratory Test Results – Sonic
Plant Wansley, Carrol and Heard Counties, Georgia

									Sieve Analysis			Moisture Content (%)	Atterberg			Classification	
Date Collected	Sample ID[1,2]	from Depth (ft bds)	to Depth (ft bds)	Average Sample Depth (ft bds)	Pond Elevation[3] (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	% Gravel	% Sand	% Fines		LL	PL	PI	USCS Symbol	Description
4/27/2017	S-1: 29-30	29	30	29.5	796.50	770.30	Ash	17E166	0.0	0.5	99.5	51.2	--	--	--	--	--
4/27/2017	S-1: 39-40	39	40	39.5	796.50	760.30	Ash	--	--	--	--	--	--	--	--	--	--
4/27/2017	S-1: 43-44	43	44	43.5	796.50	756.30	Ash	17E167	0.0	0.5	99.5	38.5	--	--	--	--	--
4/27/2017	S-1: 46-47	46	47	46.5	796.50	753.30	Residual Soil	17E168	0.0	37.7	62.3	20.1	--	--	--	--	--
4/27/2017	S-1: 54-55	54	55	54.5	796.50	745.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/27/2017	S-1: 64-65	64	65	64.5	796.50	735.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/27/2017	S-1: 74-75	74	75	74.5	796.50	725.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/24/2017	S-2: 39-40	39	40	39.5	796.25	760.05	Ash	17E169	0.0	2.2	97.8	41.4	--	--	--	--	--
4/24/2017	S-2: 46-47	46	47	46.5	796.25	753.05	Interface[4]	--	--	--	--	--	--	--	--	--	--
4/24/2017	S-2: 49-50	49	50	49.5	796.25	750.05	Residual Soil	17E170	0.1	54.2	45.7	22.6	--	--	--	--	--
4/24/2017	S-2: 54-55	54	55	54.5	796.25	745.05	Residual Soil	17E171	5.2	50.1	44.7	16.9	--	--	--	--	--
4/24/2017	S-2: 59-60	59	60	59.5	796.25	740.05	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/24/2017	S-2: 64-65	64	65	64.5	796.25	735.05	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/24/2017	S-2: 67-68	67	68	67.5	796.25	732.05	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/21/2017	S-3: 38-39	38	39	38.5	796.25	761.05	Ash	17E172	0.0	2.0	98.0	42.0	--	--	--	--	--
4/21/2017	S-3: 62-63	62	63	62.5	796.25	737.05	Ash	17E173	0.0	3.2	96.8	34.0	--	--	--	--	--
4/21/2017	S-3: 87-88	87	88	87.5	796.25	712.05	Alluvium	17E174	0.1	59.4	40.5	26.9	--	--	--	--	--
4/21/2017	S-3: 89-90	89	90	89.5	796.25	710.05	Alluvium	17E175	4.4	41.0	54.6	18.4	--	--	--	--	--
4/21/2017	S-3: 92-93	92	93	92.5	796.25	707.05	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/21/2017	S-3: 95-96	95	96	95.5	796.25	704.05	Alluvium	17E176	23.7	60.4	15.9	14.6	--	--	--	--	--
4/21/2017	S-3: 97-98	97	98	97.5	796.25	702.05	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/21/2017	S-3: 123-124	123	124	123.5	796.25	676.05	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/19/2017	S-4: 42-43	42	43	42.5	796.00	756.80	Ash	17E177	0.0	1.8	98.2	52.0	--	--	--	--	--
4/19/2017	S-4: 72-73	72	73	72.5	796.00	726.80	Ash	17E178	0.0	3.8	96.2	45.2	--	--	--	--	--
4/19/2017	S-4: 86-87	86	87	86.5	796.00	712.80	Alluvium	17E179	0.0	42.2	57.8	31.1	--	--	--	--	--
4/19/2017	S-4: 92-93	92	93	92.5	796.00	706.80	Alluvium	17E180	0.0	47.9	52.1	22.2	--	--	--	--	--
4/19/2017	S-4: 94-95	94	95	94.5	796.00	704.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/19/2017	S-4: 97-97.5	97	97.5	97.25	796.00	702.05	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/19/2017	S-4: 101-102	101	102	101.5	796.00	697.80	Residual Soil	17E181	37.0	34.6	28.4	12.8	--	--	--	--	--
4/19/2017	S-4: 109-110	109	110	109.5	796.00	689.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/19/2017	S-4: 117-118	117	118	117.5	796.00	681.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/19/2017	S-4: 125-130	125	130	127.5	796.00	671.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/20/2017	S-4: 133-134	133	134	133.5	796.00	665.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/13/2017	S-5: 59-60	59	60	59.5	796.50	740.30	Ash	17E182	0.0	3.1	96.9	51.3	--	--	--	--	--
4/13/2017	S-5: 69-70	69	70	69.5	796.50	730.30	Ash	--	--	--	--	--	--	--	--	--	--
4/13/2017	S-5: 79-80	79	80	79.5	796.50	720.30	Ash	17E183	0.0	0.8	99.2	39.3	--	--	--	--	--
4/13/2017	S-5: 87-88	87	88	87.5	796.50	712.30	Residual Soil	17E184	0.2	28.7	71.1	26.6	--	--	--	--	--
4/13/2017	S-5: 93-94	93	94	93.5	796.50	706.30	Residual Soil	17E185	0.2	30.0	69.8	23.4	39	26	13	ML	Sandy Silt
4/13/2017	S-5: 103-104	103	104	103.5	796.50	696.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/13/2017	S-5: 109-110	109	110	109.5	796.50	690.30	Residual Soil	17E186	0.3	54.7	45.0	14.0	35	22	13	SC	Clayey Sand
4/13/2017	S-5: 115-116	115	116	115.5	796.50	684.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/13/2017	S-5: 128-129	128	129	128.5	796.50	671.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/11/2017	S-6: 59-60	59	60	59.5	796.50	740.30	Ash	17D188	0.0	0.7	99.3	38.3	--	--	--	--	--
4/11/2017	S-6: 69-70	69	70	69.5	796.50	730.30	Ash	17D189	0.0	1.6	98.4	44.7	--	--	--	--	--
4/11/2017	S-6: 72-73	72	73	72.5	796.50	727.30	Residual Soil	17D190	27.0	22.4	50.6	17.3	63	30	33	CH	Gravelly Fat Clay with Sand
4/11/2017	S-6: 79-80	79	80	79.5	796.50	720.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/11/2017	S-6: 85-86	85	86	85.5	796.50	714.30	Residual Soil	17D191	0.0	26.4	73.6	15.4	--	--	--	--	--
4/11/2017	S-6: 88-89	88	89	88.5	796.50	711.30	Residual Soil	17D192	0.0	19.6	80.4	26.1	40	23	17	CL	Lean Clay with Sand
4/11/2017	S-6: 97-98	97	98	97.5	796.50	702.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/11/2017	S-6: 104-105	104	105	104.5	796.50	695.30	Residual Soil	17D193	29.2	31.9	38.9	14.9	--	--	--	--	--
4/12/2017	S-6: 109-110	109	110	109.5	796.50	690.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/12/2017	S-6: 118-119	118	119	118.5	796.50	681.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/12/2017	S-6: 119-120	119	120	119.5	796.50	680.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/12/2017	S-6: 138-139	138	139	138.5	796.50	661.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/12/2017	S-6: 148-149	148	149	148.5	796.50	651.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/11/2017	S-6 SC: 70-72	70	72	71	796.50	728.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/7/2017	S-7: 53-54	53	54	53.5	797.00	746.50	Ash	17D194	0.0	2.8	97.2	34.4	--	--	--	--	--
4/7/2017	S-7: 72-73	72	73	72.5	797.00	727.50	Residual Soil	17D195	5.0	40.0	55.0	19.0	--	--	--	--	--
4/7/2017	S-7: 77-78	77	78	77.5	797.00	722.50	Residual Soil	17D196	15.4	48.8	35.8	10.0	--	--	--	--	--
4/7/2017	S-7: 81-82	81	82	81.5	797.00	718.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/7/2017	S-7: 85-86	85	86	85.5	797.00	714.50	Residual Soil	17D197	1.0	32.8	66.2	28.8	NP	NP	NP	ML	Sandy Silt
4/7/2017	S-7: 88-89	88	89	88.5	797.00	711.50	Residual Soil	17D198	14.3	44.1	41.6	20.6	NP	NP	NP	SM	Silty Sand
4/7/2017	S-7: 98-99	98	99	98.5	797.00	701.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/7/2017	S-7: 103-104	103	104	103.5	797.00	696.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/7/2017	S-7: 108-109	108	109	108.5	797.00	691.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/10/2017	S-7: 137-138	137	138	137.5	797.00	662.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/10/2017	S-7: 148-149	148	149	148.5	797.00	651.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/10/2017	S-7: 155-156	155	156	155.5	797.00	644.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/10/2017	S-7: 169-170	169	170	169.5	797.00	630.50	Residual Soil	--	--	--	--	--	--	--	--	--	--

Laboratory Test Results – Sonic
Plant Wansley, Carrol and Heard Counties, Georgia

Date Collected	Sample ID[1,2]	from Depth (ft bds)	to Depth (ft bds)	Average Sample Depth (ft bds)	Pond Elevation[3] (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	Sieve Analysis			Moisture Content (%)	Atterberg			Classification	
									% Gravel	% Sand	% Fines		LL	PL	PI	USCS Symbol	Description
4/4/2017	S-8: 48-49	48	49	48.5	796.50	751.30	Ash	17D078	0.0	0.7	99.3	37.9	--	--	--	--	--
4/4/2017	S-8: 56-57	56	57	56.5	796.50	743.30	Ash	17D079	8.4	63.0	28.6	40.3	--	--	--	--	--
4/4/2017	S-8: 70-71	70	71	70.5	796.50	729.30	Alluvium	17D080	0.0	66.5	33.5	33.7	--	--	--	--	--
4/4/2017	S-8: 74-75	74	75	74.5	796.50	725.30	Alluvium	--	--	--	--	--	--	--	--	--	--
4/4/2017	S-8: 84-85	84	85	84.5	796.50	715.30	Residual Soil	17D081	0.0	18.0	82.0	55.3	68	41	27	MH	Elastic Silt with Sand
4/4/2017	S-8: 96-97	96	97	96.5	796.50	703.30	Residual Soil	17D082	2.6	42.1	55.3	33.3	43	31	12	ML	Sandy Silt
4/4/2017	S-8: 112-113	112	113	112.5	796.50	687.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/4/2017	S-8: 127-128	127	128	127.5	796.50	672.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/4/2017	S-8: 130-150	130	150	140	796.50	659.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/6/2017	S-8: 164-165	164	165	164.5	796.50	635.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
4/4/2017	S-8 SC: 112-113	112	113	112.5	796.50	687.30	Residual Soil	--	--	--	--	--	--	--	--	--	
3/22/2017	S-9: 48-49	48	49	48.5	795.50	750.30	Ash	17D083	0.2	24.1	75.7	28.9	--	--	--	--	--
3/22/2017	S-9: 52-53	52	53	52.5	795.50	746.30	Ash	17D084	0.0	5.3	94.7	43.3	--	--	--	--	--
3/22/2017	S-9: 54-55	54	55	54.5	795.50	744.30	Residual Soil	17D085	4.7	22.3	73.0	33.8	48	33	15	ML	Silt with Sand
3/22/2017	S-9: 75-76	75	76	75.5	795.50	723.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/22/2017	S-9: 98-99	98	99	98.5	795.50	700.30	Residual Soil	17D086	0.3	27.8	71.9	33.8	--	--	--	--	--
3/22/2017	S-9: 108-109	108	109	108.5	795.50	690.30	Residual Soil	17D087	0.0	57.4	42.6	20.9	--	--	--	--	--
3/22/2017	S-9: 125-127	125	127	126	795.50	672.80	Residual Soil	17D088	17.0	51.3	31.7	18.2	--	--	--	--	--
3/22/2017	S-9: 139-140	139	140	139.5	795.50	659.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/23/2017	S-9: 150-151	150	151	150.5	795.50	648.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/23/2017	S-9: 165-166	165	166	165.5	795.50	633.30	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/22/2017	S-9 SC: 120-121	120	121	120.5	795.50	678.30	Residual Soil	--	--	--	--	--	--	--	--	--	
3/22/2017	S-9 SC: 132-133.5	132	133.5	132.75	795.50	666.05	Residual Soil	--	--	--	--	--	--	--	--	--	
3/13/2017	S-10: 58-60	58	60	59	795.00	739.30	Ash	--	--	--	--	--	--	--	--	--	--
3/13/2017	S-10: 69-70	69	70	69.5	795.00	728.80	Residual Soil	17C557	0.1	35.0	64.9	38.4	--	--	--	--	--
3/13/2017	S-10: 73-74	73	74	73.5	795.00	724.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/13/2017	S-10: 79-80	79	80	79.5	795.00	718.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/13/2017	S-10: 85-86	85	86	85.5	795.00	712.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/13/2017	S-10: 93-94	93	94	93.5	795.00	704.80	Residual Soil	17C558	2.3	54.4	43.3	18.4	--	--	--	--	--
3/15/2017	S-10: 104-105	104	105	104.5	795.00	693.80	Residual Soil	17C559	29.5	39.9	30.6	11.0	--	--	--	--	--
3/15/2017	S-10: 114-115	114	115	114.5	795.00	683.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/15/2017	S-10: 116-117	116	117	116.5	795.00	681.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/16/2017	S-10: 138-139	138	139	138.5	795.00	659.80	Residual Soil	17C560	15.1	78.6	6.3	15.0	--	--	--	--	--
3/17/2017	S-10: 158-159	158	159	158.5	795.00	639.80	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/17/2017	S-10: 168-168.5	168	168.5	168.25	795.00	630.05	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/24/2017	S-11: 22-23	22	23	22.5	795.50	776.00	Ash	17D089	0.0	0.2	99.8	14.8	--	--	--	--	--
3/24/2017	S-11: 42-43	42	43	42.5	795.50	756.00	Ash	17D090	0.1	15.2	84.7	31.3	--	--	--	--	--
3/24/2017	S-11: 52-54	52	54	53	795.50	745.50	Residual Soil	17D091	0.1	37.1	62.8	23.7	--	--	--	--	--
3/24/2017	S-11: 59-60	59	60	59.5	795.50	739.00	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/24/2017	S-11: 67-68	67	68	67.5	795.50	731.00	Residual Soil	17D092	0.0	8.4	91.6	65.2	64	45	19	MH	Elastic Silt
3/24/2017	S-11: 78-79	78	79	78.5	795.50	720.00	Residual Soil	17D093	1.3	47.8	50.9	15.9	--	--	--	--	--
3/24/2017	S-11: 94-95	94	95	94.5	795.50	704.00	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/28/2017	S-11: 109-110	109	110	109.5	795.50	689.00	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/29/2017	S-12: 29-30	29	30	29.5	796.00	769.50	Ash	17D094	0.0	2.0	98.0	28.4	--	--	--	--	--
3/29/2017	S-12: 39-40	39	40	39.5	796.00	759.50	Ash	--	--	--	--	--	--	--	--	--	--
3/29/2017	S-12: 45-46	45	46	45.5	796.00	753.50	Residual Soil	17D095	0.4	29.0	70.6	17.4	--	--	--	--	--
3/29/2017	S-12: 59-60	59	60	59.5	796.00	739.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/29/2017	S-12: 64-65	64	65	64.5	796.00	734.50	Residual Soil	17D096	0.1	54.0	45.9	24.8	--	--	--	--	--
3/29/2017	S-12: 74-75	74	75	74.5	796.00	724.50	Residual Soil	--	--	--	--	--	--	--	--	--	--
3/29/2017	S-12: 84-85	84	85	84.5	796.00	714.50	Residual Soil	17D097	0.1	35.7	64.2	8.9	--	--	--	--	--
3/29/2017	S-12: 89-90	89	90	89.5	796.00	709.50	Residual Soil	--	--	--	--	--	--	--	--	--	--

Notes:

1. Sample IDs starting with S represent barge sonic-drilling grab samples
2. Sample IDs containing SC represent barge sonic-drilling samples that were preserved as cores.
3. Pond elevation was recorded from the gauge at the pond outlet on first day of boring.
4. Interface indicates the sample was collected at the ash and residual soil interface.

Legend:

ID - Identification
N/A - Not Applicable
USCS - Unified Soil Classification System
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
NP - Non-Plastic
ft - feet
bds - below deck surface

Laboratory Test Results – Mud Rotary
Plant Wansley, Carrol and Heard Counties, Georgia

										Sieve Analysis					Atterberg			Classification		Triaxial (CU)				Permeability				
Date Collected	Sample ID^{1,2}	from Depth (ft bds)^3	to Depth (ft bds)^3	Average Sample Depth (ft bds)^3	Pond Elevation^4 (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	Recovery (in.)	% Gravel	% Sand	% Fines	Moisture Content (%)	Specific Gravity	LL	PL	PI	USCS Symbol	Description	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Max Deviator Stress (psi)	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Hydraulic Conductivity (cm/s)	Consolidation
3/21/2017	M-1: 3-5	3	5	4	795.50	772.5	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/21/2017	M-1: 13-15	13	15	14	795.50	762.5	Ash	17D064	20	0.0	1.4	98.6	35.1	--	NP	NP	NP	ML	Silt	--	--	--	--	--	--	--	--	--
3/21/2017	M-1: 18-19.7	18	19.7	18.85	795.50	757.65	Ash	--	22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/21/2017	M-1: 19.7-20	19.7	20	19.85	795.50	756.65	Residual Soil	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 23-25	23	25	24	795.50	752.5	Residual Soil	17D065	19	1.4	38.1	60.5	35.1	--	39	26	13	ML	Sandy Silt	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 27-29	27	29	28	795.50	748.5	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 29-30	29	30	29.5	795.50	747	Residual Soil	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 31-33	31	33	32	795.50	744.5	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 33-35	33	35	34	795.50	742.5	Residual Soil	--	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 35-37	35	37	36	795.50	740.5	Residual Soil	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 38-39	38	39	38.5	795.50	738	Residual Soil	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 39-40	39	40	39.5	795.50	737	Residual Soil	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 43-45	43	45	44	795.50	732.5	Residual Soil	17D066	17	0.9	46.5	52.6	24.4	--	41	27	14	ML	Sandy Silt	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 45-47	45	47	46	795.50	730.5	Residual Soil	--	19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 47-49	47	49	48	795.50	728.5	Residual Soil	--	21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 49-51	49	51	50	795.50	726.5	Residual Soil	--	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 51-53	51	53	52	795.50	724.5	Residual Soil	17D067	19	1.2	49.8	49.0	24.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1: 53-55	53	55	54	795.50	722.5	Residual Soil	--	22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/23/2017	M-1: 58-60	58	60	59	795.50	717.5	Residual Soil	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/23/2017	M-1: 63-65	63	65	64	795.50	712.5	Residual Soil	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1 ST: 25-27	25	27	26	795.50	750.50	Ash	--	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/22/2017	M-1 ST: 40-42	40	42	41	795.50	735.50	Residual Soil	17E192	19	2.3	52.5	45.2	22.1	--	39	30	9	SM	Silty Sand	--	--	--	--	25.7	96.9	7 60	1.2E-05 5.1E-06	--
3/23/2017	M-2: 33-35	33	35	34	795.50	765.50	Ash	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/23/2017	M-2: 38-40	38	40	39	795.50	760.50	Ash	17D068	15	0.0	2.1	97.9	33.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/23/2017	M-2: 43-45	43	45	44	795.50	755.50	Ash	--	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/23/2017	M-2: 53-55	53	55	54	795.50	745.50	Ash	17D069	14	0.0	9.5	90.5	34.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/23/2017	M-2: 58-60	58	60	59	795.50	740.50	Ash	--	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/23/2017	M-2: 63-65	63	65	64	795.50	735.50	Residual Soil	17D070	15	0.0	39.3	60.7	22.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/24/2017	M-2: 68-70	68	70	69	795.50	730.50	Residual Soil	17D071	23	0.0	39.7	60.3	19.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/24/2017	M-2: 70-72	70	72	71	795.50	728.50	Residual Soil	--	9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/24/2017	M-2: 73-75	73	75	74	795.50	725.50	Residual Soil	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/24/2017	M-2: 76-78	76	78	77	795.50	722.50	Residual Soil	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

CP: **MC** Date: **09/28/22** APC: **CG** Date: **09/29/22** CA: **JG** Date: **11/14/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

Laboratory Test Results – Mud Rotary
Plant Wansley, Carrol and Heard Counties, Georgia

										Sieve Analysis					Atterberg			Classification		Triaxial (CU)				Permeability				
Date Collected	Sample ID^{1,2}	from Depth (ft bds)^{3}	to Depth (ft bds)^{3}	Average Sample Depth (ft bds)^{3}	Pond Elevation^{4} (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	Recovery (in.)	% Gravel	% Sand	% Fines	Moisture Content (%)	Specific Gravity	LL	PL	PI	USCS Symbol	Description	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Max Deviator Stress (psi)	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Hydraulic Conductivity (cm/s)	Consolidation
3/27/2017	M-3: 31-33	31	33	32	796.00	767.00	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 38-40	38	40	39	796.00	760.00	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 43-45	43	45	44	796.00	755.00	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 48-50	48	50	49	796.00	750.00	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 53-55	53	55	54	796.00	745.00	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 58-60	58	60	59	796.00	740.00	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 63-65	63	65	64	796.00	735.00	Ash	17D072	N/A	0.0	6.3	93.7	42.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 73-75	73	75	74	796.00	725.00	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 78-80	78	80	79	796.00	720.00	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 83-84.1	83	84.1	83.55	796.00	715.45	Ash	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3: 84.1-85	84.1	85	84.55	796.00	714.45	Alluvium	17D073	N/A	3.3	37.2	59.5	35.5	--	30	23	7	ML	Sandy Silt	--	--	--	--	--	--	--	--	--
3/28/2017	M-3: 87-89	87	89	88	796.00	711.00	Alluvium	17D074	N/A	2.7	40.4	56.9	28.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/28/2017	M-3: 90-92	90	92	91	796.00	708.00	Alluvium	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/28/2017	M-3: 92-94	92	94	93	796.00	706.00	Alluvium	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/27/2017	M-3 ST: 68-70	68	70	69	796.00	730.00	Ash	17E187	11	0.1	5.1	94.8	35.9	--	--	--	--	--	--	40.4	73.9	20	37.9	38.8	74.8	5 20	1.2E-05 1.1E-05	--
3/28/2017	M-3 ST: 85-87	85	87	86	796.00	713.00	Alluvium	17E458	17	0.2	29.1	70.7	29.6	--	38	30	8	ML	Silt with Sand	38.2 26.9 48.8	81.2 92.2 79.4	10 20 40	25.2 45.3 53.8	35.8	87.1	5 40	4.6E-07 2.0E-07	--
3/28/2017	M-4: 43-45	43	45	44	796.00	755.00	Ash	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/28/2017	M-4: 58-60	58	60	59	796.00	740.00	Ash	--	4.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/28/2017	M-4: 63-65	63	65	64	796.00	735.00	Ash	--	16.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 73-75	73	75	74	796.00	725.00	Ash	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 78-80	78	80	79	796.00	720.00	Ash	17D075	24	0.0	4.1	95.9	38.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 83-85	83	85	84	796.00	715.00	Ash	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 88-90	88	90	89	796.00	710.00	Residual Soil	17D076	13	1.8	26.8	71.4	32.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 91.5-93.5	91.5	93.5	92.5	796.00	706.50	Residual Soil	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 94-96	94	96	95	796.00	704.00	Residual Soil	--	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 98-100	98	100	99	796.00	700.00	Residual Soil	17D077	14	8.1	51.7	40.2	13.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 103-105	103	105	104	796.00	695.00	Residual Soil	--	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4: 107-109	107	109	108	796.00	691.00	Residual Soil	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/29/2017	M-4 ST: 68-70	68	70	69	796.00	730.00	Ash	17E188	13	0.0	2.7	97.3	33.6	2.386	NP	NP	NP	ML	Silt	38.9 43.0	79.7 73.3	30 50	64.4 84.2	38.1	77.3	30 50	9.3E-06 8.9E-06	--

CP: MC Date: 09/28/22 APC: CG Date: 09/29/22 CA: JG Date: 11/14/22

Client: GPC Project: Plant Wansley CCR Permitting Project No: GW9155

Laboratory Test Results – Mud Rotary
Plant Wansley, Carrol and Heard Counties, Georgia

Date Collected	Sample ID^{1,2}	from Depth (ft bds)^{3}	to Depth (ft bds)^{3}	Average Sample Depth (ft bds)^{3}	Pond Elevation^{4} (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	Recovery (in.)	Sieve Analysis			Moisture Content (%)	Specific Gravity	Atterberg			Classification		Triaxial (CU)				Permeability				Consolidation
										% Gravel	% Sand	% Fines			LL	PL	PI	USCS Symbol	Description	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Max Deviator Stress (psi)	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Hydraulic Conductivity (cm/s)	
3/30/2017	M-5: 48-50	48	50	49	796.00	750.00	Ash	--	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/30/2017	M-5: 53-55	53	55	54	796.00	745.00	Ash	--	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/30/2017	M-5: 58-60	58	60	59	796.00	740.00	Ash	17D157	24	0.0	2.0	98.0	43.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/30/2017	M-5: 73-75	73	75	74	796.00	725.00	Ash	--	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/30/2017	M-5: 78-80	78	80	79	796.00	720.00	Ash	17D158	24	0.0	1.9	98.1	44.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/30/2017	M-5: 85-87	85	87	86	796.00	713.00	Residual Soil	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/31/2017	M-5: 87-89	87	89	88	796.00	711.00	Residual Soil	--	19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/31/2017	M-5: 89-91	89	91	90	796.00	709.00	Residual Soil	17D159	21	0.7	37.8	61.5	31.0	--	52	32	20	MH	Sandy Elastic Silt	--	--	--	--	--	--	--	--	--
3/31/2017	M-5: 91-93	91	93	92	796.00	707.00	Residual Soil	--	21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/31/2017	M-5: 93-95	93	95	94	796.00	705.00	Residual Soil	17D160	16	0.6	51.4	48.0	14.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/31/2017	M-5: 98-100	98	100	99	796.00	700.00	Residual Soil	17D161	23	0.8	33.1	66.1	32.1	--	39	29	10	ML	Sandy Silt	--	--	--	--	--	--	--	--	--
3/31/2017	M-5: 103-105	103	105	104	796.00	695.00	Residual Soil	--	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/31/2017	M-5: 107-109	107	109	108	796.00	691.00	Residual Soil	17D162	19	0.4	47.8	51.8	20.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/4/2017	M-5: 110-112	110	112	111	796.00	688.00	Residual Soil	--	19.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/4/2017	M-5: 113-115	113	115	114	796.00	685.00	Residual Soil	--	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/4/2017	M-5: 118-120	118	120	119	796.00	680.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/4/2017	M-5: 123-125	123	125	124	796.00	675.00	Residual Soil	--	18.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3/30/2017	M-5 ST: 83-85	83	85	84	796.00	715.00	Residual Soil	--	18	0.2	40.4	59.4	23.3	--	43	24	19	CL	Sandy Lean Clay									--
5/2/2017	M-6: 48-50	48	50	49	797.00	751.00	Ash	17E478	24	0.1	2.7	97.2	40.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/2/2017	M-6: 52-55	52	55	53.5	797.00	746.50	Ash	--	8.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/2/2017	M-6: 63-65	63	65	64	797.00	736.00	Ash	--	15.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/2/2017	M-6: 68-70	68	70	69	797.00	731.00	Ash	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/2/2017	M-6: 73-75	73	75	74	797.00	726.00	Residual Soil	17E479	24	0.0	8.5	91.5	42.2	--	46	35	11	ML	Silt	--	--	--	--	--	--	--	--	--
5/2/2017	M-6: 78-80	78	80	79	797.00	721.00	Residual Soil	--	13.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/2/2017	M-6: 83-85	83	85	84	797.00	716.00	Residual Soil	--	21.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/3/2017	M-6: 90-92	90	92	91	797.00	709.00	Residual Soil	--	20.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/3/2017	M-6: 94-96	94	96	95	797.00	705.00	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/3/2017	M-6: 98-100	98	100	99	797.00	701.00	Residual Soil	--	16.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/3/2017	M-6: 102-104	102	104	103	797.00	697.00	Residual Soil	--	20.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/3/2017	M-6: 106-108	106	108	107	797.00	693.00	Residual Soil	17E480	20.5	3.7	42.8	53.5	18.6	2.778	NP	NP	NP	ML	Sandy Silt	--	--	--	--	--	--	--	--	--
5/3/2017	M-6: 108-110	108	110	109	797.00	691.00	Residual Soil	--	19.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/3/2017	M-6: 113-115	113	115	114	797.00	686.00	Residual Soil	--	5.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/3/2017	M-6: 118-120	118	120	119	797.00	681.00	Residual Soil	--	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

CP: MC Date: 09/28/22 APC: CG Date: 09/29/22 CA: JG Date: 11/14/22

Client: GPC Project: Plant Wansley CCR Permitting Project No: GW9155

Laboratory Test Results – Mud Rotary
Plant Wansley, Carrol and Heard Counties, Georgia

										Sieve Analysis					Atterberg			Classification		Triaxial (CU)				Permeability				
Date Collected	Sample ID^{1,2}	from Depth (ft bds)^{3}	to Depth (ft bds)^{3}	Average Sample Depth (ft bds)^{3}	Pond Elevation^{4} (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	Recovery (in.)	% Gravel	% Sand	% Fines	Moisture Content (%)	Specific Gravity	LL	PL	PI	USCS Symbol	Description	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Max Deviator Stress (psi)	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Hydraulic Conductivity (cm/s)	Consolidation
5/2/2017	M-6 ST: 68-70	68	70	69	797.00	731.00	Ash	17E189	12	0.0	3.4	96.6	38.1	--	NP	NP	NP	ML	Silt	--	--	--	--	36.2	78.0	3 70	7.3E-06 4.7E-06	√
5/2/2017	M-6 ST: 86-88	86	88	87	797.00	713.00	Residual Soil	--	18	0.0	59.8	40.2	18	--	NP	NP	NP	SM	Silty Sand	--	--	--	--	--	--	--	--	√
4/26/2017	M-7: 48-50	48	50	49	796.25	750.25	Ash	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/26/2017	M-7: 53-55	53	55	54	796.25	745.25	Ash	--	22.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/26/2017	M-7: 63-65	63	65	64	796.25	735.25	Ash	--	16.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/26/2017	M-7: 68-70	68	70	69	796.25	730.25	Residual Soil	17E481	21.6	0.0	14.5	85.5	43.2	--	51	34	17	MH	Elastic Silt	--	--	--	--	--	--	--	--	--
4/26/2017	M-7: 72-74	72	74	73	796.25	726.25	Residual Soil	--	19.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/26/2017	M-7: 76-78	76	78	77	796.25	722.25	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/26/2017	M-7: 80-82	80	82	81	796.25	718.25	Residual Soil	--	19.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/26/2017	M-7: 88-90	88	90	89	796.25	710.25	Residual Soil	--	21.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/27/2017	M-7: 92-94	92	94	93	796.25	706.25	Residual Soil	--	19.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/27/2017	M-7: 96-98	96	98	97	796.25	702.25	Residual Soil	17E482	24	0.0	25.6	74.4	29.5	--	50	31	19	MH	Elastic Silt	--	--	--	--	--	--	--	--	--
4/27/2017	M-7: 101-103	101	103	102	796.25	697.25	Residual Soil	--	19.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/27/2017	M-7: 105-107	105	107	106	796.25	693.25	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/27/2017	M-7: 109-111	109	111	110	796.25	689.25	Residual Soil	--	22.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/27/2017	M-7: 113-115	113	115	114	796.25	685.25	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/28/2017	M-7: 115-117	115	117	116	796.25	683.25	Residual Soil	--	19.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/28/2017	M-7: 119-121	119	121	120	796.25	679.25	Residual Soil	17E483	21.6	0.0	46.5	53.5	17.6	--	37	21	16	CL	Sandy Lean Clay	--	--	--	--	--	--	--	--	--
4/28/2017	M-7: 123-125	123	125	124	796.25	675.25	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/28/2017	M-7: 127-129	127	129	128	796.25	671.25	Residual Soil	--	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/28/2017	M-7: 131-133	131	133	132	796.25	667.25	Residual Soil	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/28/2017	M-7: 135-137	135	137	136	796.25	663.25	Residual Soil	--	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/2/2017	M-7: 138-140	138	140	139	796.25	660.25	Residual Soil	17E484	11	0.0	51.7	48.3	20.5	--	41	22	19	SC	Clayey Sand	--	--	--	--	--	--	--	--	--
5/2/2017	M-7: 143-145	143	145	144	796.25	655.25	Residual Soil	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/2/2017	M-7: 148-150	148	150	149	796.25	650.25	Residual Soil	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/2/2017	M-7: 153	153	153	153	796.25	646.25	Residual Soil	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/26/2017	M-7 ST: 58-60	58	60	59	796.25	740.25	Ash	17E190	22	0.0	1.3	98.7	36.0	--	NP	NP	NP	ML	Silt	36.0 41.5 31.6	75.8 75.9 79.4	5 30 60	21.0 61.9 127.3	45.3	69.7	3 60	7.1E-05 4.9E-05	--
4/26/2017	M-7 ST: 84-86	84	86	85	796.25	714.25	Residual Soil	17E459	24	0.1	5.8	94.1	59.1	--	61	39	22	MH	Elastic Silt	60.2 58.3 58.9	62.2 65.1 64.6	7 30 60	16.0 25.3 43.5	58.3	66.1	7 60	3.7E-05 1.5E-05	--
4/27/2017	M-7 ST: 100-100.8	100	100.8	100.4	796.25	698.85	Residual Soil	--	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Laboratory Test Results – Mud Rotary
Plant Wansley, Carrol and Heard Counties, Georgia

										Sieve Analysis					Atterberg			Classification		Triaxial (CU)				Permeability				
Date Collected	Sample ID[1,2]	from Depth (ft bds)[3]	to Depth (ft bds)[3]	Average Sample Depth (ft bds)[3]	Pond Elevation[4] (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	Recovery (in.)	% Gravel	% Sand	% Fines	Moisture Content (%)	Specific Gravity	LL	PL	PI	USCS Symbol	Description	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Max Deviator Stress (psi)	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Hydraulic Conductivity (cm/s)	Consolidation
4/21/2017	M-8: 43-45	43	45	44	796.00	755.00	Ash	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/21/2017	M-8: 48-50	48	50	49	796.00	750.00	Ash	17E197	19.2	0.0	0.2	99.8	34.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/21/2017	M-8: 53-55	53	55	54	796.00	745.00	Ash	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 63-65	63	65	64	796.00	735.00	Residual Soil	17E198	24	0.0	23.7	76.3	54.1	--	NP	NP	NP	ML	Silt with Sand	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 66-68	66	68	67	796.00	732.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 70-72	70	72	71	796.00	728.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 78-80	78	80	79	796.00	720.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 82-84	82	84	83	796.00	716.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 90-92	90	92	91	796.00	708.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 94-96	94	96	95	796.00	704.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 98-100	98	100	99	796.00	700.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 106-108	106	108	107	796.00	692.00	Residual Soil	--	20.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 110-112	110	112	111	796.00	688.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8: 114-116	114	116	115	796.00	684.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/25/2017	M-8: 118-120	118	120	119	796.00	680.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/25/2017	M-8: 122-124	122	124	123	796.00	676.00	Residual Soil	17E199	22.8	0.8	52.6	46.6	20.5	--	37	26	11	SM	Silty Sand	--	--	--	--	--	--	--	--	--
4/25/2017	M-8: 126-128	126	128	127	796.00	672.00	Residual Soil	--	16.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/25/2017	M-8: 130-132	130	132	131	796.00	668.00	Residual Soil	--	20.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/25/2017	M-8: 134-136	134	136	135	796.00	664.00	Residual Soil	--	22.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/25/2017	M-8: 138-140	138	140	139	796.00	660.00	Residual Soil	--	10.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/25/2017	M-8: 142-144	142	144	143	796.00	656.00	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/25/2017	M-8: 147-149	147	149	148	796.00	651.00	Residual Soil	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8 ST: 58-60	58	60	59	796.00	740.00	Ash	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8 ST: 74-76	74	76	75	796.00	724.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8 ST: 86-88	86	88	87	796.00	712.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/24/2017	M-8 ST: 102-104	102	104	103	796.00	696.00	Residual Soil	17E195	24	0.3	40.6	59.1	31.4	--	NP	NP	NP	ML	Sandy Silt	--	--	--	--	29.5	89.1	13 30	1.9E-05 1.4E-05	√

Laboratory Test Results – Mud Rotary
Plant Wansley, Carrol and Heard Counties, Georgia

										Sieve Analysis					Atterberg			Classification		Triaxial (CU)				Permeability				
Date Collected	Sample ID[1,2]	from Depth (ft bds)[3]	to Depth (ft bds)[3]	Average Sample Depth (ft bds)[3]	Pond Elevation[4] (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	Recovery (in.)	% Gravel	% Sand	% Fines	Moisture Content (%)	Specific Gravity	LL	PL	PI	USCS Symbol	Description	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Max Deviator Stress (psi)	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Hydraulic Conductivity (cm/s)	Consolidation
4/12/2017	M-9: 28-30	28	30	29	796.25	770.25	Ash	17D163	24	0.0	1.0	99.0	27.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/12/2017	M-9: 33-35	33	35	34	796.25	765.25	Ash		24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/12/2017	M-9: 38-40	38	40	39	796.25	760.25	Ash	17D164	24	0.0	2.7	97.3	35.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 55-57	55	57	56	796.25	743.25	Residual Soil	17D165	23	0.0	29.1	70.9	47.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 57-59	57	59	58	796.25	741.25	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 61-63	61	63	62	796.25	737.25	Residual Soil	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 65-67	65	67	66	796.25	733.25	Residual Soil	--	22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 72-74	72	74	73	796.25	726.25	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 76-78	76	78	77	796.25	722.25	Residual Soil	--	21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 80-82	80	82	81	796.25	718.25	Residual Soil	17D166	24	0.0	35.3	64.7	37.6	--	NP	NP	NP	ML	Sandy Silt	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 84-86	84	86	85	796.25	714.25	Residual Soil	--	22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 88-90	88	90	89	796.25	710.25	Residual Soil	17D167	23	0.6	44.6	54.8	31.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9: 96-98	96	98	97	796.25	702.25	Residual Soil	--	N/A	--	--	--	--	--					--	--	--	--	--	--	--	--	--	--
4/17/2017	M-9: 100.5-102.5	100.5	102.5	101.5	796.25	697.75	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/18/2017	M-9: 104.5-106.5	104.5	106.5	105.5	796.25	693.75	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/18/2017	M-9: 108.5-110.5	108.5	110.5	109.5	796.25	689.75	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/18/2017	M-9: 112.5-114.5	112.5	114.5	113.5	796.25	685.75	Residual Soil	17E200	24	0.9	57.0	42.1	24.8	--	42	30	12	SM	Silty Sand	--	--	--	--	--	--	--	--	--
4/18/2017	M-9: 116.5-118.5	116.5	118.5	117.5	796.25	681.75	Residual Soil	--	21.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/18/2017	M-9: 120.5-122.5	120.5	122.5	121.5	796.25	677.75	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/18/2017	M-9: 124.5-126.5	124.5	126.5	125.5	796.25	673.75	Residual Soil	--	16.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/12/2017	M-9 ST: 43-45	43	45	44	796.25	755.25	Ash	--	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/12/2017	M-9 ST: 48-50	48	50	49	796.25	750.25	Ash	17D199	24	0.0	1.3	98.7	31.8	--	NP	NP	NP	ML	Silt	35.1	79.8	40	159.8	31.8	81.7	20 40	1.2E-05 2.4E-05	√
4/13/2017	M-9 ST: 53-55	53	55	54	796.25	745.25	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/13/2017	M-9 ST: 68-70	68	70	69	796.25	730.25	Residual Soil	17D200	26	0.0	41.6	58.4	35.3	2.819	43	34	13	ML	Sandy Silt	34.5 45.0 38.1	87.2 76.7 82.9	6 30 55	17.4 30.3 43.4	44.1	78.5	30	1.6E-05	√
4/13/2017	M-9 ST: 92-94	92	94	93	796.25	706.25	Residual Soil	--	28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

CP: **MC** Date: **09/28/22** APC: **CG** Date: **09/29/22** CA: **JG** Date: **11/14/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

Laboratory Test Results – Mud Rotary
Plant Wansley, Carroll and Heard Counties, Georgia

										Sieve Analysis					Atterberg			Classification		Triaxial (CU)				Permeability				
Date Collected	**Sample ID^{1,2}**	**from Depth (ft bds)^{3}**	**to Depth (ft bds)^{3}**	**Average Sample Depth (ft bds)^{3}**	**Pond Elevation^{4} (ft)**	**Average Sample Elevation (ft)**	**Material Type**	**Lab Sample ID**	**Recovery (in.)**	**% Gravel**	**% Sand**	**% Fines**	**Moisture Content (%)**	**Specific Gravity**	**LL**	**PL**	**PI**	**USCS Symbol**	**Description**	**Initial Moisture Content (%)**	**Initial Dry Unit Weight (pcf)**	**Confining Pressure (psi)**	**Max Deviator Stress (psi)**	**Initial Moisture Content (%)**	**Initial Dry Unit Weight (pcf)**	**Confining Pressure (psi)**	**Hydraulic Conductivity (cm/s)**	**Consolidation**
4/20/2017	M-10: 28-30	28	30	29	796.00	770.00	Ash	17E201	19.2	0.0	0.4	99.6	33.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10: 33-35	33	35	34	796.00	765.00	Ash	--	20.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10: 43-45	43	45	44	796.00	755.00	Ash	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10: 48-50	48	50	49	796.00	750.00	Ash	17E202	24	0.0	2.8	97.2	32.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10: 58-60	58	60	59	796.00	740.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10: 64-66	64	66	65	796.00	734.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10: 68-70	68	70	69	796.00	730.00	Residual Soil	--	21.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10: 72-74	72	74	73	796.00	726.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10: 76-78	76	78	77	796.00	722.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/21/2017	M-10: 84-86	84	86	85	796.00	714.00	Residual Soil	17E203	24	0.0	28.4	71.6	34.8	--	41	25	16	CL	Lean Clay with Sand	--	--	--	--	--	--	--	--	--
4/21/2017	M-10: 88-90	88	90	89	796.00	710.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/21/2017	M-10: 92-94	92	94	93	796.00	706.00	Residual Soil	--	21.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/21/2017	M-10: 96-98	96	98	97	796.00	702.00	Residual Soil	--	20.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/21/2017	M-10: 100-102	100	102	101	796.00	698.00	Residual Soil	17E204	18	0.0	48.1	51.9	19.7	--	33	21	12	CL	Sandy Lean Clay	--	--	--	--	--	--	--	--	--
4/21/2017	M-10: 104-106	104	106	105	796.00	694.00	Residual Soil	--	16.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10 ST: 38-40	38	40	39	796.00	760.00	Ash	17E191	24	0.0	22.8	77.2	52.4	2.269	NP	NP	NP	ML	Silt with Sand	31.1 36.1	69.1 77.4	10 20	48.1 133.8	--	--	--	--	--
4/20/2017	M-10 ST: 53-55	53	55	54	796.00	745.00	Interface^{5}	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10 ST: 60-62	60	62	61	796.00	738.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/20/2017	M-10 ST: 80-82	80	82	81	796.00	718.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/10/2017	M-11: 23-25	23	25	24	796.75	775.75	Ash	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/10/2017	M-11: 33-35	33	35	34	796.75	765.75	Ash	--	13.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/10/2017	M-11: 43-45	43	45	44	796.75	755.75	Ash	17D168	19.2	0.0	0.2	99.8	30.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/10/2017	M-11: 50-52	50	52	51	796.75	748.75	Residual Soil	17D169	22.8	0.3	18.9	80.8	46.9	--	60	42	18	MH	Elastic Silt with Sand	--	--	--	--	--	--	--	--	--
4/10/2017	M-11: 52-54	52	54	53	796.75	746.75	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/10/2017	M-11: 58-60	58	60	59	796.75	740.75	Residual Soil	17D170	22.8	0.0	53.1	46.9	31.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/10/2017	M-11: 60-62	60	62	61	796.75	738.75	Residual Soil	--	20.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 62-64	62	64	63	796.75	736.75	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 64-66	64	66	65	796.75	734.75	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 66-68	66	68	67	796.75	732.75	Residual Soil	17D171	24	0.0	27.3	72.7	37.0	--	60	39	21	MH	Elastic Silt with Sand	--	--	--	--	--	--	--	--	--

CP: MC Date: 09/28/22 APC: CG Date: 09/29/22 CA: JG Date: 11/14/22

Client: GPC Project: Plant Wansley CCR Permitting Project No: GW9155

Laboratory Test Results – Mud Rotary
Plant Wansley, Carrol and Heard Counties, Georgia

										Sieve Analysis					Atterberg			Classification		Triaxial (CU)				Permeability				
Date Collected	Sample ID^{1,2}	from Depth (ft bds)^{3}	to Depth (ft bds)^{3}	Average Sample Depth (ft bds)^{3}	Pond Elevation^{4} (ft)	Average Sample Elevation (ft)	Material Type	Lab Sample ID	Recovery (in.)	% Gravel	% Sand	% Fines	Moisture Content (%)	Specific Gravity	LL	PL	PI	USCS Symbol	Description	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Max Deviator Stress (psi)	Initial Moisture Content (%)	Initial Dry Unit Weight (pcf)	Confining Pressure (psi)	Hydraulic Conductivity (cm/s)	Consolidation
4/11/2017	M-11: 68-70	68	70	69	796.75	730.75	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 70--72	70	72	71	796.75	728.75	Residual Soil	--	21.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 72-74	72	74	73	796.75	726.75	Residual Soil	17D172	21.6	0.0	51.7	48.3	22.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 74-76	74	76	75	796.75	724.75	Residual Soil	--	22.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 76-78	76	78	77	796.75	722.75	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 78-80	78	80	79	796.75	720.75	Residual Soil	--	21.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 80-82	80	82	81	796.75	718.75	Residual Soil	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 82-84	82	84	83	796.75	716.75	Residual Soil	17D173	24	0.0	5.1	94.9	43.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/11/2017	M-11: 86-88	86	88	87	796.75	712.75	Residual Soil	--	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/12/2017	M-11: 90.5-92.5	90.5	92.5	91.5	796.75	708.25	Residual Soil	--	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/12/2017	M-11: 93	93	93	93	796.75	706.75	Residual Soil	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/10/2017	M-11 ST: 54-56	54	56	55	796.75	744.75	Residual Soil	17E196	24	0.0	11.6	88.4	73.9	--	71	43	28	MH	Elastic Silt	--	--	--	--	73.9	58	4	5.5E-05	--
4/6/2017	M-12: 23-25	23	25	24	797.00	776.00	Ash	17D174	14.4	0.0	1.5	98.5	26.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 28-30	28	30	29	797.00	771.00	Ash	--	7.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 43-45	43	45	44	797.00	756.00	Residual Soil	17D175	21.6	0.0	31.2	68.8	36.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 45-45.8	45	45.8	45.4	797.00	754.60	Residual Soil	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 45.8-46.6	45.8	46.6	46.2	797.00	753.80	Residual Soil	--	19.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 47-49	47	49	48	797.00	752.00	Residual Soil	17D176	20.4	0.6	41.9	57.5	29.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 49-51	49	51	50	797.00	750.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 51-53	51	53	52	797.00	748.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 53-55	53	55	54	797.00	746.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12: 58-60	58	60	59	797.00	741.00	Residual Soil	17D177	24	0.0	42.9	57.1	32.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/7/2017	M-12: 63-65	63	65	64	797.00	736.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/7/2017	M-12: 68-70	68	70	69	797.00	731.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/7/2017	M-12: 73-75	73	75	74	797.00	726.00	Residual Soil	--	N/A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4/6/2017	M-12 ST: 38-40	38	40	39	797.00	761.00	Residual Soil	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

1. Sample IDs starting with M represent barge mud rotary-drilling samples
2. Sample IDs containing ST represent Shelby tube samples, otherwise all samples are split-spool samples.
3. Sample depth reported as feet below deck surface expect for boring M-1 where depth reported as feet below top of ash
4. Pond elevation was recorded from the gauge at the pond outlet on first day of each boring.
5. Interface indicates the sample was collected at the ash and residual soil interface.

Legend:

ID - Identification
N/A - Not Applicable
CU - Consolidated-Undrained Triaxial Compression Test
USCS - Unified Soil Classification System
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
NP - Non-Plastic

ft - feet
in. - inches
bds - below deck surface
pcf - pounds per cubic foot
psi - pounds per square inch
cm/s - centimeters per second
√ - test performed
% - percent

ATTACHMENT 2

In Situ Testing - Standard Penetrometer Tests (SPT)

The SPT N-value was measured as the number of "blows" needed to advance the split spoon sampler six inches which was recorded over 4 intervals for a total of 24 inches. The middle two 6-inch intervals were summed and reported as a "SPT N-value". The standard SPT N-value measured in the field corresponds to a 140-pound (lb) hammer falling 30 inches with a 60 percent efficient hammer system; therefore, the field measured SPT N-value was corrected for variations in drill rigs, hammer efficiency, and sampling methods. The corrected SPT N-value is then used in engineering correlations and computations. The corrected N-value (N_{60}) is computed as follows:

$$N_{60} = N_{meas} C_E C_B C_S C_R \qquad (1)$$

where:

N_{60} = SPT N-value corrected to 60 percent efficiency (blows/ft);
N_{meas} = SPT N-value measured in the field (blows/ft);
C_E = correction factor for the applied energy of the hammer;
C_B = correction factor for the borehole diameter;
C_S = correction factor for the sampling method; and
C_R = correction factor for the rod length.

Correction factors for the borehole diameter, sampling method, and rod length are provided in Table A. The correction factor for the applied energy is computed as follows:

$$C_E = \frac{ER}{60} \qquad (2)$$

where:

ER = Energy Ratio of the hammer on the drilling rig used during the field investigation. ER is 92 for the drill rig used during the site investigation.

In many correlations, corrected SPT N-values are normalized to account for the in-situ effective vertical stress at the sampling depth. The normalized, corrected blow count [$(N_1)_{60}$] is computed as follows:

$$(N_1)_{60} = C_N N_{60} \qquad (3)$$

where:

C_N = correction factor for overburden stress.

The correction for overburden stress is computed as:

$$C_N = (P_a/\sigma'_{vo})^n \quad (4)$$

where:

P_a = atmospheric pressure (psf);
σ_{vo}' = effective vertical stress (psf); and
n = exponent based on soil type.

The exponent, n, is typically 1 for clays and ranges from 0.5 to 0.6 for sands. Soil specific correlations for the exponent have been developed for various geomaterials, but are not locally available. For this Package, the value of n was conservatively assumed to be 0.5.

SPT N-values were measured at approximately 5-ft intervals within the CCR and at intervals ranging from continuous (2-ft intervals) to approximately 5-ft intervals in the native soil within the borings, except at depths where Shelby tube samples were collected. The measured SPT N-values were corrected (N_{60}) and normalized for overburden stress [$(N_1)_{60}$].

Table A. Borehole Diameter, Sampling Method, and Rod Length Correction Factors (adapted from Skempton [1986])

Correction Factor	Variable	Value
Borehole diameter factor, C_B	2.5 – 4.5 inches	1.00
	6.0 inches	1.05
	8.0 inches	1.15
Sampling method factor, C_S	Standard sampler	1.00
	Sampler without liner (not recommended)	1.20
Rod length factor, C_R	10 – 13 feet	0.75
	13 – 20 feet	0.85
	20 – 30 feet	0.95
	> 30 feet	1.00

ATTACHMENT 3

CP: **MC** Date: **09/28/22** APC: **CG** Date: **09/29/22** CA: **JG** Date: **11/14/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

Summary of Horizontal Hydraulic Conductivity Test Data from Aquifer Testing and Pore Pressure Dissipation Testing
Plant Wansley, Carroll and Heard Counties, Georgia

Soil Layer	Test Type	Column1	Test Location	Test Mid-Point Elevation (ft NAVD88)	Test Date	Test ID	Parameter	Value	Units	Anistropy Ratio, k_v/k_h	Solution Method	Data Source	Page No.
Bedrock	Iso-Flow Packer	N/A	S-4	649.3	4/20/2017	1	k_h	9.61E-05	cm/sec	1	Bouwer-Rice	B-2 Appendix A.4	436
PWR	Iso-Flow Packer	N/A	S-5	668.3	4/13/2017	1	k_h	2.88E-03	cm/sec	1	Bouwer-Rice	B-2 Appendix A.4	438
PWR	Iso-Flow Packer	N/A	S-8	674.8	4/4/2017	1	k_h	8.79E-05	cm/sec	1	Bouwer-Rice	B-2 Appendix A.4	440
Bedrock	Iso-Flow Packer	N/A	S-10	653.3	3/20/2017	1	k_h	8.13E-06	cm/sec	1	Bouwer-Rice	B-2 Appendix A.4	442
PWR	Iso-Flow Packer	N/A	S-11	691	3/27/2017	1	k_h	4.77E-05	cm/sec	1	Bouwer-Rice	B-2 Appendix A.4	444
Bedrock	Iso-Flow Packer	N/A	S-11	680.5	3/28/2017	1	k_h	3.10E-05	cm/sec	1	Bouwer-Rice	B-2 Appendix A.4	446
PWR	Iso-Flow Packer	N/A	S-12	711.5	3/29/2017	1	k_h	1.32E-05	cm/sec	1	Bouwer-Rice	B-2 Appendix A.4	448
Bedrock	Iso-Flow Packer	N/A	S-12	701	3/30/2017	1	k_h	3.74E-05	cm/sec	1	Bouwer-Rice	B-2 Appendix A.4	450
CCR	PPD	N/A	sCPTu-2	735	3/1/2016	N/A	k_h	2.43E-04	cm/sec	N/A	N/A	FS Phase II App. A.4	282
CCR	PPD	N/A	sCPTu-2	730	3/1/2016	N/A	k_h	4.21E-04	cm/sec	N/A	N/A	FS Phase II App. A.4	282
Native Soil	PPD	N/A	sCPTu-2	725	3/1/2016	N/A	k_h	2.89E-04	cm/sec	N/A	N/A	FS Phase II App. A.4	282
Native Soil	PPD	N/A	sCPTu-2	720	3/1/2016	N/A	k_h	4.49E-04	cm/sec	N/A	N/A	FS Phase II App. A.4	282
Native Soil	PPD	N/A	sCPTu-2	716	3/1/2016	N/A	k_h	2.64E-04	cm/sec	N/A	N/A	FS Phase II App. A.4	282
Native Soil	PPD	N/A	sCPTu-2	710	3/1/2016	N/A	k_h	2.02E-04	cm/sec	N/A	N/A	FS Phase II App. A.4	282
Native Soil	PPD	N/A	sCPTu-1	714	3/1/2016	N/A	k_h	1.07E-04	cm/sec	N/A	N/A	FS Phase II App. A.4	281

Notes:

k_h - horizontal hydraulic conductivity
cm/sec - centimeters per second
CCR - coal combustion residuals
PWR - partially weathered rock
PPD - pore pressure dissipation
HAR - Hydrogeologic Assessment Report, Revision 01 [Geosyntec, 2019a]
FS Phase II - Ash Pond Closure Feasibility Study, Phase II Summary Report [Geosyntec, 2016]
B-2 - Ash Pond Closure Pre-Design Study, Phase B-2 Final Draft Report [Geosyntec, 2017]

Summary of Horizontal Hydraulic Conductivity Test Data from Aquifer Testing and Pore Pressure Dissipation Testing
Plant Wansley, Carroll and Heard Counties, Georgia

Soil Layer	Test Type	Column1	Test Location	Test Mid-Point Elevation (ft NAVD88)	Test Date	Test ID	Parameter	Value	Units	Anistropy Ratio, k_v/k_h	Solution Method	Data Source	Page No.
PWR	Slug Test	Falling	WGWA-1 (APA-1)	658	1/27/2016	1	k_h	1.12E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	517
PWR	Slug Test	Rising	WGWA-1 (APA-1)	658	1/27/2016	1	k_h	6.10E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	518
Bedrock	Slug Test	Falling	WGWA-2 (APA-2D)	661	1/27/2016	1	k_h	1.23E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	519
Bedrock	Slug Test	Rising	WGWA-2 (APA-2D)	661	1/27/2016	1	k_h	2.74E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	520
Bedrock	Slug Test	Falling	WGWC-8 (APC-1)	726	1/28/2016	1	k_h	3.02E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	521
Bedrock	Slug Test	Rising	WGWC-8 (APC-1)	726	1/28/2016	1	k_h	2.22E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	522
Bedrock	Slug Test	Falling	WGWC-19 (APC-2)	694	1/26/2016	1	k_h	1.10E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	523
Bedrock	Slug Test	Rising	WGWC-19 (APC-2)	694	1/26/2016	1	k_h	1.43E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	524
Bedrock	Slug Test	Falling	WGWC-19 (APC-2)	694	1/26/2016	a	k_h	2.75E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	525
Bedrock	Slug Test	Rising	WGWC-19 (APC-2)	694	1/26/2016	a	k_h	4.25E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	526
Saprolite/PWR	Slug Test	Falling	WGWC-10 (APC-3D)	669	1/26/2016	1	k_h	5.67E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	527
Saprolite/PWR	Slug Test	Rising	WGWC-10 (APC-3D)	669	1/27/2016	1	k_h	1.70E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	528
Bedrock	Slug Test	Falling	WGWC-12 (APC-4D)	752	1/28/2016	1	k_h	4.55E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	529
Bedrock	Slug Test	Rising	WGWC-12 (APC-4D)	752	1/28/2016	1	k_h	6.95E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	530
Bedrock	Slug Test	Falling	WGWC-13 (APC-5D)	725	1/28/2016	1	k_h	2.47E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	531
Bedrock	Slug Test	Rising	WGWC-13 (APC-5D)	725	1/28/2016	1	k_h	9.55E-06	cm/sec	1	Bouwer-Rice	HAR Appendix E	532
Bedrock	Slug Test	Falling	WGWC-14 (APC-5S)	760	1/28/2016	1	k_h	9.62E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	533
Bedrock	Slug Test	Rising	WGWC-14 (APC-5S)	760	1/28/2016	1	k_h	3.91E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	534
Bedrock	Slug Test	Falling	WGWC-15 (APC-6D)	754	1/29/2016	1	k_h	5.36E-06	cm/sec	1	Bouwer-Rice	HAR Appendix E	535
Bedrock	Slug Test	Rising	WGWC-15 (APC-6D)	754	1/29/2016	1	k_h	1.57E-06	cm/sec	1	Bouwer-Rice	HAR Appendix E	536
Saprolite/PWR	Slug Test	Falling	WGWC-16 (APC-6S)	775	1/29/2016	1	k_h	1.35E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	537
Saprolite/PWR	Slug Test	Rising	WGWC-16 (APC-6S)	775	1/29/2016	1	k_h	1.98E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	538
Bedrock	Slug Test	Falling	WGWC-17 (APC-7)	726	1/29/2016	1	k_h	8.07E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	539
Bedrock	Slug Test	Rising	WGWC-17 (APC-7)	726	1/29/2016	1	k_h	2.46E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	540
Bedrock	Slug Test	N/A	PZ-01	814	12/12/2014	1	k_h	1.30E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	541
Bedrock	Slug Test	N/A	PZ-01	814	12/12/2014	2	k_h	5.13E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	542
Bedrock	Slug Test	N/A	PZ-04	877	12/22/2014	N/A							
Bedrock	Slug Test	N/A	PZ-06	897	12/16/2014	1	k_h	3.97E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	553
Bedrock	Slug Test	N/A	PZ-06	897	12/16/2014	2	k_h	3.79E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	554
Bedrock	Slug Test	N/A	PZ-08	850	12/15/2014	1	k_h	2.21E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	557
Bedrock	Slug Test	N/A	PZ-08	850	12/15/2014	2	k_h	2.66E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	558
Bedrock	Slug Test	N/A	PZ-10	807	12/5/2014	2	k_h	4.70E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	561
Bedrock	Slug Test	N/A	PZ-11	797	12/4/2014	1	k_h	1.70E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	562
Bedrock	Slug Test	N/A	PZ-11	797	12/4/2014	2	k_h	1.78E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	563
Saprolite	Slug Test	N/A	PZ-12	776	12/8/2014	1	k_h	1.74E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	564
Saprolite	Slug Test	N/A	PZ-12	776	12/8/2014	2	k_h	1.80E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	565
Saprolite	Slug Test	N/A	PZ-13	799	12/9/2014	1	k_h	5.25E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	566
Saprolite	Slug Test	N/A	PZ-13	799	12/9/2014	2	k_h	2.49E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	567
Saprolite	Slug Test	N/A	PZ-15	794	12/10/2014	1	k_h	3.95E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	570
Saprolite	Slug Test	N/A	PZ-15	794	12/10/2014	2	k_h	3.92E-05	cm/sec	1	Bouwer-Rice	HAR Appendix E	571
Saprolite	Slug Test	N/A	PZ-16	781	12/10/2014	1	k_h	3.64E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	572
Saprolite	Slug Test	N/A	PZ-16	781	12/10/2014	2	k_h	3.56E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	573
Saprolite	Slug Test	N/A	PZ-17	788	12/11/2014	1	k_h	3.29E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	574
Saprolite	Slug Test	N/A	PZ-17	788	12/11/2014	2	k_h	4.20E-03	cm/sec	1	Bouwer-Rice	HAR Appendix E	575
Saprolite	Slug Test	N/A	PZ-18	782	12/11/2014	1	k_h	2.74E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	576
Saprolite	Slug Test	N/A	PZ-18	782	12/11/2014	2	k_h	2.93E-04	cm/sec	1	Bouwer-Rice	HAR Appendix E	577
Saprolite	N/A	N/A	PZ-20	757	1/31/2017	N/A							
Saprolite/PWR	N/A	N/A	PZ-21	790	1/25/2017	N/A							
CCR	Slug Test	N/A	PZA1-Deep	727.5	4/11/2017	1	k_h	1.69E-04	cm/sec	0.1	Bouwer-Rice	FS Phase II App. A.6	309

Summary of Vertical Hydraulic Conductivity Test Data from Flexible Wall Permeameter Laboratory Testing and CPT Data
Plant Wansley, Carroll and Heard Counties, Georgia

Soil Layer	Test Type	Test Location	Sample Mid-Point Elevation (ft NAVD88)	Test Date	Consol. Pressure (psi)	Test Result			Data Source	Page No.
						Parameter	Value	Units		
Saprolite	Flex. Wall Perm.	M-1	735.5	6/5/2017	7	k_v	1.2E-05	cm/sec	HAR Appendix E	646
Saprolite	Flex. Wall Perm.	M-1	735.5	6/5/2017	60	k_v	5.1E-06	cm/sec	HAR Appendix E	646
CCR	Flex. Wall Perm.	M-3	730.0	6/19/2017	5	k_v	1.2E-05	cm/sec	HAR Appendix E	647
CCR	Flex. Wall Perm.	M-3	730.0	6/19/2017	20	k_v	1.1E-05	cm/sec	HAR Appendix E	647
Alluvium	Flex. Wall Perm.	M-3	713.0	6/5/2017	5	k_v	4.6E-07	cm/sec	HAR Appendix E	648
Alluvium	Flex. Wall Perm.	M-3	713.0	6/5/2017	40	k_v	2.0E-07	cm/sec	HAR Appendix E	648
CCR	Flex. Wall Perm.	M-4	730.0	6/19/2017	30	k_v	9.3E-06	cm/sec	HAR Appendix E	649
CCR	Flex. Wall Perm.	M-4	730.0	6/19/2017	50	k_v	8.9E-06	cm/sec	HAR Appendix E	649
CCR	Flex. Wall Perm.	M-6	731.0	6/19/2017	3	k_v	7.3E-06	cm/sec	HAR Appendix E	650
CCR	Flex. Wall Perm.	M-6	731.0	6/19/2017	70	k_v	4.7E-06	cm/sec	HAR Appendix E	650
CCR	Flex. Wall Perm.	M-7	740.3	6/19/2017	3	k_v	7.1E-05	cm/sec	HAR Appendix E	651
CCR	Flex. Wall Perm.	M-7	740.3	6/19/2017	60	k_v	4.9E-05	cm/sec	HAR Appendix E	651
Saprolite	Flex. Wall Perm.	M-7	714.3	6/5/2017	7	k_v	3.7E-05	cm/sec	HAR Appendix E	652
Saprolite	Flex. Wall Perm.	M-7	714.3	6/5/2017	60	k_v	1.5E-05	cm/sec	HAR Appendix E	652
Saprolite	Flex. Wall Perm.	M-8	696.0	5/18/2017	13	k_v	1.9E-05	cm/sec	HAR Appendix E	653
Saprolite	Flex. Wall Perm.	M-8	696.0	5/18/2017	30	k_v	1.4E-05	cm/sec	HAR Appendix E	653
CCR	Flex. Wall Perm.	M-9	750.3	6/13/2017	20	k_v	1.2E-05	cm/sec	HAR Appendix E	654
CCR	Flex. Wall Perm.	M-9	750.3	6/13/2017	40	k_v	2.4E-05	cm/sec	HAR Appendix E	654
Saprolite	Flex. Wall Perm.	M-9	730.3	5/15/2017	30	k_v	1.6E-05	cm/sec	HAR Appendix E	655
Saprolite	Flex. Wall Perm.	M-11	714.3	5/24/2017	4	k_v	5.5E-05	cm/sec	HAR Appendix E	656
Saprolite	Flex. Wall Perm.	PB-2	706.8	3/29/2017	34	k_v	4.3E-07	cm/sec	HAR Appendix E	658
Saprolite	Flex. Wall Perm.	PB-5	796.0	5/10/2017	6	k_v	1.2E-05	cm/sec	HAR Appendix E	659
PWR	Flex. Wall Perm.	PB-6	796.4	5/9/2017	9	k_v	7.6E-06	cm/sec	HAR Appendix E	660
Saprolite	Flex. Wall Perm.	PB-7	780.5	5/12/2017	16	k_v	5.4E-05	cm/sec	HAR Appendix E	661
Saprolite	Flex. Wall Perm.	PB-7	733.0	5/9/2017	27	k_v	6.6E-06	cm/sec	HAR Appendix E	662
Saprolite	Flex. Wall Perm.	PB-7	726.0	5/9/2017	29	k_v	5.9E-06	cm/sec	HAR Appendix E	663
CCR	Flex. Wall Perm.	B-1	743.6	4/13/2016	28	k_v	3.9E-05	cm/sec	FS Phase II App. A.7	374
CCR	Flex. Wall Perm.	B-2	733.0	4/13/2016	30	k_v	1.6E-05	cm/sec	FS Phase II App. A.7	416
Saprolite	Flex. Wall Perm.	B-2	715.0	4/13/2016	35	k_v	2.9E-05	cm/sec	FS Phase II App. A.7	417
Separator Dike	Flex. Wall Perm.	B-3	770.6	4/13/2016	15	k_v	2.6E-06	cm/sec	FS Phase II App. A.7	473
Separator Dike	Flex. Wall Perm.	B-3	753.1	4/14/2016	23	k_v	5.0E-07	cm/sec	FS Phase II App. A.7	474
Saprolite	Flex. Wall Perm.	B-3	700.6	4/14/2016	45	k_v	3.1E-08	cm/sec	FS Phase II App. A.7	475

Notes:

k_v - vertical hydraulic conductivity
cm/sec - centimeters per second
CCR - coal combustion residuals
PWR - partially weathered rock
HAR - Hydrogeologic Assessment Report, Revision 01 [Geosyntec, 2019a]
FS Phase II - Ash Pond Closure Feasibility Study, Phase II Summary Report [Geosyntec, 2016]

CLOSURE STABILITY
CALCULATION
PACKAGE

Geosyntec
consultants

CALCULATION PACKAGE COVER SHEET

Client: Georgia Power Company **Project:** Plant Wansley CCR Permitting **Project #:** GW9155

TITLE OF PACKAGE: CLOSURE STABILITY CALCULATION PACKAGE

PREPARATION

CALCULATION PREPARED BY:
(Calculation Preparer, CP)

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11/04/2022

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Date

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03/10/2023

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Date

REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
1	Submittal to Georgia EPD	03/10/2023	CG	MC	BM	JG

CP: **CG** Date: **11/04/22** APC: **MC** Date: **11/04/22** CA: **JG** Date: **11/17/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

CLOSURE STABILITY CALCULATION PACKAGE

PURPOSE

This *Slope Stability Analysis* calculation package (herein referred to as the Package) was prepared in support of the Closure by Removal (CBR) permit application package for the permanent closure of Ash Pond 1 (AP-1) at Plant Wansley (Site). Upon closure, AP-1 will be used as an industrial water pond. A Storage Water Pond, used for Site operations, is located east of AP-1, with the two bodies of water separated by an earthen dike, referred to as the Separator Dike (Category II Dam). A Category I Dam located on the northeast perimeter controls the water level in the Storage Water Pond. In accordance with the requirements of Georgia Safe Dams program, the Separator Dike must remain stable in the event of a failure of the Category I Dam and sudden loss of two-thirds of the water volume in the Storage Water Pond. Such an event may induce rapid drawdown (RDD) conditions with respect to the Separator Dike.

The purpose of this Package is to present engineering calculations to evaluate the slope stability of the existing earthen Separator Dike under static, seismic, and rapid drawdown conditions. Specifically, analyses were performed to evaluate the following:

- Static slope stability of the Separator Dike at end-of-construction (short-term condition) and long-term conditions;
- Slope stability of the Separator Dike under the loading conditions imposed by a rapid drawdown of the Storage Water Pond for short-term conditions with the water level of AP-1 at design elevation;
- Static slope stability of the Separator Dike with the lowered pool level of the Storage Water Pond for both short-term and long-term conditions; and
- Seismic (pseudostatic) slope stability of the Separator Dike for post-closure conditions and lowered pool level of the Storage Water Pond.

The remainder of this Package is organized to present: (i) design criteria; (ii) analysis methodology; (iii) design cross section and cases analyzed; (iv) subsurface stratigraphy and design parameters; (v) analysis results; and (vi) conclusions.

All elevations presented in this Package are based on North American Vertical Datum of 1988 (NAVD 88).

DESIGN CRITERIA

The stability of the existing earthen Separator Dike was evaluated using relevant design criteria from the Georgia Department of Natural Resources, Environmental Protection Division (GA EPD) CCR regulations, Rule 391-3-4-10 (GA EPD CCR Rule) [GA EPD, 2016], which adopts most provisions of the United States Environmental Protection Agency's (USEPA's) federal CCR Rule contained in 40 CFR §257 (and 40 CFR §261 by reference), as amended [USEPA, 2015; USEPA, 2016] and/or recommendations in technical literature that represent the state of practice for geotechnical design of slopes. The GA EPD CCR Rule [GA EPD 391-3-4-.10(4)] states that the CCR surface impoundment should meet the structural integrity criteria in 40 CFR 257.73, which are:

- The calculated static factor of safety (FS) under the end-of-construction (short-term) loading condition must equal or exceed 1.30 based on the recommendation in the US Army Corps of Engineers (USACE) slope stability manual [USACE, 2003] referenced in the Preamble to the federal CCR Rule contained in 40 CFR §257 (and 40 CFR §261 by reference);

- The calculated static FS under the long-term, maximum storage pool loading condition must equal or exceed 1.50 [US EPA 40 CFR 257.73I(1)(i)]; and

- The calculated seismic FS must equal or exceed 1.00 [US EPA 40 CFR 257.73(e)(1)(iii)].

For the slope stability analysis of the Separator Dike under RDD conditions, the calculated factor of safety (FS) for the critical slip surface must equal or exceed 1.30 as per the recommendation of the United States Army Corps of Engineers (USACE) [USACE, 2003]. The required FS of 1.30 was selected because the existing water surface elevation of the Storage Water Pond is considered to represent the maximum storage pool elevation.

ANALYSIS METHODOLOGY

Slope stability analyses were performed using Spencer's method [Spencer, 1973], as implemented in the computer program Slide2, version 9.018 [Rocscience, 2021]. The Slide2 software generates potential slip surfaces, calculates the FS for each of these surfaces, and identifies the slip surface with the lowest calculated FS (i.e., the critical slip surface). Circular, non-circular, and block-type slip surfaces were analyzed in Slide2 to identify the lowest calculated FS for the design cross section and cases analyzed. Searches for the critical slip surface in Slide2 were performed with the optimization feature enabled.

For the RDD loading conditions, shear strengths of materials not expected to freely drain during the drawdown of the Storage Water Pond were calculated using Duncan, Wright, and Wong's three-stage approach [Duncan et al., 1990] as implemented in the Slide2 computer program. The three-stage approach considers both undrained (i.e., total stress) and drained (i.e., effective stress) shear strengths of materials that are not freely draining.

As part of the slope stability analyses, the minimum elevation to which the water table within the Storage Water Pond could be lowered under RDD conditions without stability enhancements (e.g., addition of a riprap buttress) was identified.

Then, slope stability analyses were performed using the water surface corresponding to loss of two-thirds of the total volume. Additional slope stability analyses were performed to size a buttress at the toe of the Separator Dike to enhance stability to meet the design criterion for: (i) RDD; (ii) static, short-term; (iii) static, long-term; and (iv) seismic loading conditions.

SUBSURFACE STARTIGRAPHY AND DESIGN PARAMETERS

Information required for the slope stability analyses includes:

- Representative subsurface stratigraphy of the Separator Dike;
- Unit weights and shear strengths (short-term and long-term) of the different materials encountered at the Site;
- Water table elevation; and
- The horizontal pseudostatic coefficient (for seismic slope stability only).

Subsurface Stratigraphy and Geotechnical and Hydraulic Parameters

Figure 1 presents the subsurface stratigraphy for a typical section through the Separator Dike. The data used to develop the subsurface stratigraphy and derive the geotechnical and hydraulic parameters were obtained from field and laboratory investigations performed at the Site and presented in the *Material Properties and Major Design Parameters* calculation package (Data Package) [Geosyntec, 2022]. Based on the data sources presented in the Data Package, the subsurface stratigraphy at the Site primarily consists of existing native soil, partially weathered rock (PWR), and bedrock. The Site also consists of the existing Separator Dike that was constructed using compacted native soil that currently separates the CCR surface impoundment and the Storage Water Pond. A riprap buttress is proposed at the Storage Water Pond side toe of the Separator Dike and the riprap was modeled with a unit weight of 130 pounds per cubic foot (pcf) and an effective friction angle of 40 degrees based on typical values for riprap. A riprap layer, as well as a seepage and stability berm are also proposed to be constructed on the AP-1 side of the Separator dike for erosion protection and increased stability, which were modeled with the same parameters as the riprap buttress.

A summary of the geotechnical parameters used in this Package for the different materials is presented in **Table 1**. Drained shear strength parameters were used for all materials in the long-term, steady-state, static slope stability analyses. Consistent with U.S. Army Corps of Engineers (USACE) Guidance [USACE, 2003], the analyses for short-term, end-of-construction conditions were conducted using the assumption that the Separator Dike and native soil would exhibit undrained shear strengths during temporary conditions.

Drained shear strength parameters were used for the riprap, PWR and Bedrock in the short-term, static slope stability analyses because these materials are considered free draining. For the seismic slope stability analyses, the same parameters as the short-term, static slope stability analyses were used for the materials.

For the RDD loading conditions, the shear strengths of the Separator Dike material and native soil were calculated using Duncan, Wright, and Wong's three-stage approach [Duncan et al., 1990]. **Figure 2** shows the undrained and drained shear strength models for the Separator Dike material and native soil. The remaining materials encountered at the Site are considered freely draining and thus, modeled with drained shear strengths under the RDD loading conditions. Drained shear strength parameters were used for all materials in the long-term, steady-state, static slope stability analyses

Water Table Elevations

During removal of the CCR, the water table at AP-1 is to be lowered to 2-feet below the ground surface. The Storage Water Pond is assumed to be at full operating elevation of EL. 780. Post-closure, the AP-1 pond will be allowed to fill back up to a maximum of EL. 781.5. The Storage Water Pond has a low pool level of EL. 733.2. Therefore, the water table was modeled in the analyses as follows:

- Static (short-term and long-term) and seismic slope stability was analyzed on the upstream (AP-1) side with the water table 2 feet below the ground surface and the Storage Water Pond at EL. 780; and

- Rapid drawdown slope stability was analyzed on the downstream (Storage Water Pond) side with AP-1 at EL. 781.5 and an initial Storage Water Pond level of EL. 780. The drawdown level at the Storage Water Pond was EL. 733.2.

- Static (short-term and long-term) and seismic slope stability was analyzed on the downstream side with AP-1 at EL. 781.5 and the Storage Water Pond at the low pool EL. 733.2.

Horizontal Pseudostatic Coefficients

The estimation of horizontal pseudostatic coefficients for the seismic slope stability analyses is presented in the *Pseudostatic Coefficients for Seismic Analysis* calculation package [Geosyntec, 2021]. A horizontal pseudostatic coefficient of 0.08 was used for potential slip surfaces passing through the separator dike for the seismic slope stability analyses.

DESIGN CROSS SECTION AND CASES ANALYZED

Design Cross Sections

Four cross sections were selected for the static and seismic slope stability analyses, with locations and descriptions provided below. The nomenclature for the cross-sections were selected as E, F, G, and H to correspond to the drawing set. The cross-section locations were selected to represent the varying thicknesses of dike material, height of dike above the bottom of AP-1 and the Storage Water Pond, and subsurface conditions. The location of the selected sections and are shown in **Figure 1** and depicted in **Figure 3** through **Figure 6**.

- **Cross section E** extends through the northern part of the Separator Dike. As shown in **Figure 3**, cross section E includes approximately 94 ft of dike material underlain by approximately 6 ft to 50 ft of native soil decreasing in thickness from the west to east. The side slope of the Separator Dike has an approximate 18 to 25 degree angle from horizontal on the downstream side. The upstream side slope varies from approximately 8 to 21 degrees from horizontal. The steeper side slopes are in the middle to upper third of the dike.

- **Cross section F** extends through the middle portion of the Separator Dike. As shown in **Figure 4**, the separator dike is approximately 90 ft tall above an approximate 50 ft thick layer of native soil and has a slope angle of approximately 15 to 23 degrees from horizontal on the downstream side and 19 to 27 degrees from horizontal on the upstream side. The steeper side slope is in the upper third on the downstream face and the lower and upper third on the upstream face. The bedrock below the dike rises sharply from the middle of the dike to the west (approximately 75 ft rise over 250 ft). The native soil pinches out at the upstream toe of the dike. The bedrock rises more gradually from the middle of the dike to the east towards the downstream toe (approximately 60 ft over 300 ft). The native soil thickness on the downstream toe of the dike is approximately 30 ft.

- **Cross section G** is located at the middle of the Separator Dike. As shown in **Figure 5,** the Separator Dike stands approximately 93 ft tall above approximately 50 ft of native soil. The native soil varies in thickness from approximately 20 ft on the upstream toe to 30 ft on the downstream toe with the greatest thickness of 50 ft in the middle of the separator dike. The downstream slope angle varies from approximately 16 to 23 degrees with the steeper slope in the upper third of the dike. The upstream slope angle varies from 10 to 28 degrees with the steeper sections of 25 and 28 degrees at the upper third and toe of the dike, respectively.

- **Cross section H** is located towards the southern side of the Separator Dike. **Figure 6** shows cross section H. The separator dike at this cross section has a 72 ft height overlying 60 ft of native soil. The native soil below the dike varies in thickness from approximately 40 ft on the upstream toe and 25 ft on the downstream toe with the greatest thickness of 60 ft in the middle. The upstream side slope angle varies from approximately 16 to 21 degrees from horizontal with the steeper slope in the upper third of the dike. The downstream side slope angle varies from approximately 17 to 26 degrees from horizontal with the steeper slope in the upper third of the dike.

Cases Analyzed

The following potential slip surfaces were considered in the static (short-term and long-term), seismic, and rapid drawdown slope stability analyses performed for all cross sections:

- AP-1 Empty – Static and Seismic
    - Upstream slip surfaces analyzed. As part of the anticipated means and methods of the contractor during removal of the CCR in AP-1, the phreatic surface within AP-1 was considered 2-feet below the ground surface for all cases. The Storage Water Pond was considered to be EL. 780 with a steady state condition. The seepage and stability berm plus the riprap blanket were not modeled during the short term condition to account for AP-1 to be emptied prior to placement of the berm and blanket.

- Rapid Drawdown
    - Downstream slip surfaces were analyzed. AP-1 was assumed to have water at EL. 781.5 and the Storage Water Pond was lowered from EL.780 to EL. 733.2. The phreatic surface was analyzed to follow the downstream face of the dike during drawdown.
- Storage Water Pond Low Pool – Static and Seismic
    - Downstream slip surfaces were analyzed. AP-1 was assumed to have water at EL. 781.5 and the Storage Water Pond was assumed to have water at EL. 733.2 with a steady state condition.

ANALYSIS RESULTS

A summary of calculated FS for critical slip surfaces evaluated from the static (short-term and long-term), seismic, and rapid drawdown slope stability analyses is provided in **Table 2**.

Based on the results of the long-term static conditions for cross sections F and G when AP-1 is empty, a stability and seepage berm is required to address exit gradients at the upstream toe and to increase the calculated global stability FS for this loading condition to meet the target FS of 1.5. This stability and seepage berm is proposed to be constructed at all cross sections and was included in the analysis.

Based on the results from the rapid drawdown analyses, lowering the water surface within the Storage Water Pond to an elevation of 733.2 ft during RDD would result in the FS lower than 1.30 without an adding a stability buttress. Therefore, for all three sections considered (i.e., E, F, G, and H) a riprap buttress is modeled at the downstream toe of the Separator Dike to increase the calculated FS for the RDD loading conditions to meet the target FS of 1.30.

Cross Section E - Long-term AP-1 Empty

The critical slip surface for the long-term, static slope stability analyses of cross section E for the upstream side is shown in **Figure 7**. The critical slip surface passes through the top of the separator dike and riprap erosion blanket with the FS=2.23. It occurs in the upper portion of the dike.

Cross Section E- Short-term AP-1 Empty

The critical slip surfaces for the short-term, static slope stability analyses of cross section E for the upstream side is shown in **Figure 8**. The critical slip surface passes through the separator dike and the native soil with the FS=1.54. The critical slip surface bottoms out at the interface of the native soil and partially weathered rock (PWR).

Cross Section E – Seismic AP-1 Empty

The critical slip surfaces for the seismic (pseudostatic) slope stability analyses of cross section E for the upstream face is shown in **Figure 9**. The critical slip surface passes through the separator dike and the native soil with the FS=1.25. The critical slip surface bottoms out at the interface of the native soil and partially weathered rock (PWR).

Cross Section E – Rapid Drawdown

The critical slip surfaces for the rapid drawdown slope stability analyses of cross section E for the downstream side is shown in **Figure 10**. The critical slip surface passes through the upper half of the separator dike with the FS=1.37. The critical slip surface exits the separator dike immediately above the riprap buttress.

Cross Section E - Long-term Storage Water Pond Low Pool

The critical slip surface for the long-term, static slope stability analyses of cross section E for the downstream side is shown in **Figure 11**. The critical slip surface enters through the top of the separator dike and exits through the toe of the separator dike below the riprap buttress and bottoms out at the interface of the PWR and native soil with the FS=2.11.

Cross Section E - Short-term Storage Water Pond Low Pool

The critical slip surface for the short-term, static slope stability analyses of cross section E for the downstream side is shown in **Figure 12**. The critical slip surface enters through the top of the separator dike and exits through the toe of the separator dike through the riprap buttress and bottoms out at the interface of the PWR and native soil with the FS=1.75.

Cross Section E – Seismic Storage Water Pond Low Pool

The critical slip surfaces for the seismic (pseudostatic) slope stability analyses of cross section E for the downstream face is shown in **Figure 13**. The critical slip surface enters through the top of the separator dike and exits through the toe of the separator dike through the riprap buttress and bottoms out at the interface of the PWR and native soil with the FS=1.28.

Cross Section F - Long-term AP-1 Empty

The critical slip surface for the long-term, static slope stability analyses of cross section F for the upstream side is shown in **Figure 14**. The critical slip surface passes through the top of the separator dike and riprap erosion blanket with the FS=2.17. It occurs in the upper portion of the dike.

Cross Section F- Short-term AP-1 Empty

The critical slip surfaces for the short-term, static slope stability analyses of cross section F for the upstream side is shown in **Figure 15**. The critical slip surface passes through the separator dike and the native soil with the FS=1.54. The critical slip surface bottoms out at the interface of the native soil and partially weathered rock (PWR) at the toe of the dike.

Cross Section F – Seismic AP-1 Empty

The critical slip surfaces for the seismic (pseudostatic) slope stability analyses of cross section F for the upstream face is shown in **Figure 16**. The critical slip surface passes through the separator dike and the native soil with the FS=1.43. The critical slip surface bottoms out at the interface of the native soil and partially weathered rock (PWR) exiting at the toe of the dike.

Cross Section F – Rapid Drawdown

The critical slip surfaces for the rapid drawdown slope stability analyses of cross section F for the downstream side is shown in **Figure 17**. The critical slip surface enters through the top of the separator dike and exits through the toe of the separator dike below the riprap buttress and bottoms out within the native soil with the FS=1.31.

Cross Section F - Long-term Storage Water Pond Low Pool

The critical slip surface for the long-term, static slope stability analyses of cross section F for the downstream side is shown in **Figure 18**. The critical slip surface occurs at the toe of the dike, through the riprap buttress and exits through the native soil layer. The bottom of the slip surface is within the native soil layer with the FS=1.66.

Cross Section F - Short-term Storage Water Pond Low Pool

The critical slip surface for the short-term, static slope stability analyses of cross section F for the downstream side is shown in **Figure 19**. The critical slip surface enters through the top of the separator dike and exits below the riprap buttress with the FS=1.66. The bottom of the slip surface is within the native soil.

Cross Section F – Seismic Storage Water Pond Low Pool

The critical slip surfaces for the seismic (pseudostatic) slope stability analyses of cross section F for the downstream face is shown in **Figure 20**. The critical slip surface enters through the top of the separator dike and exits below the riprap buttress with the FS=1.25. The bottom of the slip surface is at the interface of the PWR and native soil.

Cross Section G - Long-term AP-1 Empty

The critical slip surface for the long-term, static slope stability analyses of cross section G for the upstream side is shown in **Figure 21**. The critical slip surface passes through the toe of the separator dike with the FS=1.60.

Cross Section G - Short-term AP-1 Empty

The critical slip surface for the short-term, static slope stability analyses of cross section G for the upstream side is shown in **Figure 22**. The critical slip surface passes through the top of the separator dike, exiting through the native soil at the toe of the slope. The slip surface bottoms out at the native soil and PWR interface with the FS=1.44.

Cross Section G – Seismic AP-1 Empty

The critical slip surfaces for the seismic (pseudostatic) slope stability analyses of cross section G for the upstream side is shown in **Figure 23**. The critical slip surface passes through the top of the separator dike, exiting through the native soil at the toe of the slope. The slip surface bottoms out at the native soil and PWR interface with the FS=1.22.

Cross Section G – Rapid Drawdown

The critical slip surfaces for the rapid drawdown slope stability analyses of cross section G for the downstream side is shown in **Figure 24**. The critical slip surface passes through the upper half of the separator dike with the FS=1.33. The critical slip surface exits the separator dike immediately above the riprap buttress.

Cross Section G - Long-term Storage Water Pond Low Pool

The critical slip surface for the long-term, static slope stability analyses of cross section G for the downstream side is shown in **Figure 25**. The critical slip surface passes through the top of the separator dike, exiting through the native soil past the toe with the FS=1.94. The bottom of the slip surface is within the native soil layer.

Cross Section G - Short-term Storage Water Pond Low Pool

The critical slip surfaces for the short-term, static slope stability analyses of cross section G for the downstream side is shown in **Figure 26**. The critical slip surface passes through the top of the separator dike, exiting through the native soil past the toe with the FS=1.63. The bottom of the slip surface is within the native soil layer.

Cross Section G – Seismic Storage Water Pond Low Pool

The critical slip surfaces for the seismic (pseudostatic) slope stability analyses of cross section G for the downstream side is shown in **Figure 27**. The critical slip surface passes through the top of the separator dike, exiting through the native soil past the toe with the FS=1.22. The bottom of the slip surface is is at the interface of the PWR and native soil layer.

Cross Section H - Long-term AP-1 Empty

The critical slip surface for the long-term, static slope stability analyses of cross section H for the upstream side is shown in **Figure 28**. The critical slip surface passes through the top of the separator dike and exits through the native soil layer past the toe of the dike with the FS=1.98. The slip surface bottom is within the native soil layer.

Cross Section H - Short-term AP-1 Empty

The critical slip surfaces for the short-term, static slope stability analyses of cross section H for the upstream side is shown in **Figure 29**. The critical slip surface passes through the top of the separator dike and exits through the native soil layer past the toe of the dike with the FS=1.54. The slip surface bottom is within the native soil layer.

Cross Section H – Seismic AP-1 Empty

The critical slip surfaces for the seismic (pseudostatic) slope stability analyses of cross section H for the upstream side is shown in **Figure 30**. The critical slip surface passes through the top of the separator dike and exits through the native soil layer past the toe of the dike with the FS=1.25. The slip surface bottom is at the interface of the PWR and the native soil layer.

Cross Section H – Rapid Drawdown

The critical slip surfaces for the rapid drawdown slope stability analyses of cross section H for the downstream side is shown in **Figure 31**. The critical slip surface passes through the middle section of the separator dike with the FS=1.32. The critical slip surface exits the separator dike immediately above the riprap buttress.

Cross Section H - Long-term Storage Water Pond Low Pool

The critical slip surface for the long-term, static slope stability analyses of cross section H for the downstream side is shown in **Figure 32**. The critical slip surface passes through the top of the separator dike, exiting below the riprap buttress with the FS=2.04. The bottom of the slip surface is within the native soil.

Cross Section H - Short-term Storage Water Pond Low Pool

The critical slip surface for the short-term, static slope stability analyses of cross section H for the downstream face is shown in **Figure 33**. The critical slip surface passes through the top of the separator dike, exiting within the upper bench of the riprap buttress with the FS=1.66. The bottom of the slip surface is at the interface between the native soil and the dike.

Cross Section H – Seismic Storage Water Pond Low Pool

The critical slip surface for the seismic (pseudostatic) slope stability analyses of cross section H for the downstream side is shown in **Figure 34**. The critical slip surface passes through the top of the separator dike, through the native soil and exiting within the lower bench of the riprap buttress with the FS=1.26. The bottom of the slip surface is within the native soil layer.

CONCLUSIONS

Short-term and long-term, static, rapid drawdown, and seismic slope stability analyses were performed for three design cross sections through the existing Separator Dike with the proposed riprap buttress, seepage berm, and riprap blanket at the Site as part of this Package. Based on the analyses presented in this Package, the calculated FS for the cross sections considered are greater than the design target FS for static (short-term and long-term), rapid drawdown, and seismic loading conditions.

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United States Environmental Protection Agency (USEPA) (2016). Code of Federal Regulations (CFR) Title 40, Part 257 Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur.

TABLES

Table 1. Summary of Geotechnical Parameters Used in Slope Stability Analyses (1)

Material	**Total Unit Weight (pcf)**	**Undrained Shear Strength Parameters**	**Drained Shear Strength Parameters**	
		Undrained Shear Strength, s_u (psf) and/or Undrained Shear Strength Ratio, s_u/σ_v' (-)	**Effective Friction Angle, ϕ' (°)**	**Effective Cohesion, c' (psf)**
Native Soil	115	$s_u/\sigma_v' = 0.4$ minimum s_u = 1,200 psf	32	0
Dike	125	$s_u/\sigma_v' =0.5$ minimum s_u = 1,000 psf	32	100
Partially Weathered Rock (PWR)	125	-	40	0
Riprap	130	-	40	0
Bedrock	125	-	40	0

Notes:

1. Geotechnical parameters shown in the table above are discussed in the *Material Properties and Major Design Parameters* calculation package [Geosyntec, 2022].

Table 2. Calculated Factors of Safety for Critical Slip Surfaces from Static, Seismic, and Rapid Drawdown Slope Stability Analyses

Cross Section	Condition		Figure	Target FS	Calculated FS	Design Criteria Met?
E	Static – AP-1 Empty (Upstream)	Long-Term (drained)	7	1.50	2.23	Yes
		Short-Term (undrained)	8	1.30	1.54	Yes
	Seismic – AP-1 Empty (Upstream)	(undrained)	9	1.00	1.25	Yes
	Rapid Drawdown (Downstream)	(drained/undrained)	10	1.30	1.37	Yes
	Static – Low Storage Pool (Downstream)	Long-Term (drained)	11	1.50	2.11	Yes
		Short-Term (undrained)	12	1.30	1.75	Yes
	Seismic – Low Storage Pool (Downstream)	(undrained)	13	1.00	1.28	Yes
F	Static – AP-1 Empty (Upstream)	Long-Term (drained)	14	1.50	2.17	Yes
		Short-Term (undrained)	15	1.30	1.54	Yes
	Seismic – AP-1 Empty (Upstream)	(undrained)	16	1.00	1.43	Yes

	Rapid Drawdown (Downstream)	(drained/undrained)	17	1.30	1.31	Yes
	Static – Low Storage Pool (Downstream)	Long-Term (drained)	18	1.50	1.66	Yes
		Short-Term (undrained)	19	1.30	1.66	Yes
	Seismic – Low Storage Pool (Downstream)	(undrained)	20	1.00	1.25	Yes
G	Static – AP-1 Empty (Upstream)	Long-Term (drained)	21	1.50	1.60	Yes
		Short-Term (undrained)	22	1.30	1.44	Yes
	Seismic – AP-1 Empty (Upstream)	(undrained)	23	1.00	1.22	Yes
	Rapid Drawdown (Downstream)	(drained/undrained)	24	1.30	1.33	Yes
	Static – Low Storage Pool (Downstream)	Long-Term (drained)	25	1.50	1.94	Yes
		Short-Term (undrained)	26	1.30	1.63	Yes
	Seismic – Low Storage Pool (Downstream)	(undrained)	27	1.00	1.22	Yes
H	Static – AP-1 Empty (Upstream)	Long-Term (drained)	28	1.50	1.98	Yes
		Short-Term (undrained)	29	1.30	1.54	Yes

	Seismic – AP-1 Empty (Upstream)	(undrained)	30	1.00	1.25	Yes
	Rapid Drawdown (Downstream)	(drained/undrained)	31	1.30	1.32	Yes
	Static – Low Storage Pool (Downstream)	Long-Term (drained)	32	1.50	2.04	Yes
		Short-Term (undrained)	33	1.30	1.66	Yes
	Seismic – Low Storage Pool (Downstream)	(undrained)	34	1.00	1.26	Yes

FIGURES

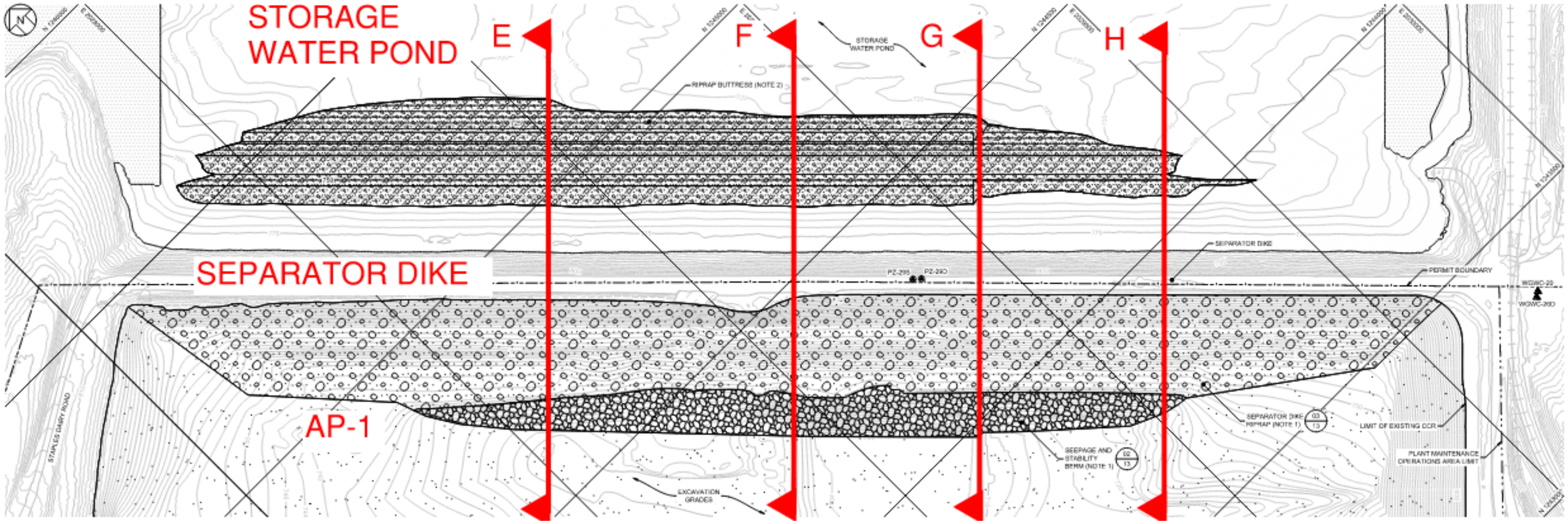


Figure 1- Selected Cross Section Location for Slope Stability Analyses and Areas of Proposed Closure.

CP: **CG** Date: **11/04/22** APC: **MC** Date: **11/04/22** CA: **JG** Date: **11/17/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

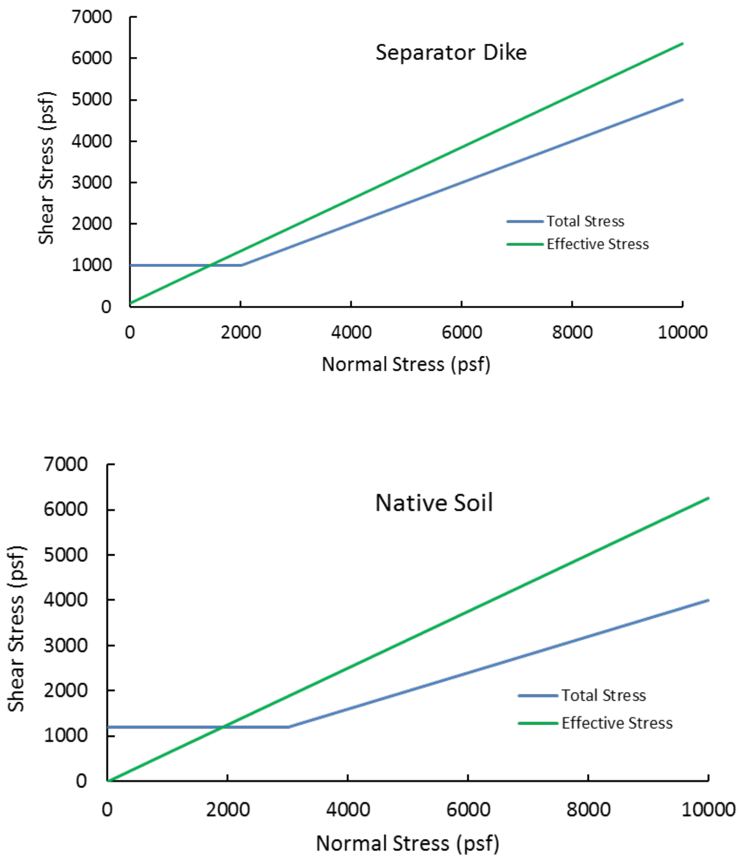


Figure 2- Shear Strength Models for Separator Dike Material and Native Soil for Rapid Drawdown Loading Conditions

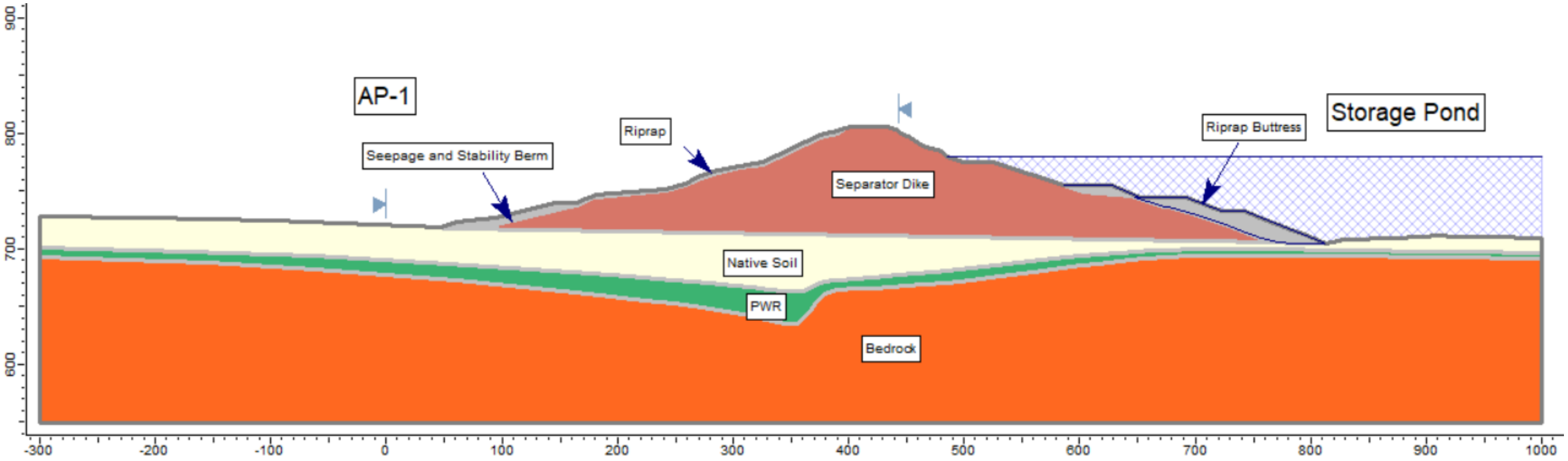


Figure 3- Cross section E

CP: **CG** Date: **11/04/22** APC: **MC** Date: **11/04/22** CA: **JG** Date: **11/17/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

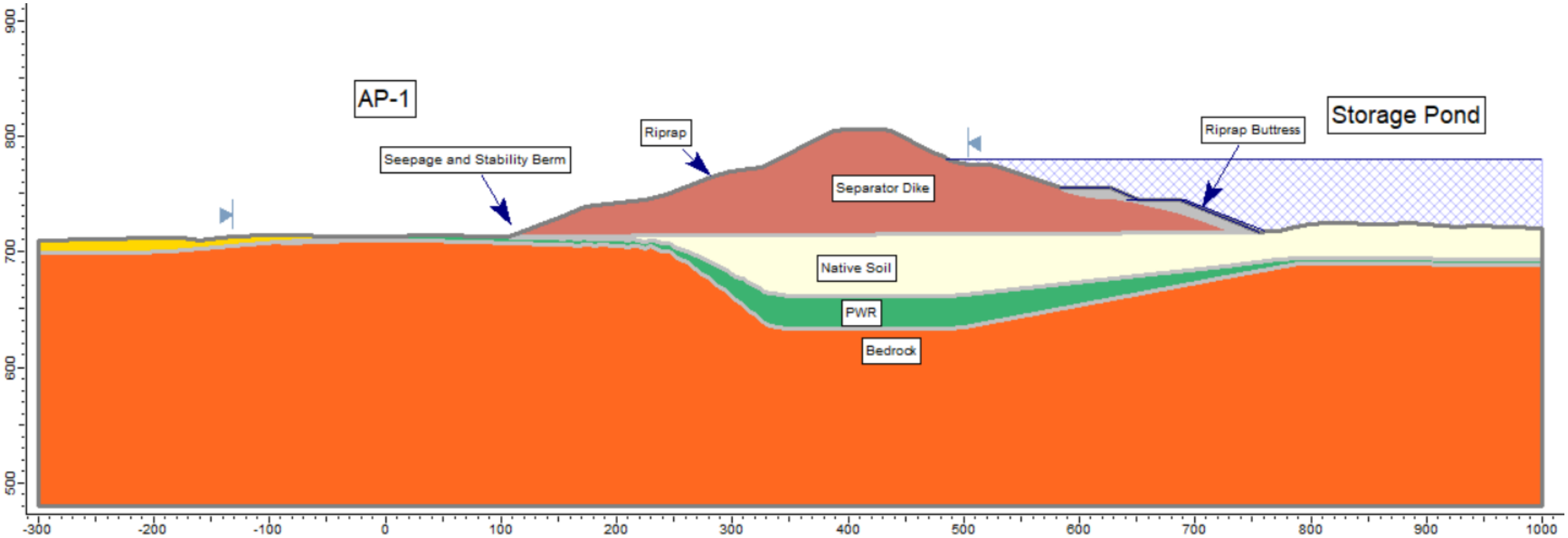


Figure 4- Cross section F

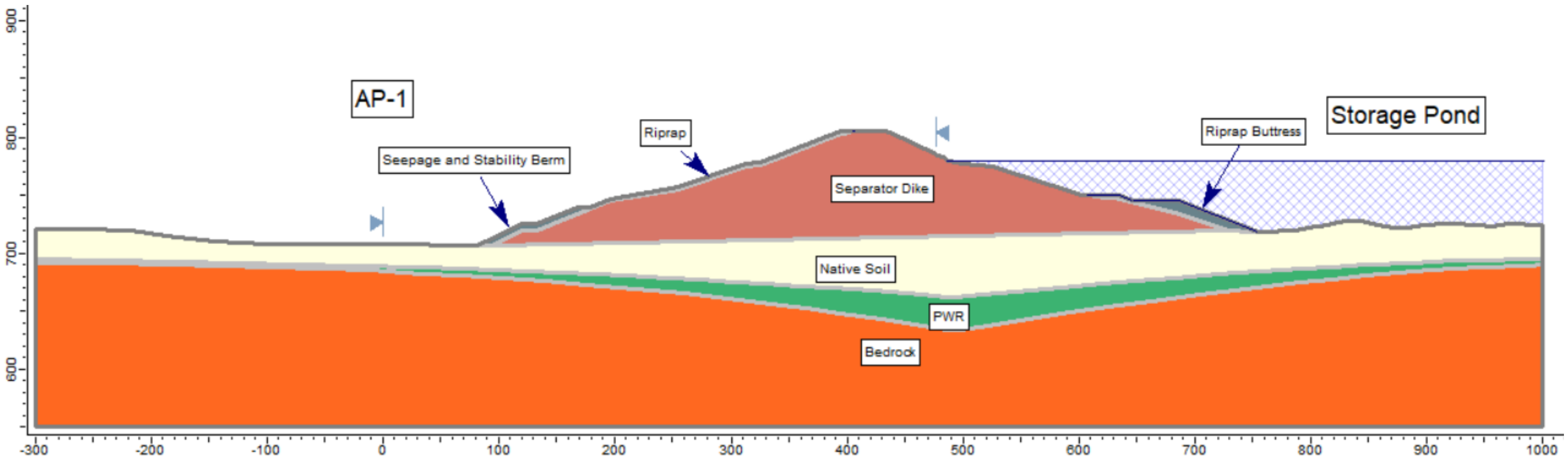


Figure 5- Cross section G

CP: **CG** Date: **11/04/22** APC: **MC** Date: **11/04/22** CA: **JG** Date: **11/17/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

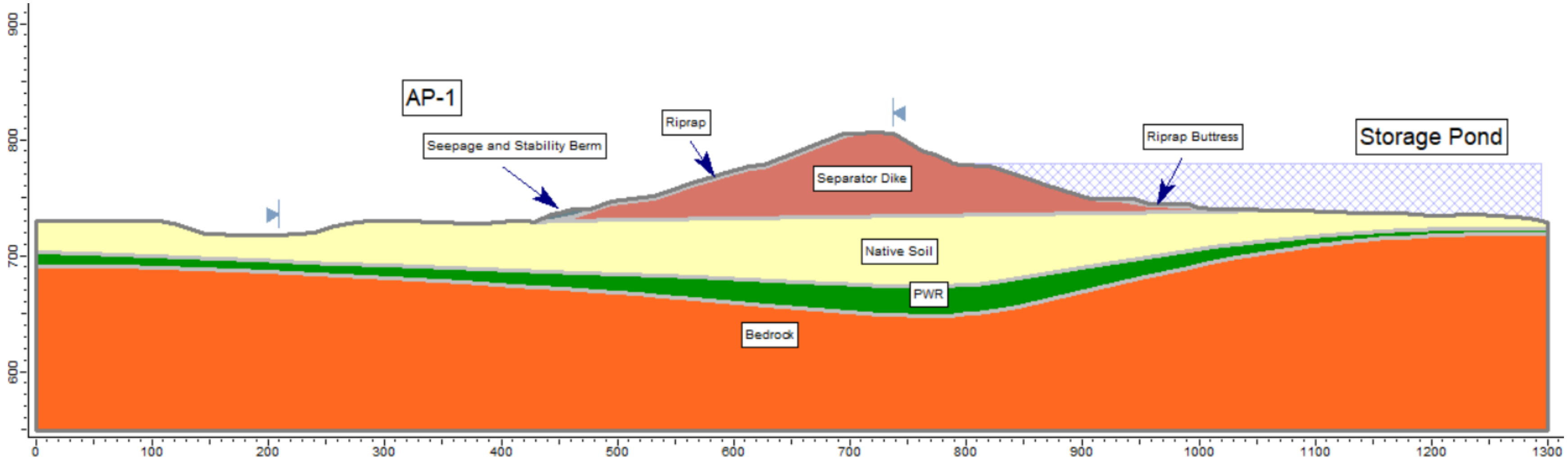
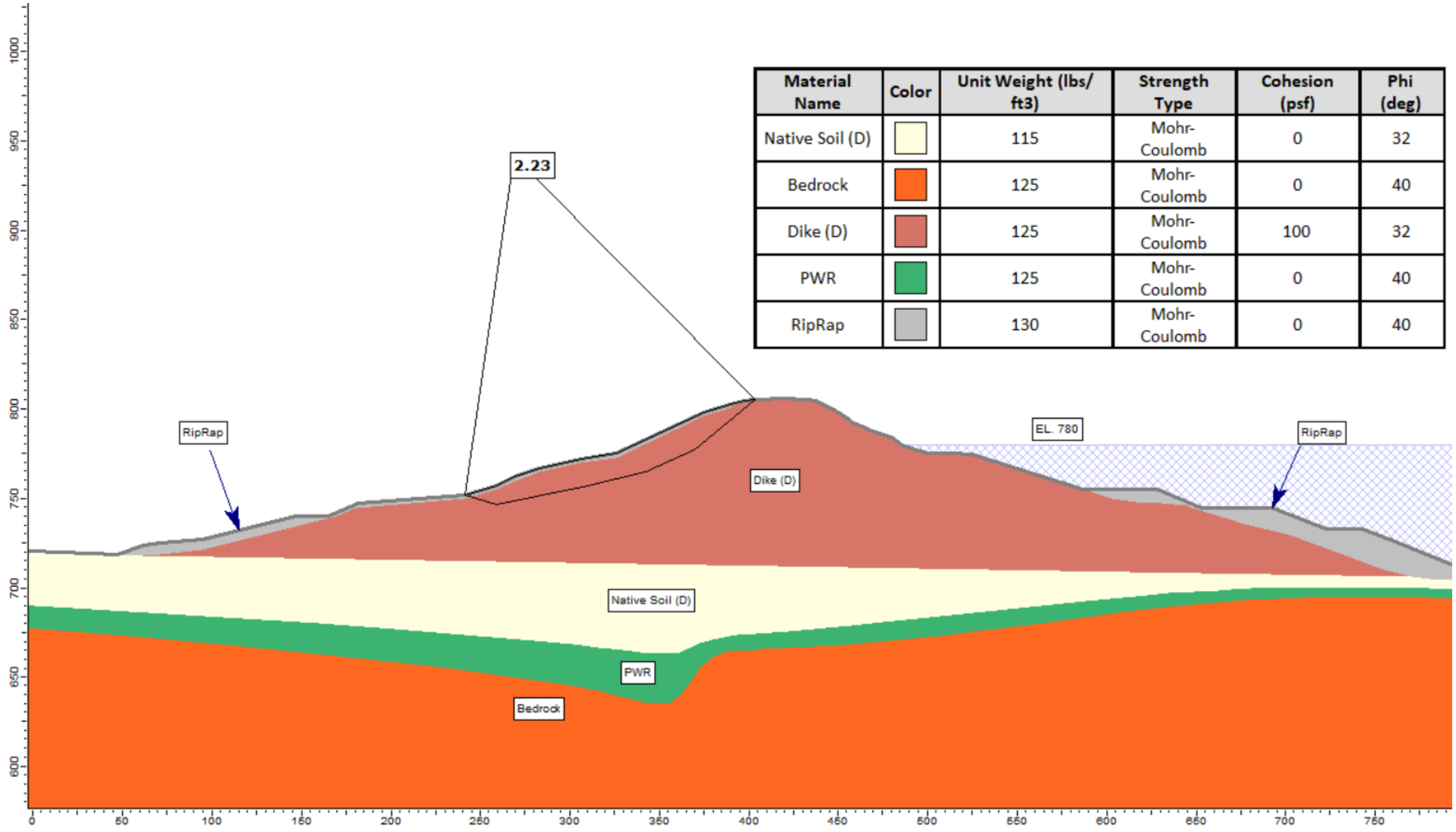
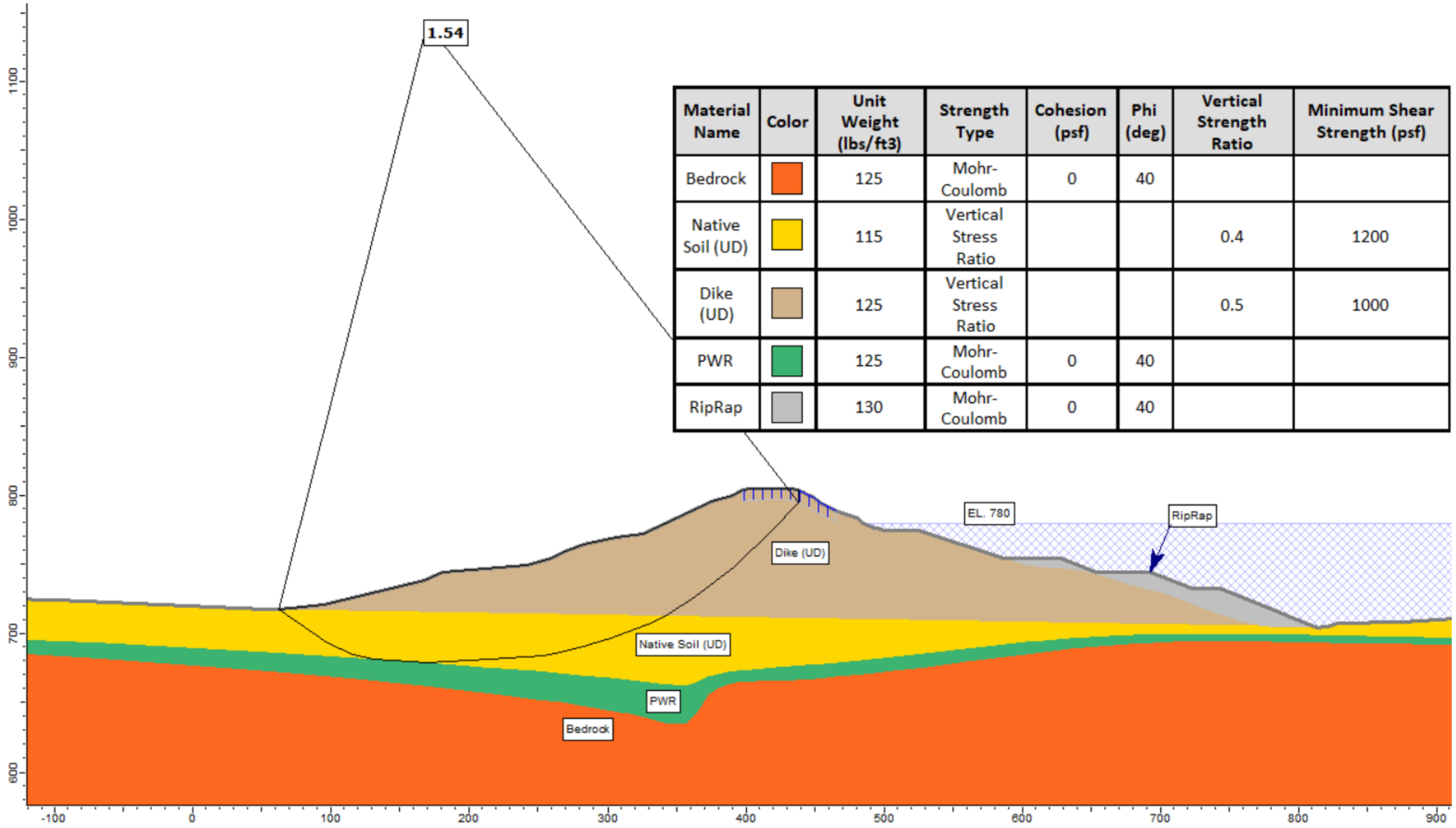


Figure 6- Cross section H



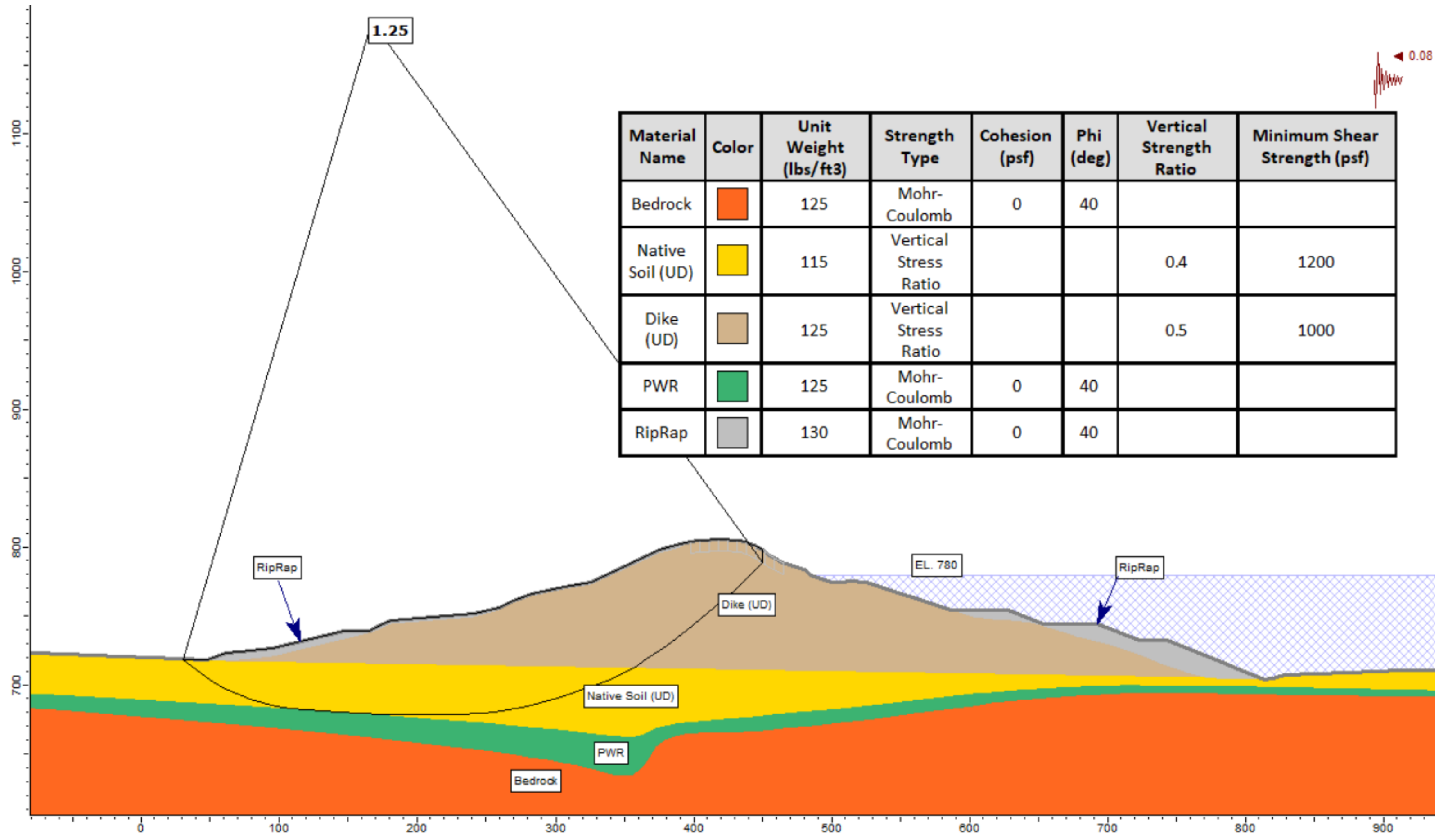
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Soil (D)	⬜	115	Mohr-Coulomb	0	32
Bedrock	🟧	125	Mohr-Coulomb	0	40
Dike (D)	🟥	125	Mohr-Coulomb	100	32
PWR	🟩	125	Mohr-Coulomb	0	40
RipRap	⬜	130	Mohr-Coulomb	0	40

Figure 7- Long-term Static Slope Stability Analyses Results for Cross Section E (AP-1 Empty)



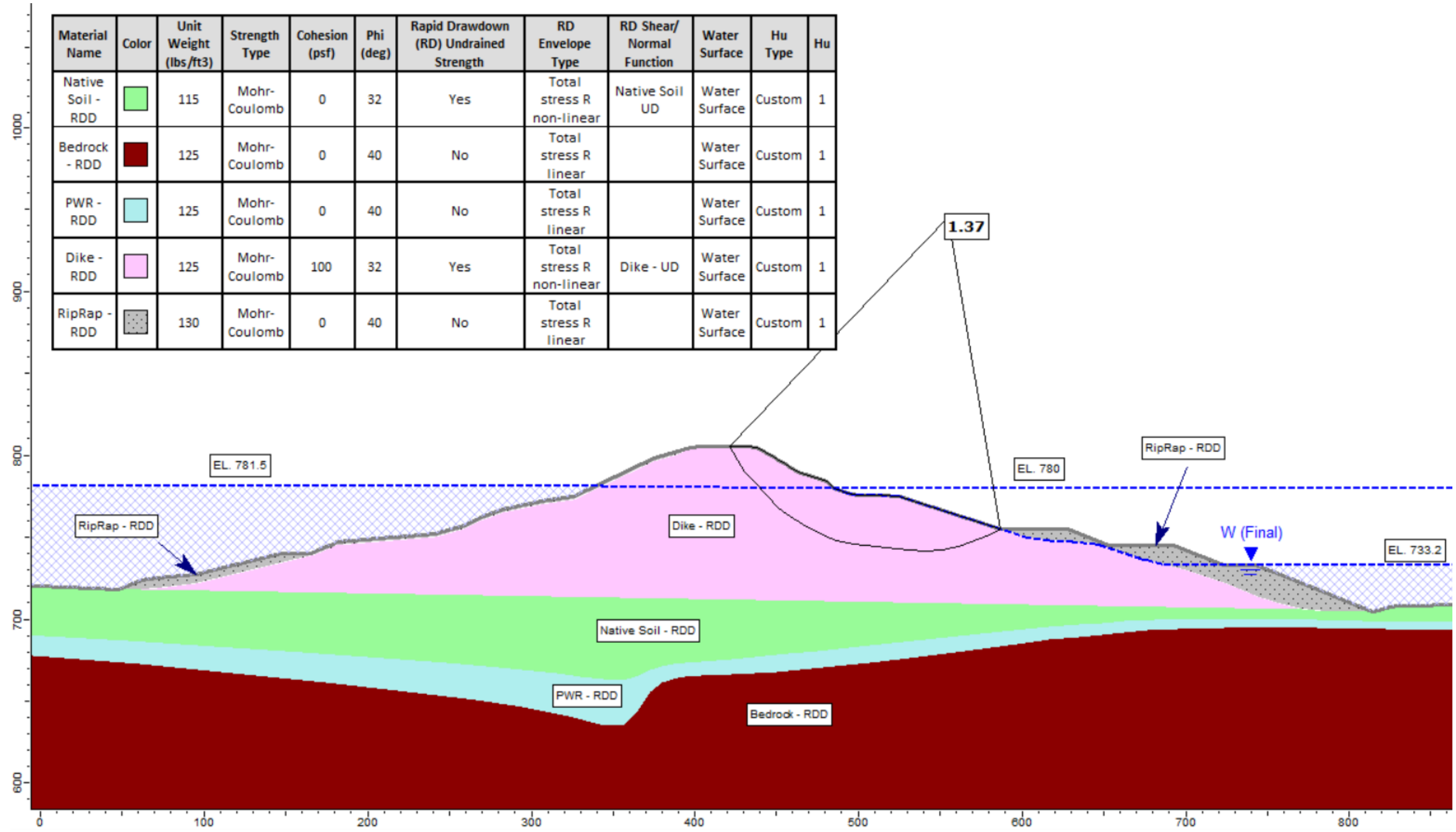
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
PWR	🟩	125	Mohr-Coulomb	0	40		
RipRap	⬜	130	Mohr-Coulomb	0	40		

Figure 8- Short-term Static Slope Stability Analyses Results for Cross Section E (AP-1 Empty)



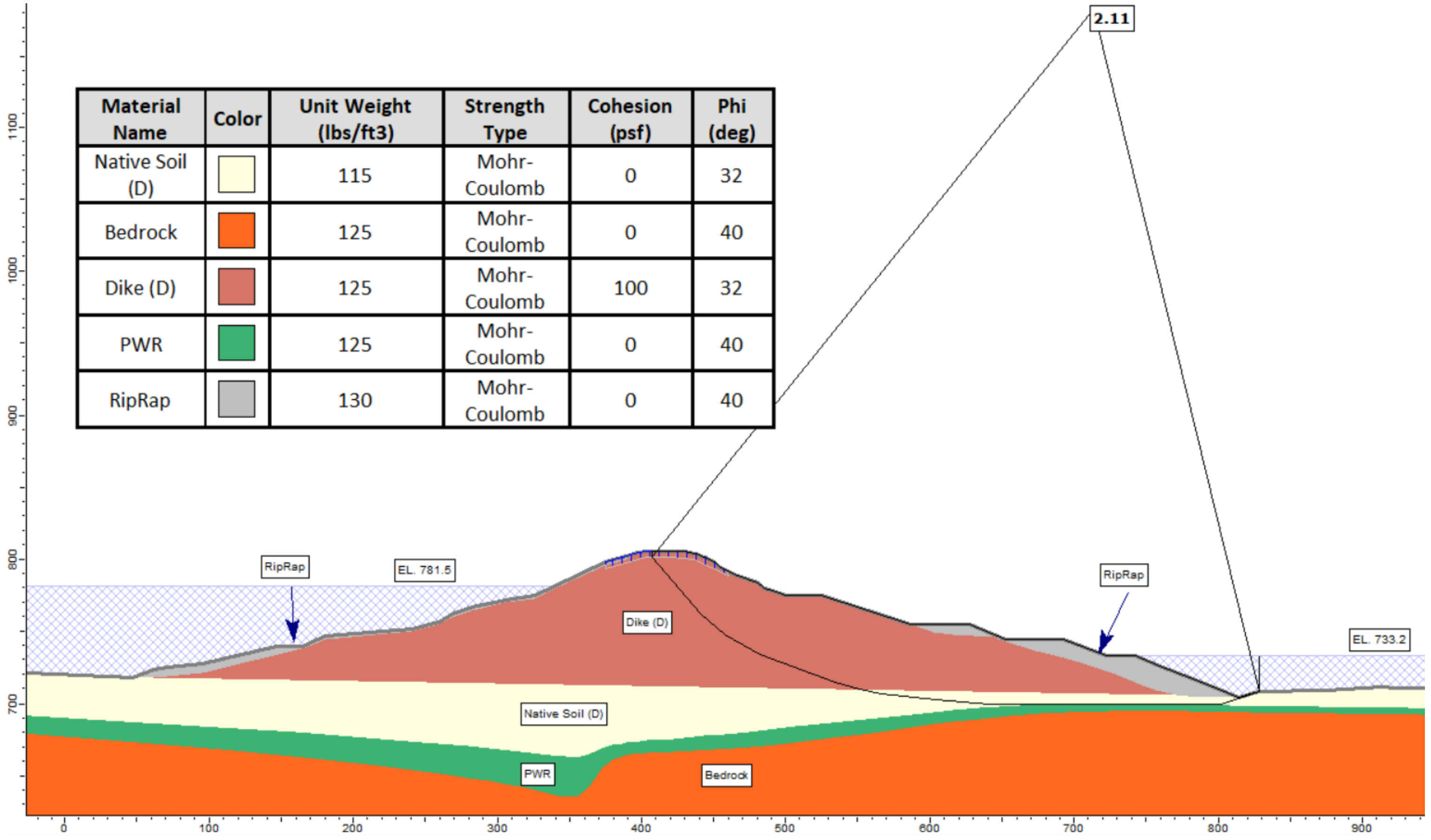
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
PWR	🟩	125	Mohr-Coulomb	0	40		
RipRap	⬜	130	Mohr-Coulomb	0	40		

Figure 9- Seismic Slope Stability Analyses Results for Cross Section E (AP-1 Empty)



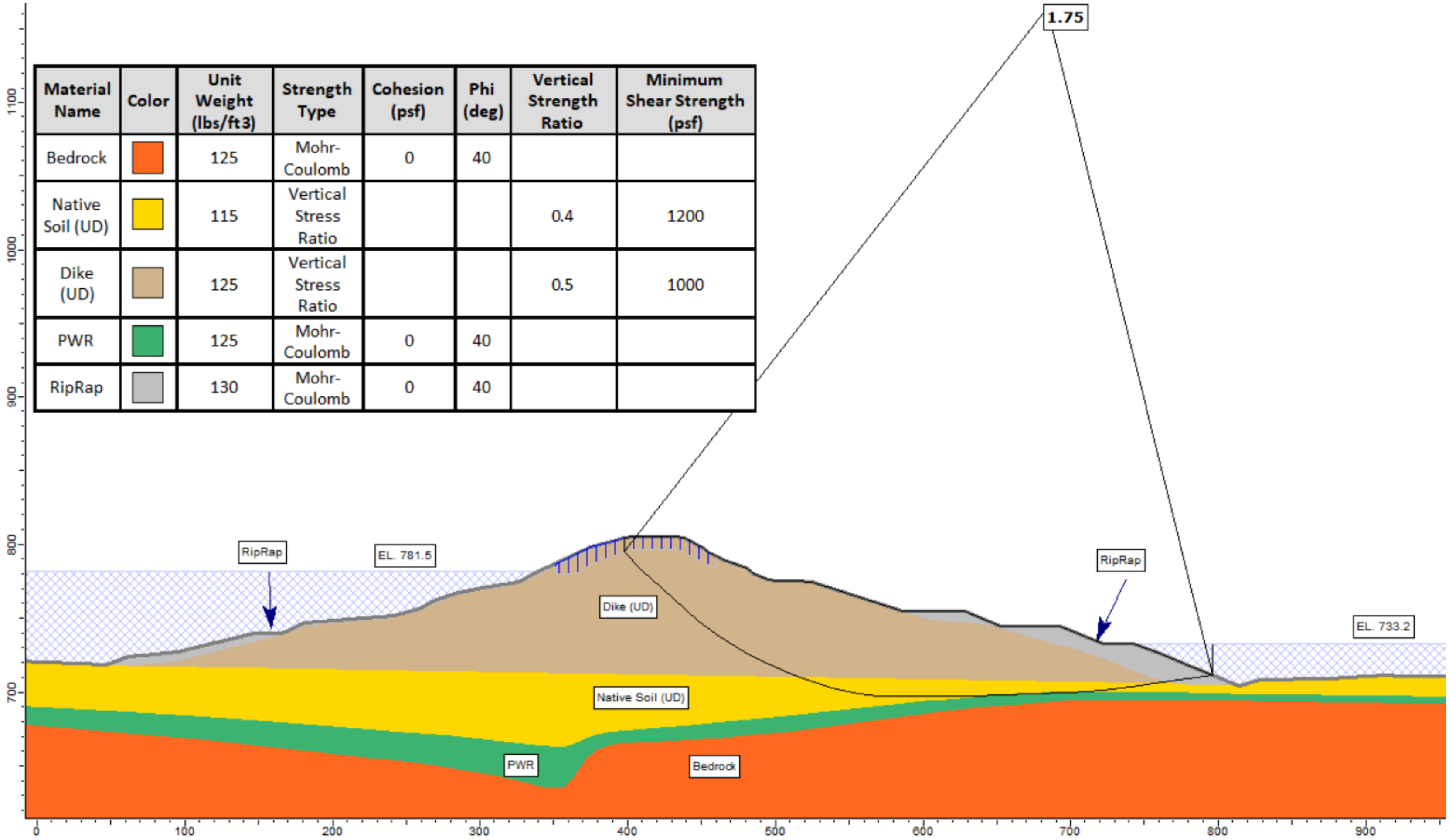
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Envelope Type	RD Shear/ Normal Function	Water Surface	Hu Type	Hu
Native Soil - RDD	🟩	115	Mohr-Coulomb	0	32	Yes	Total stress R non-linear	Native Soil UD	Water Surface	Custom	1
Bedrock - RDD	🟥	125	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1
PWR - RDD	🟦	125	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1
Dike - RDD	🟪	125	Mohr-Coulomb	100	32	Yes	Total stress R non-linear	Dike - UD	Water Surface	Custom	1
RipRap - RDD	▨	130	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1

Figure 10- Rapid Drawdown Slope Stability Analyses Results for Cross Section E



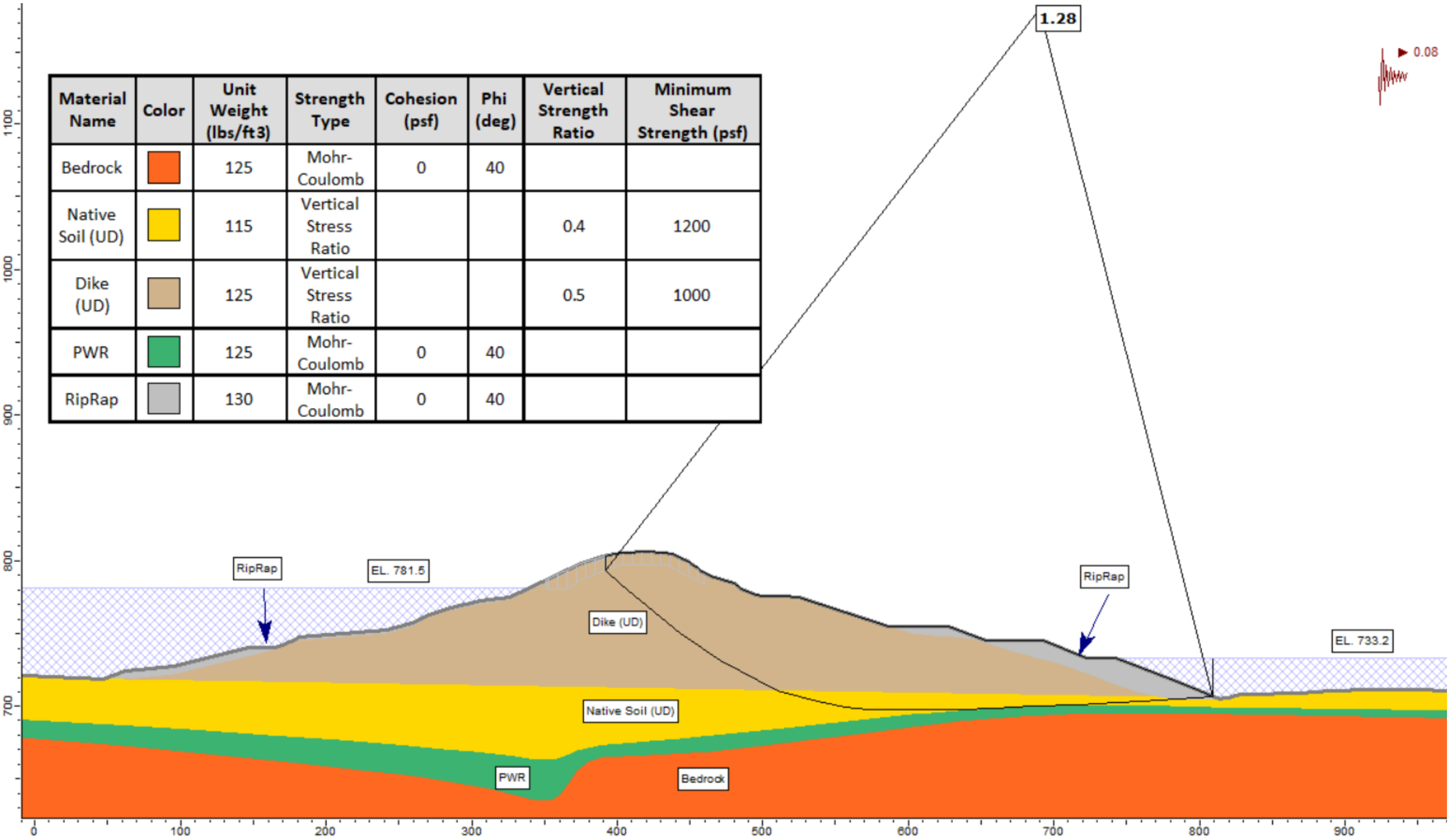
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Soil (D)	🟨	115	Mohr-Coulomb	0	32
Bedrock	🟧	125	Mohr-Coulomb	0	40
Dike (D)	🟥	125	Mohr-Coulomb	100	32
PWR	🟩	125	Mohr-Coulomb	0	40
RipRap	⬜	130	Mohr-Coulomb	0	40

Figure 11- Long-term Static Slope Stability Analyses Results for Section E (Storage Water Pond Low Pool)



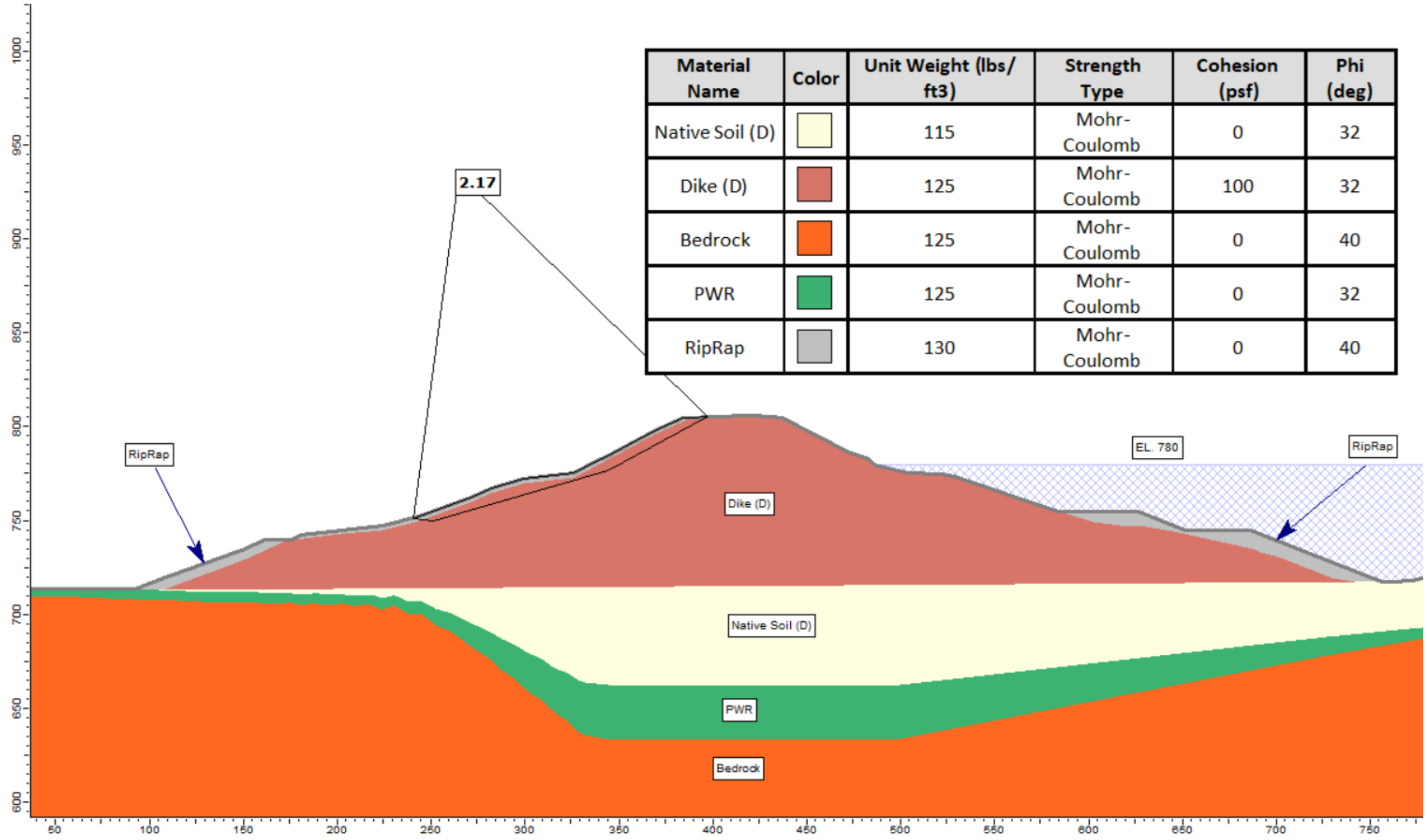
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
PWR	🟩	125	Mohr-Coulomb	0	40		
RipRap	⬜	130	Mohr-Coulomb	0	40		

Figure 12- Short-term Static Slope Stability Analyses Results for Section E (Storage Water Pond Low Pool)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
PWR	🟩	125	Mohr-Coulomb	0	40		
RipRap	⬜	130	Mohr-Coulomb	0	40		

Figure 13- Seismic Slope Stability Analyses Results for Section E (Storage Water Pond Low Pool)

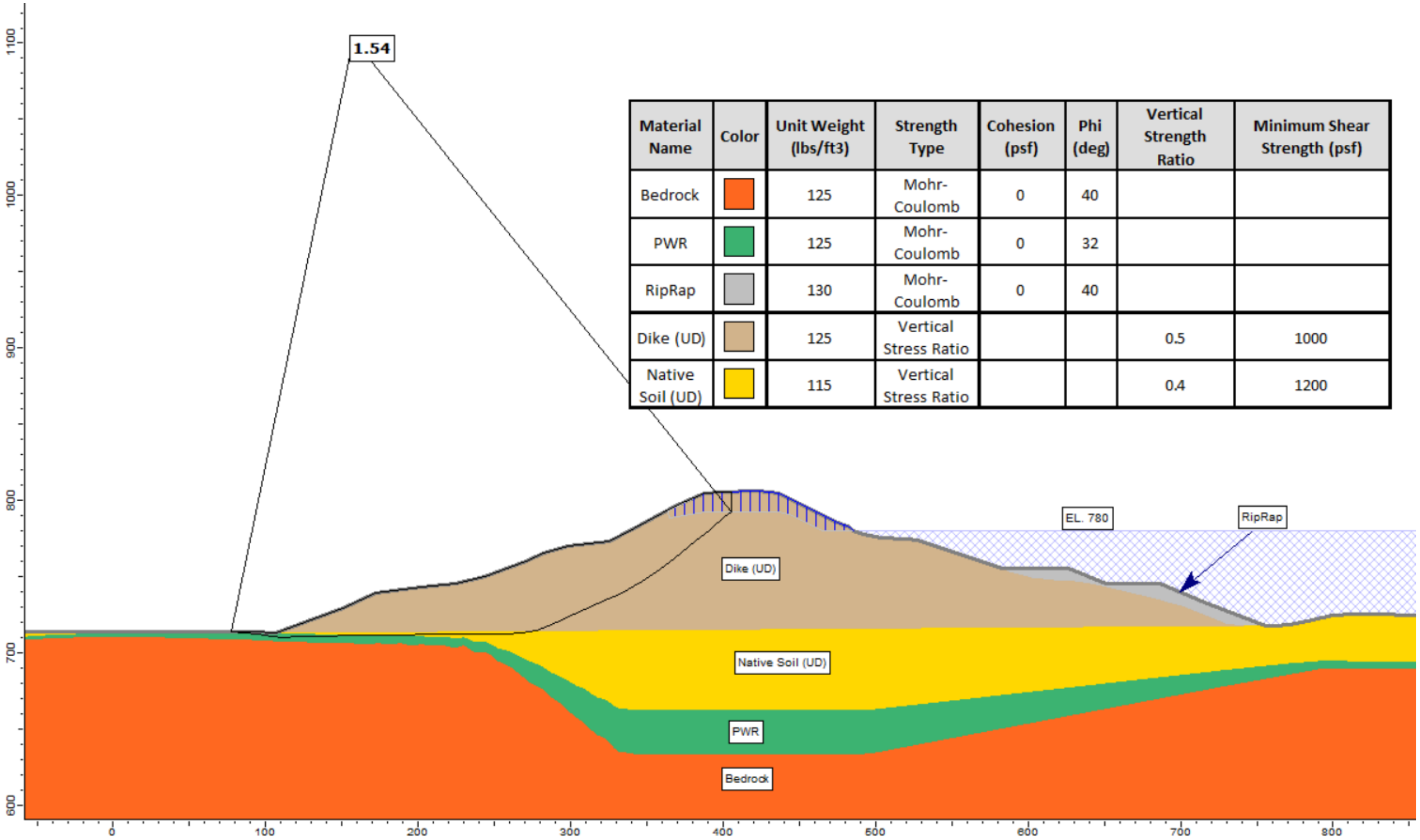


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Soil (D)	🟨	115	Mohr-Coulomb	0	32
Dike (D)	🟥	125	Mohr-Coulomb	100	32
Bedrock	🟧	125	Mohr-Coulomb	0	40
PWR	🟩	125	Mohr-Coulomb	0	32
RipRap	⬜	130	Mohr-Coulomb	0	40

Figure 14- Long-term Static Slope Stability Analyses Results for Cross Section F (AP-1 Empty)

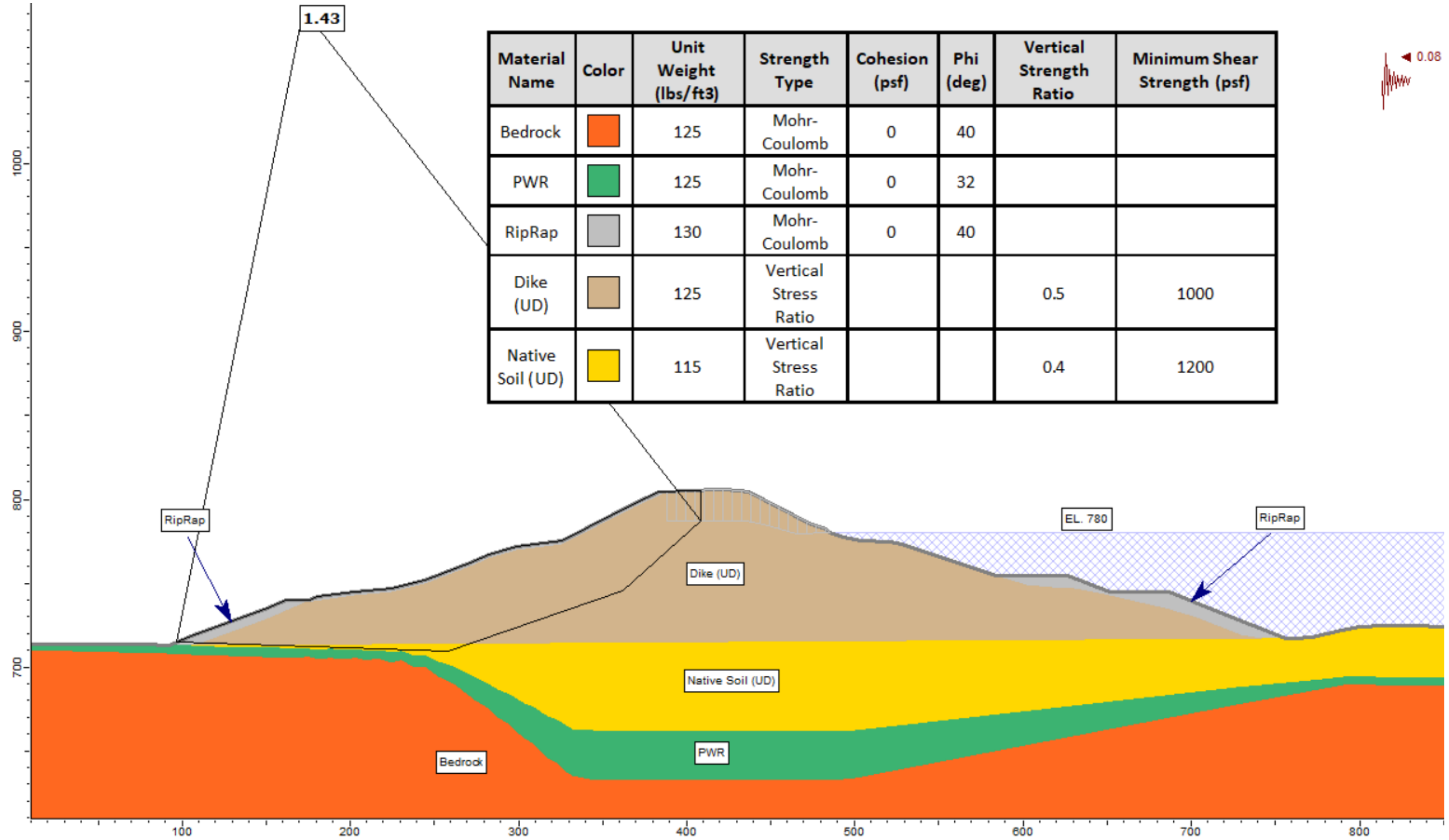
CP: **CG** Date: **11/04/22** APC: **MC** Date: **11/04/22** CA: **JG** Date: **11/17/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**



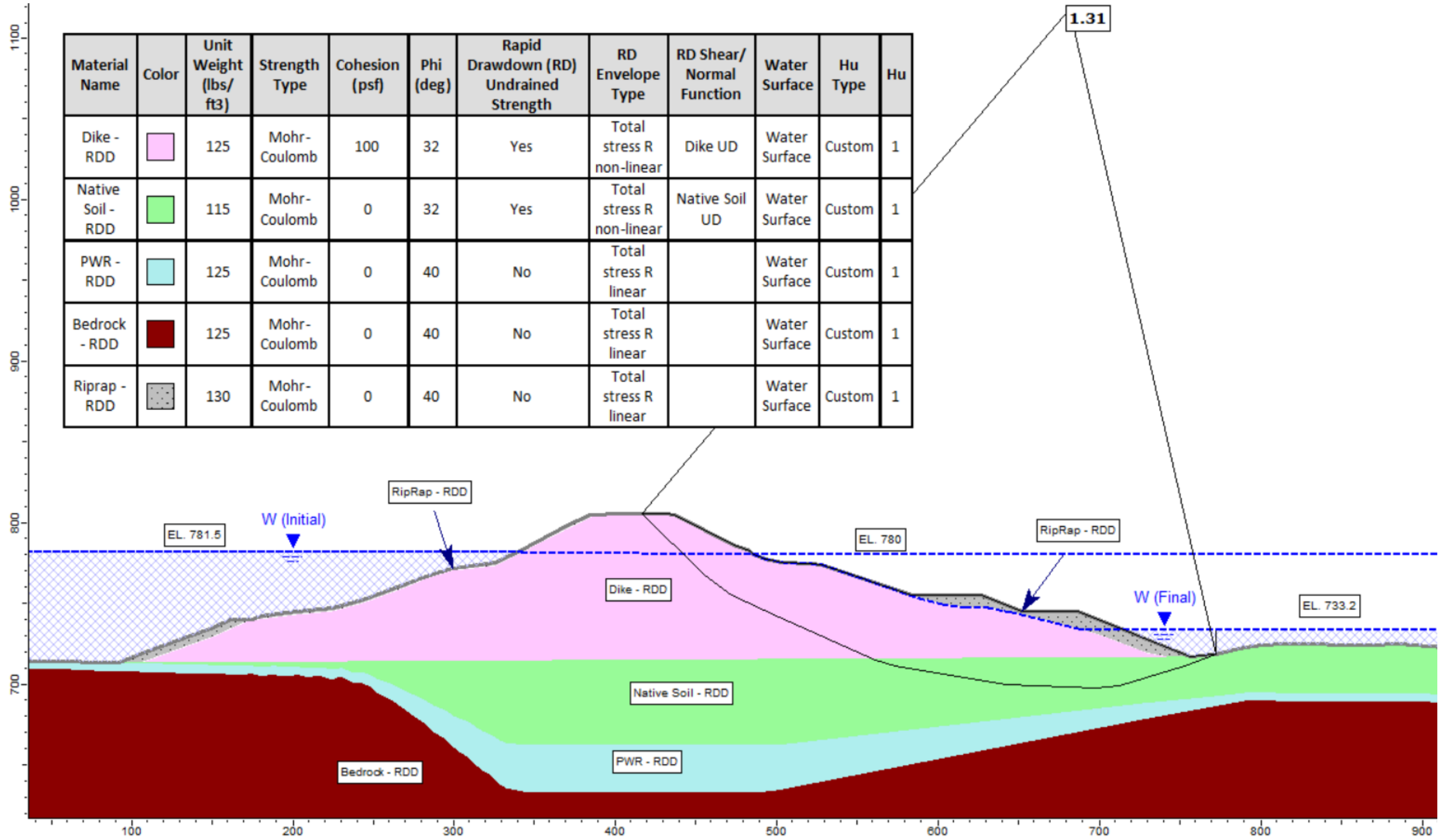
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Bedrock	🟧	125	Mohr-Coulomb	0	40		
PWR	🟩	125	Mohr-Coulomb	0	32		
RipRap	⬜	130	Mohr-Coulomb	0	40		
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200

Figure 15- Short-term Static Slope Stability Analyses Results for Cross Section F (AP-1 Empty)



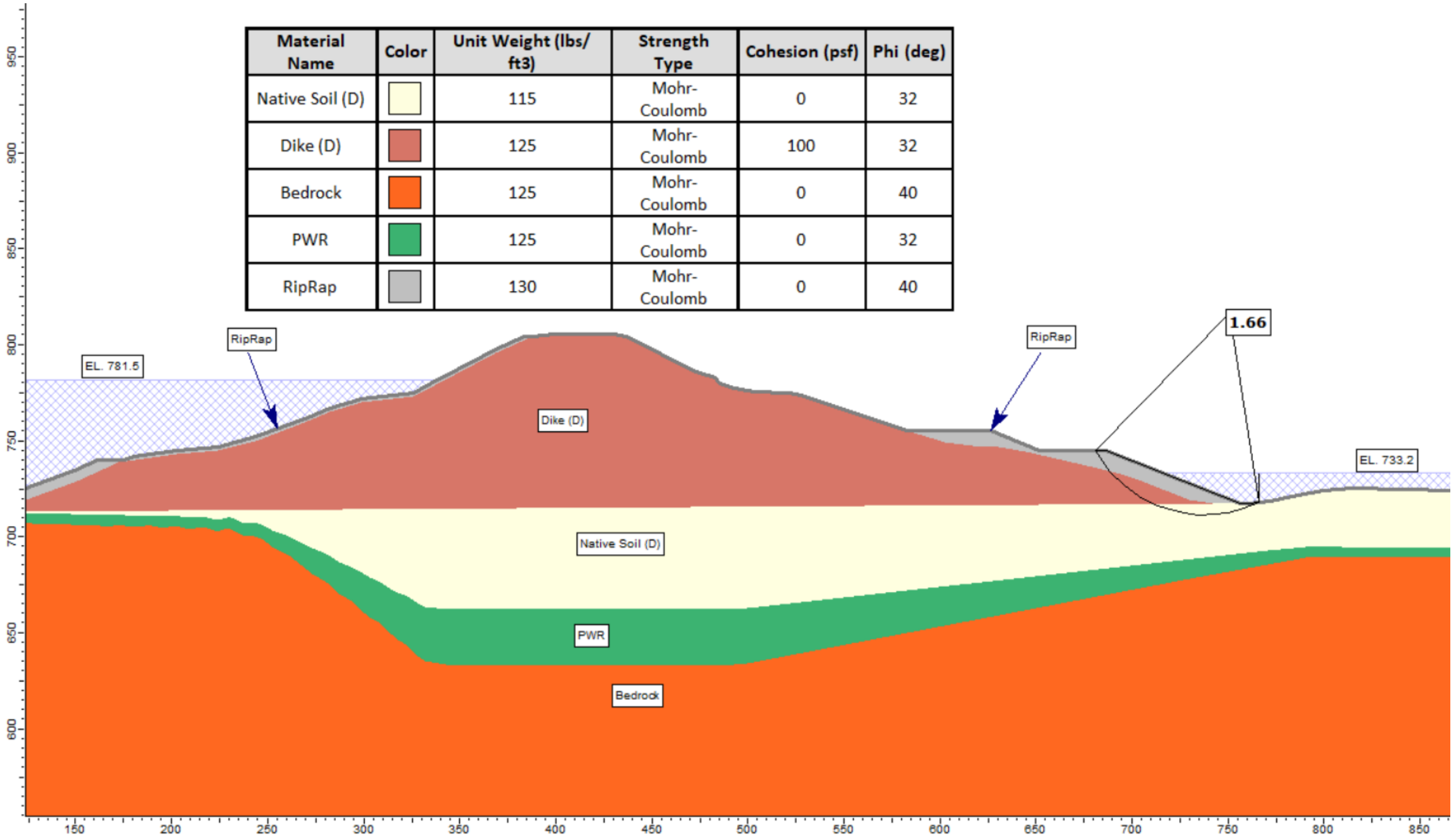
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Bedrock	🟧	125	Mohr-Coulomb	0	40		
PWR	🟩	125	Mohr-Coulomb	0	32		
RipRap	⬜	130	Mohr-Coulomb	0	40		
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200

Figure 16- Seismic Slope Stability Analyses Results for Cross Section F (AP-1 Empty)



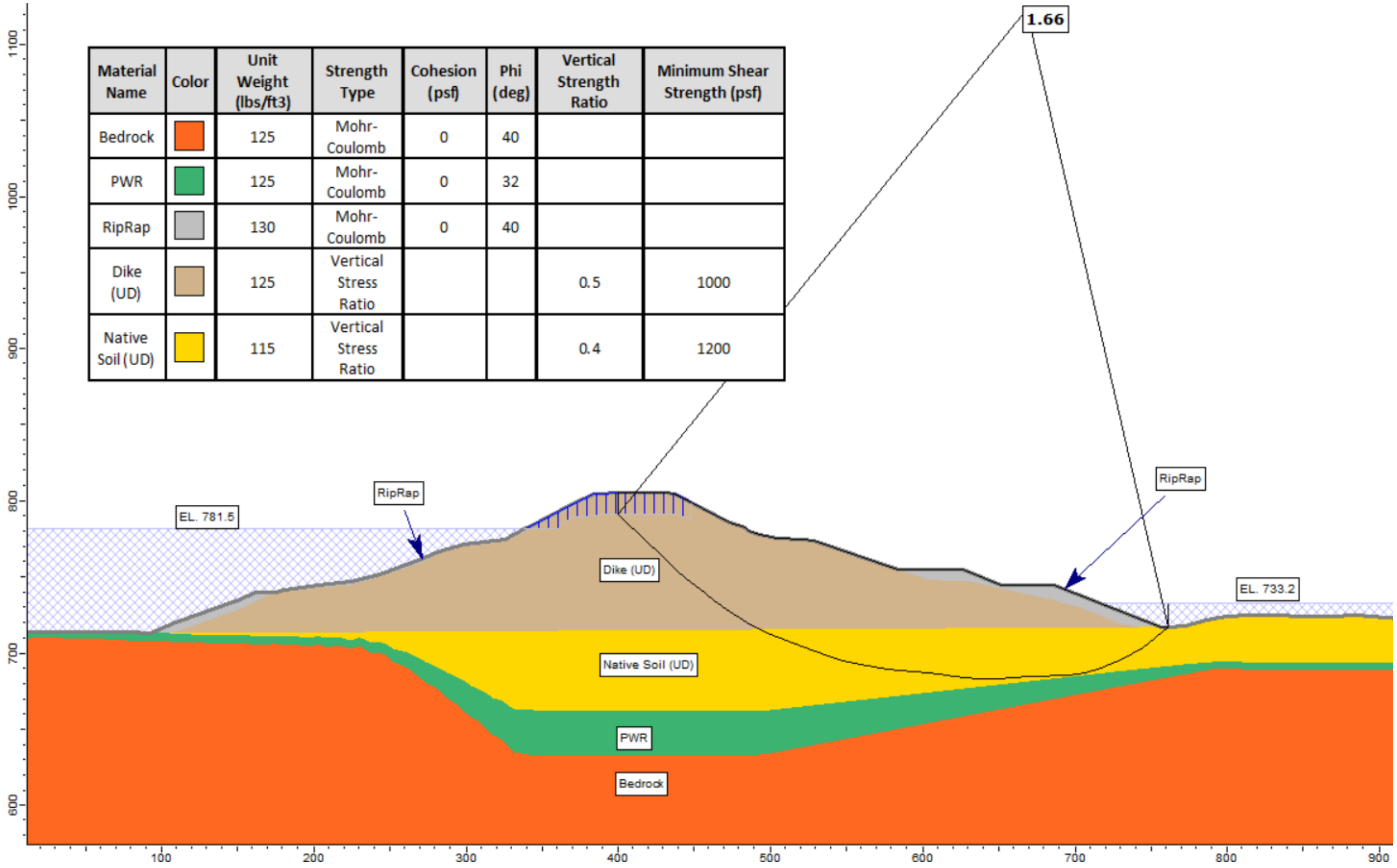
Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Envelope Type	RD Shear/ Normal Function	Water Surface	Hu Type	Hu
Dike - RDD	🟪	125	Mohr-Coulomb	100	32	Yes	Total stress R non-linear	Dike UD	Water Surface	Custom	1
Native Soil - RDD	🟩	115	Mohr-Coulomb	0	32	Yes	Total stress R non-linear	Native Soil UD	Water Surface	Custom	1
PWR - RDD	🟦	125	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1
Bedrock - RDD	🟥	125	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1
Riprap - RDD	▨	130	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1

Figure 17- Rapid Drawdown Slope Stability Analyses Results for Cross Section F



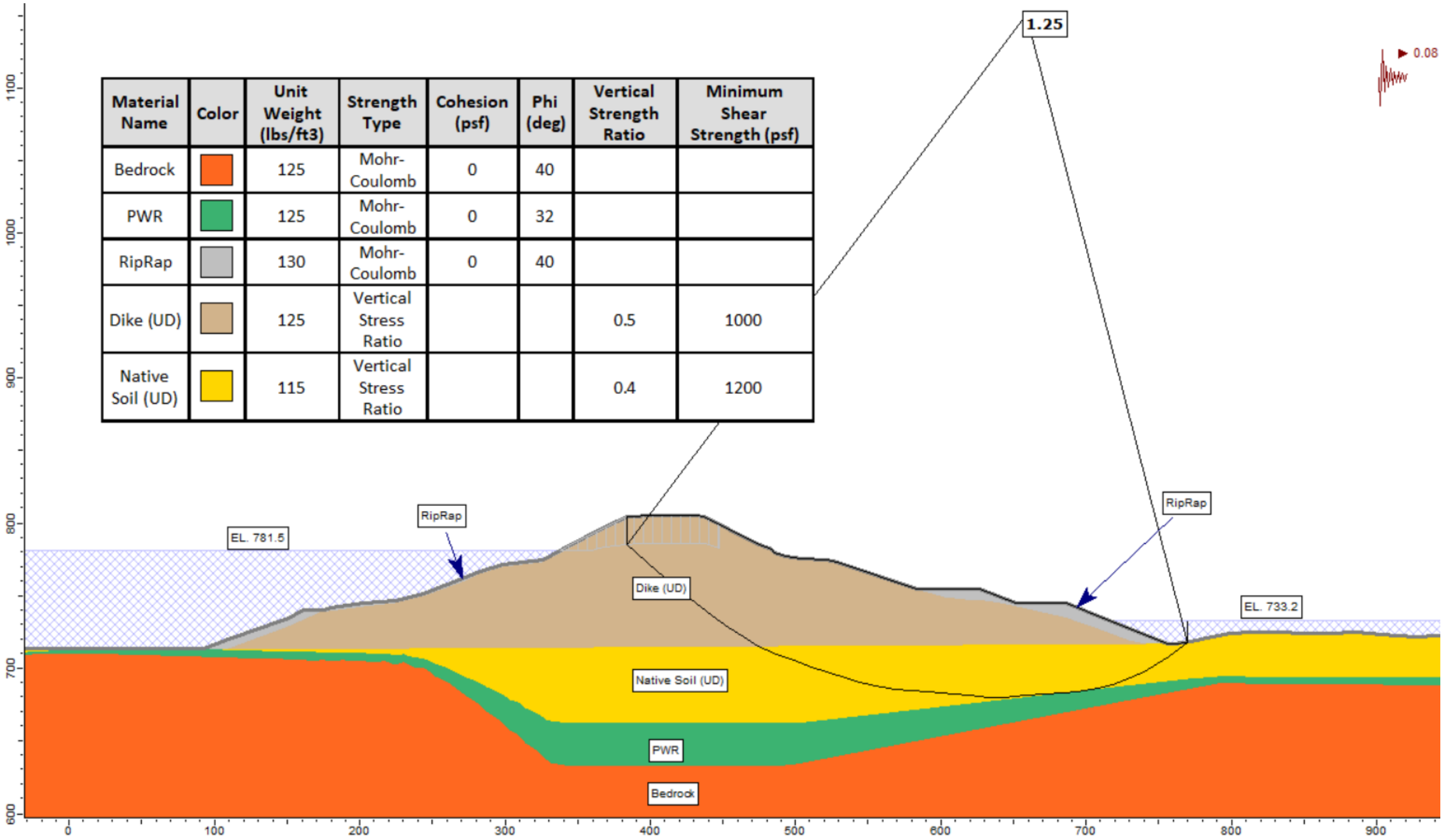
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Soil (D)	🟨	115	Mohr-Coulomb	0	32
Dike (D)	🟥	125	Mohr-Coulomb	100	32
Bedrock	🟧	125	Mohr-Coulomb	0	40
PWR	🟩	125	Mohr-Coulomb	0	32
RipRap	⬜	130	Mohr-Coulomb	0	40

Figure 18- Long-term Static Slope Stability Analyses Results for Cross Section F (Storage Water Pond Low Pool)



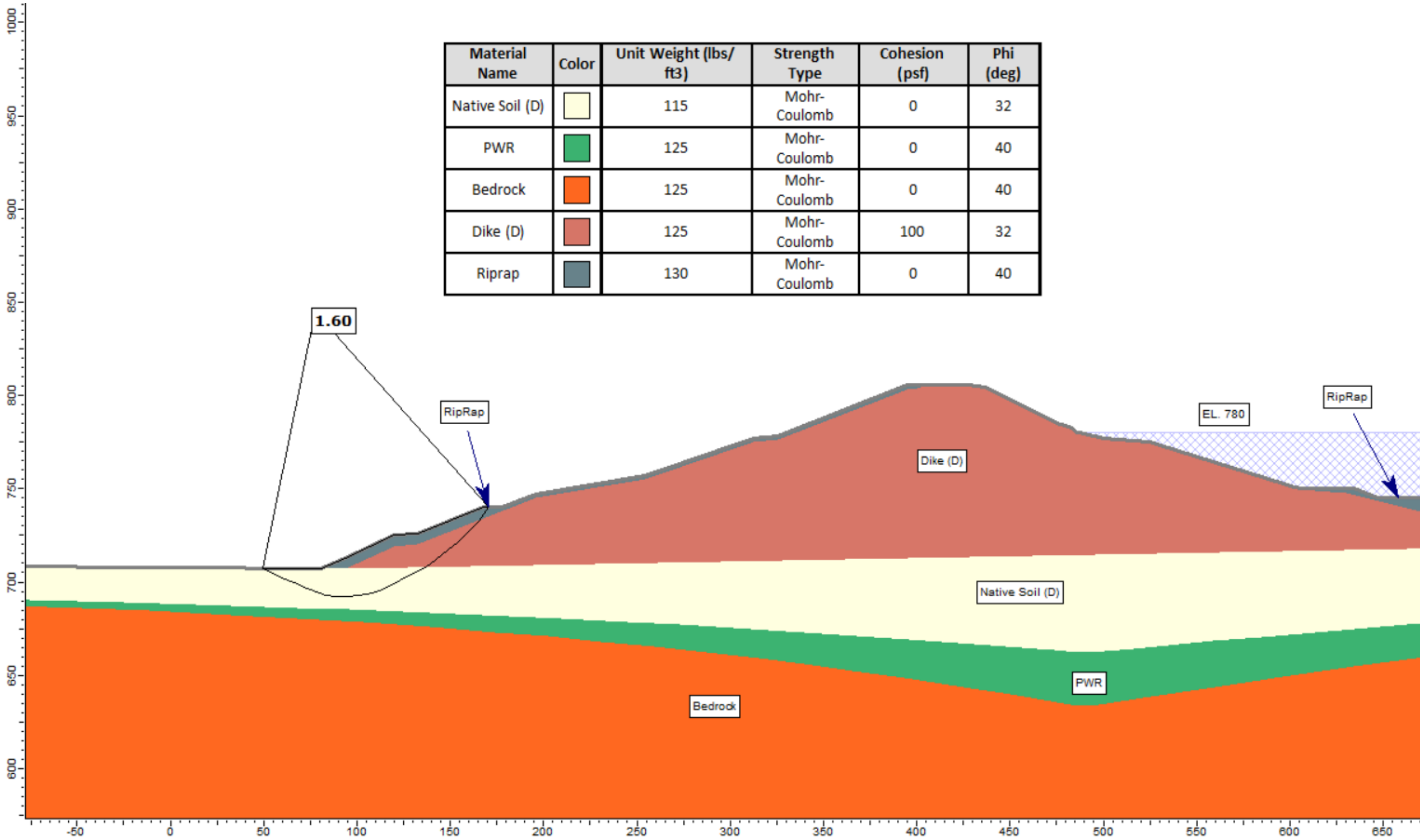
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Bedrock	🟧	125	Mohr-Coulomb	0	40		
PWR	🟩	125	Mohr-Coulomb	0	32		
RipRap	⬜	130	Mohr-Coulomb	0	40		
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200

Figure 19- Short-term Static Slope Stability Analyses Results for Cross Section F (Storage Water Pond Low Pool)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Bedrock	🟧	125	Mohr-Coulomb	0	40		
PWR	🟩	125	Mohr-Coulomb	0	32		
RipRap	⬜	130	Mohr-Coulomb	0	40		
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200

Figure 20- Seismic Slope Stability Analyses Results for Cross Section F (Storage Water Pond Low Pool)

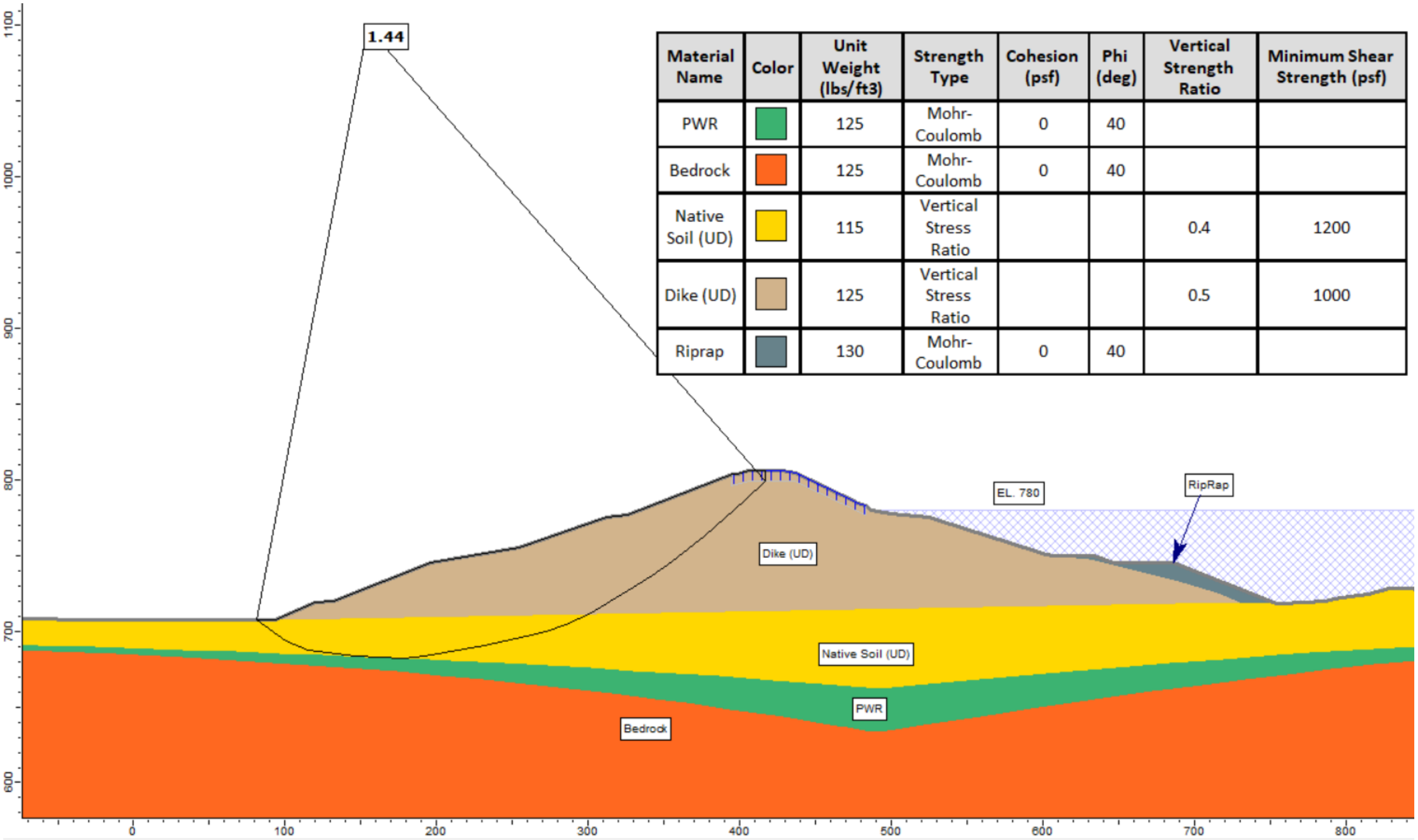


Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Soil (D)	⬜	115	Mohr-Coulomb	0	32
PWR	🟩	125	Mohr-Coulomb	0	40
Bedrock	🟧	125	Mohr-Coulomb	0	40
Dike (D)	🟥	125	Mohr-Coulomb	100	32
Riprap	⬛	130	Mohr-Coulomb	0	40

Figure 21- Long-term Static Slope Stability Analyses Results for Cross Section G (AP-1 Empty)

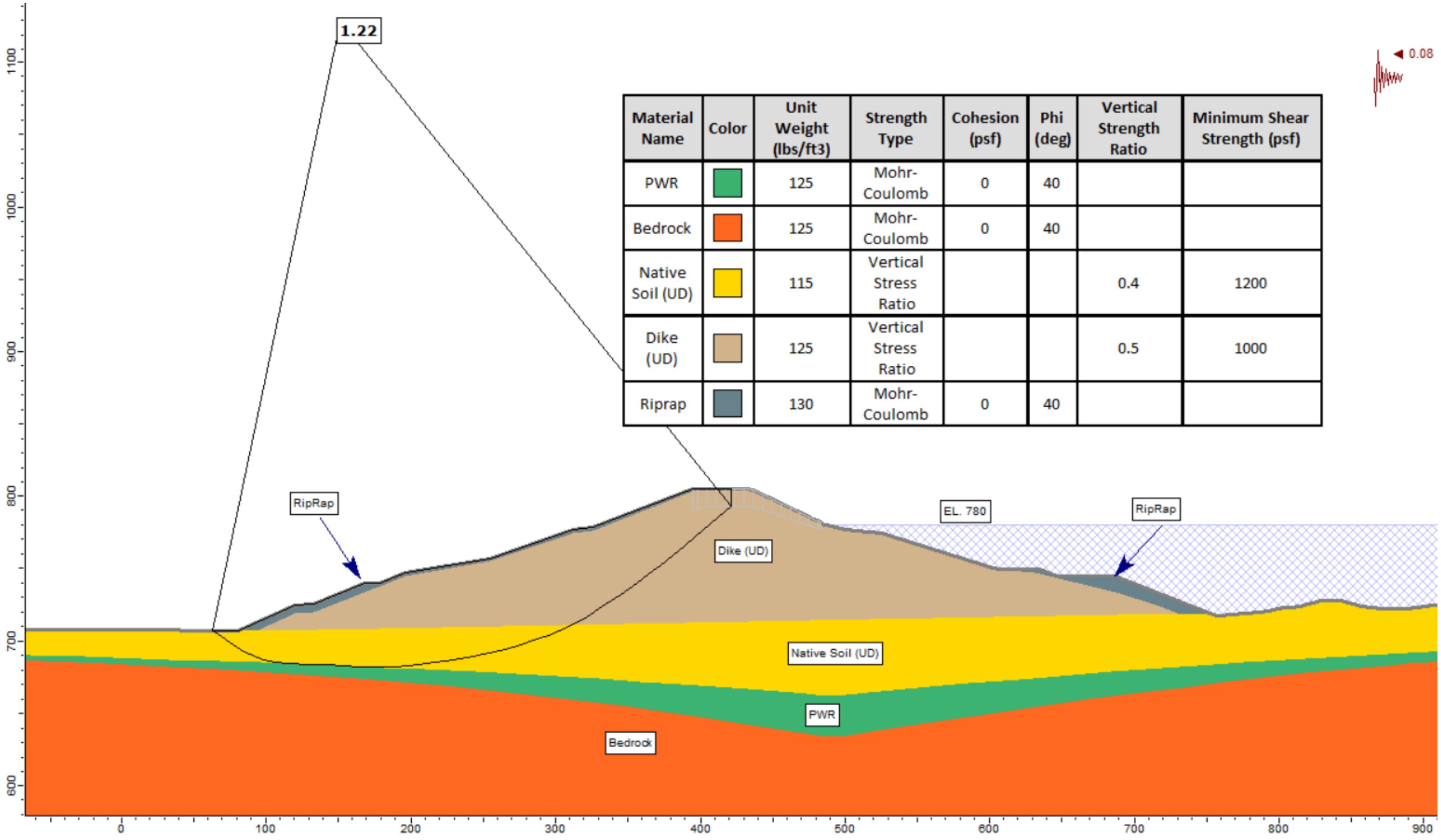
CP: **CG** Date: **11/04/22** APC: **MC** Date: **11/04/22** CA: **JG** Date: **11/17/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**



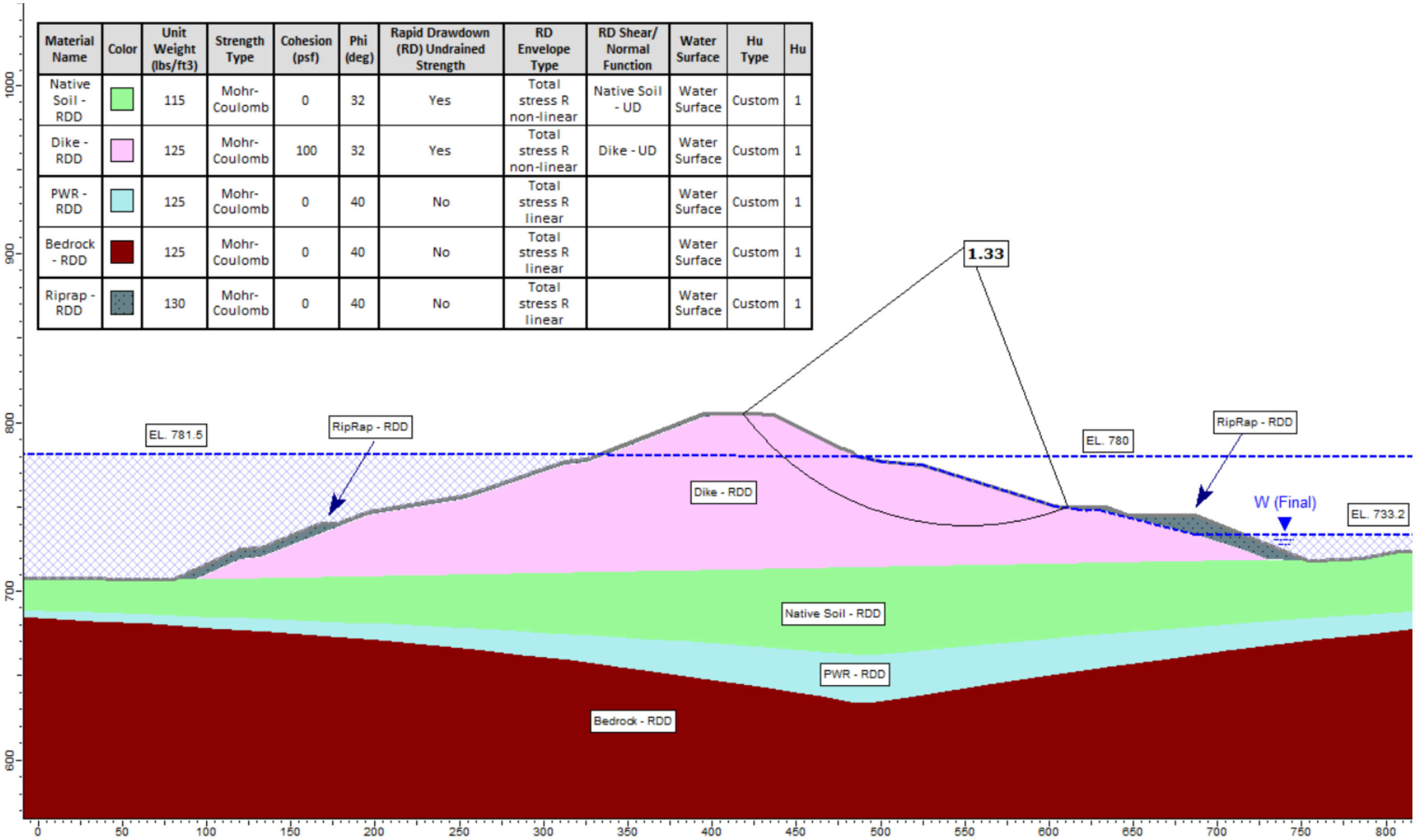
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
PWR	🟩	125	Mohr-Coulomb	0	40		
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
Riprap	⬛	130	Mohr-Coulomb	0	40		

Figure 22- Short-term Static Slope Stability Analyses Results for Cross Section G (AP-1 Empty)



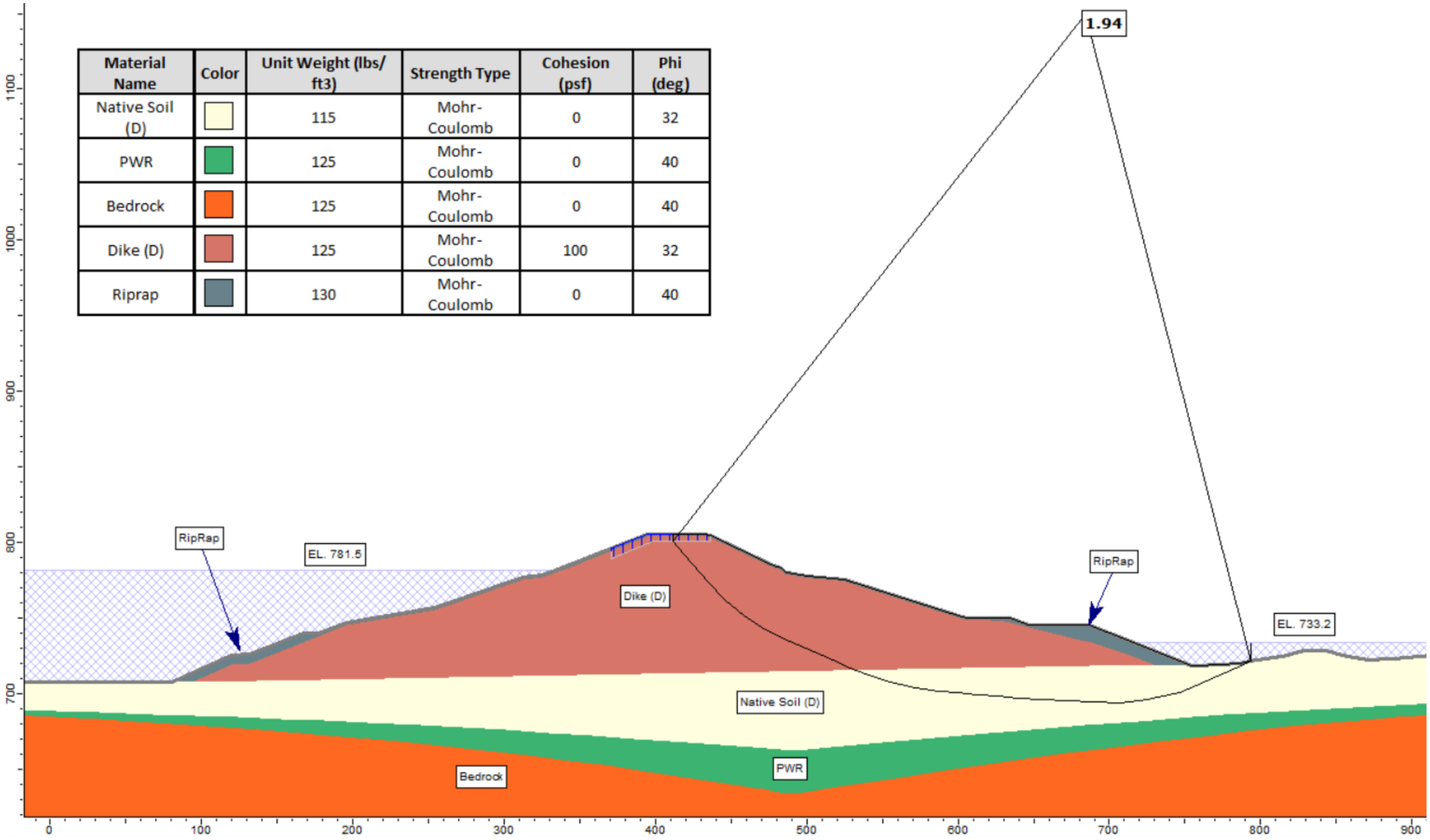
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
PWR	🟩	125	Mohr-Coulomb	0	40		
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
Riprap	⬛	130	Mohr-Coulomb	0	40		

Figure 23- Seismic Slope Stability Analyses Results for Cross Section G (AP-1 Empty)



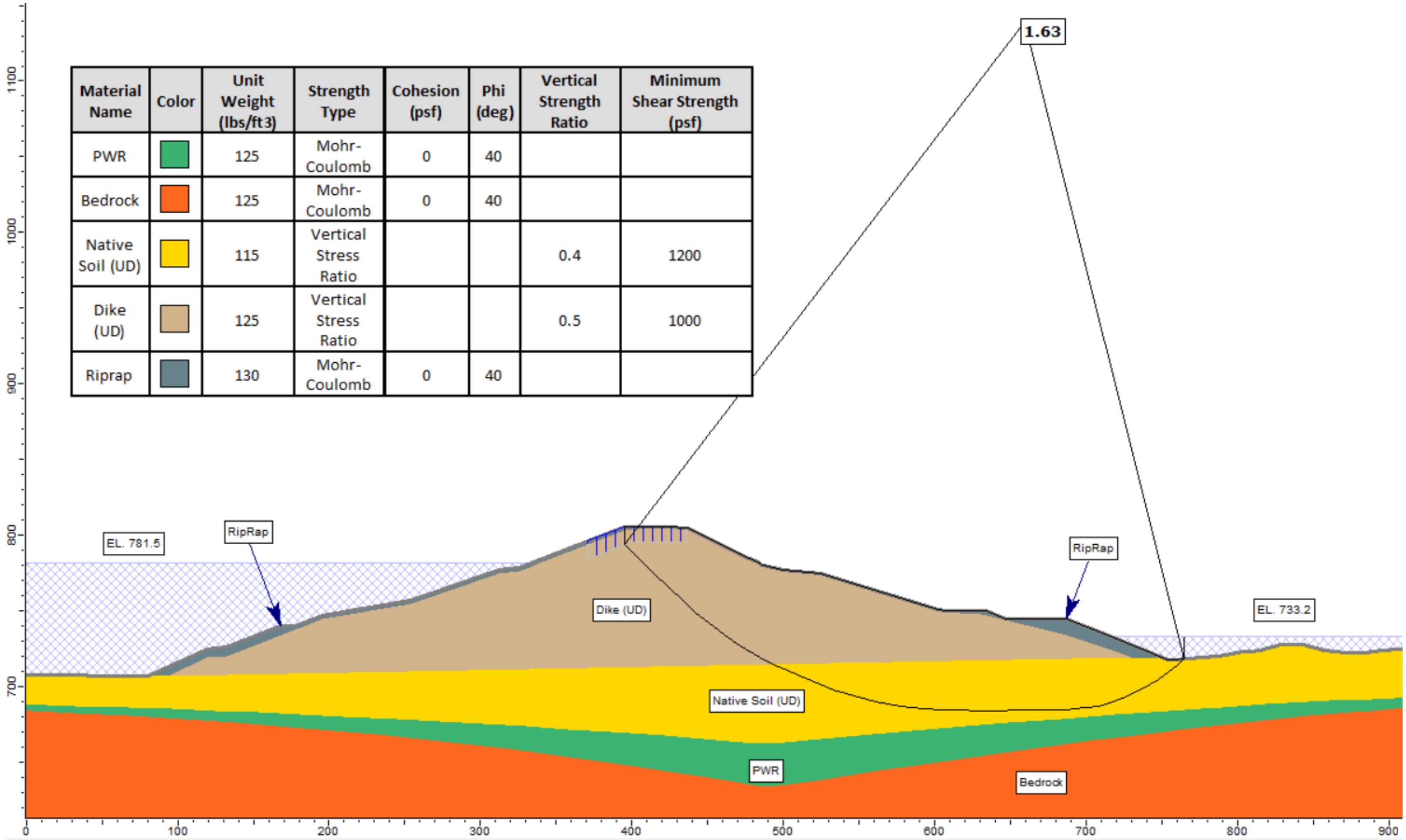
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Envelope Type	RD Shear/ Normal Function	Water Surface	Hu Type	Hu
Native Soil - RDD	🟩	115	Mohr-Coulomb	0	32	Yes	Total stress R non-linear	Native Soil - UD	Water Surface	Custom	1
Dike - RDD	🟪	125	Mohr-Coulomb	100	32	Yes	Total stress R non-linear	Dike - UD	Water Surface	Custom	1
PWR - RDD	🟦	125	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1
Bedrock - RDD	🟥	125	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1
Riprap - RDD	▨	130	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1

Figure 24- Rapid Drawdown Slope Stability Analyses Results for Cross Section G



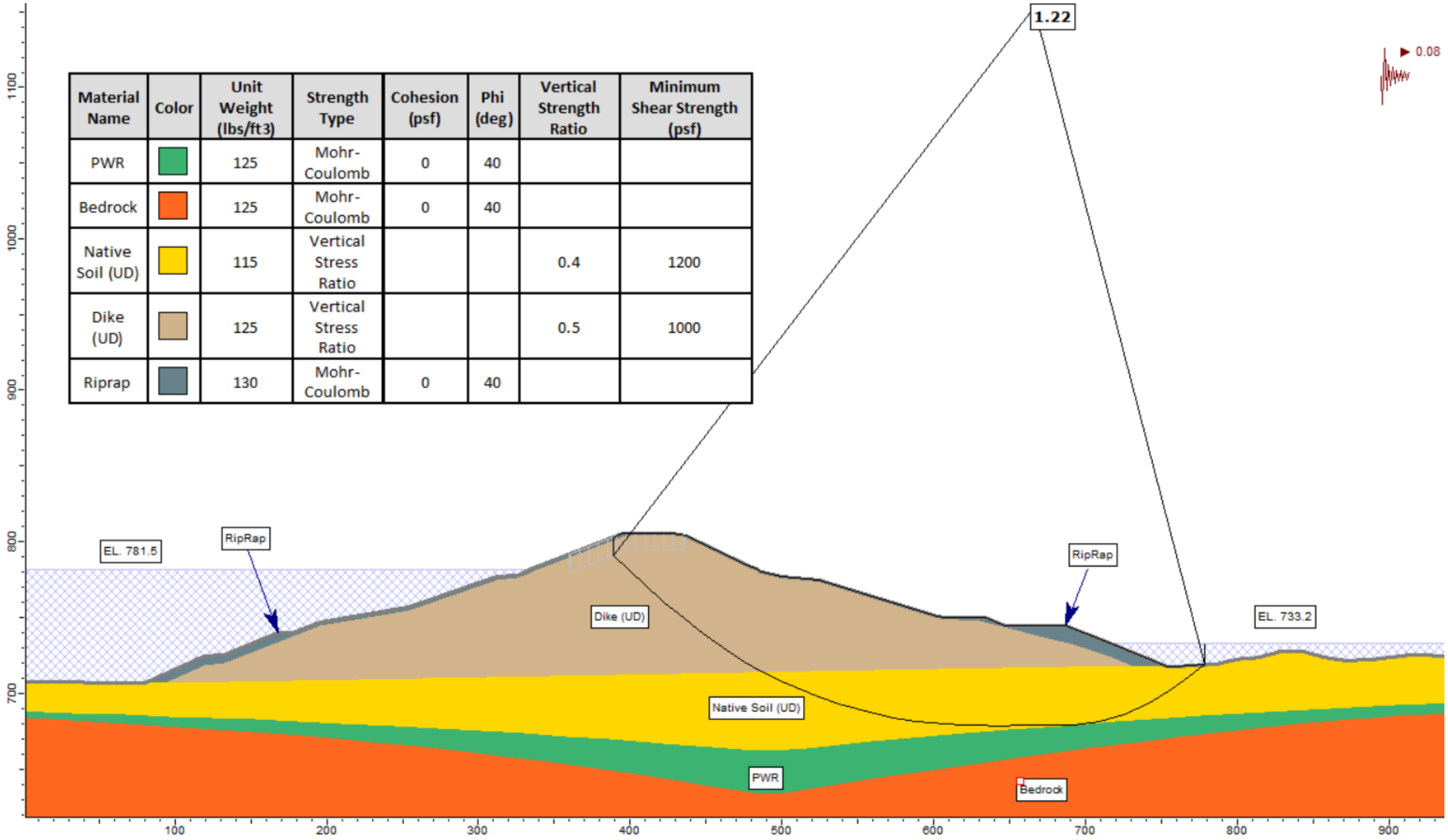
Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Soil (D)	🟨	115	Mohr-Coulomb	0	32
PWR	🟩	125	Mohr-Coulomb	0	40
Bedrock	🟧	125	Mohr-Coulomb	0	40
Dike (D)	🟥	125	Mohr-Coulomb	100	32
Riprap	⬛	130	Mohr-Coulomb	0	40

Figure 25- Long-term Static Slope Stability Analyses Results for Section G (Storage Water Pond Low Pool)



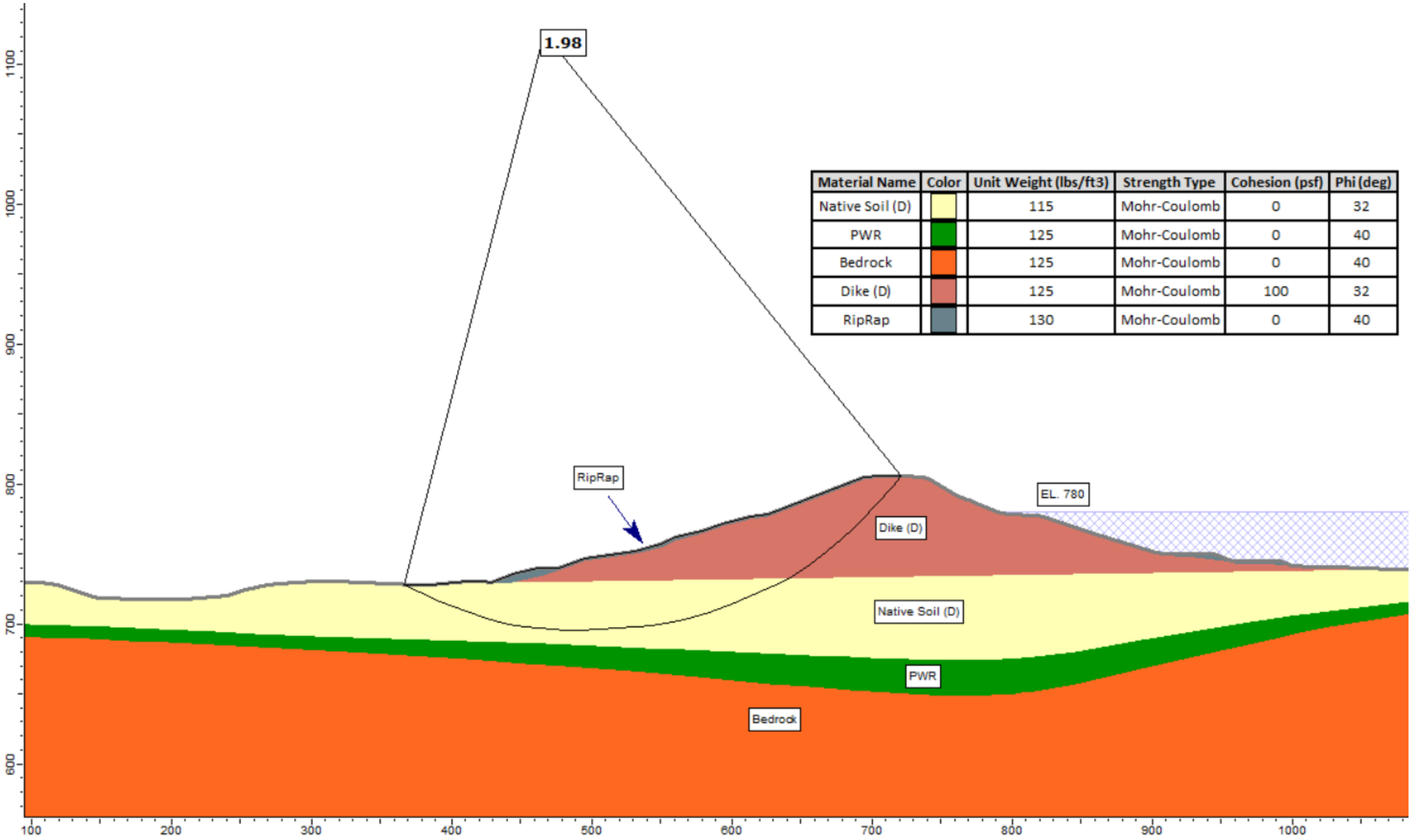
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
PWR	🟩	125	Mohr-Coulomb	0	40		
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
Riprap	⬛	130	Mohr-Coulomb	0	40		

Figure 26- Short-term Static Slope Stability Analyses Results for Section G (Storage Water Pond Low Pool)



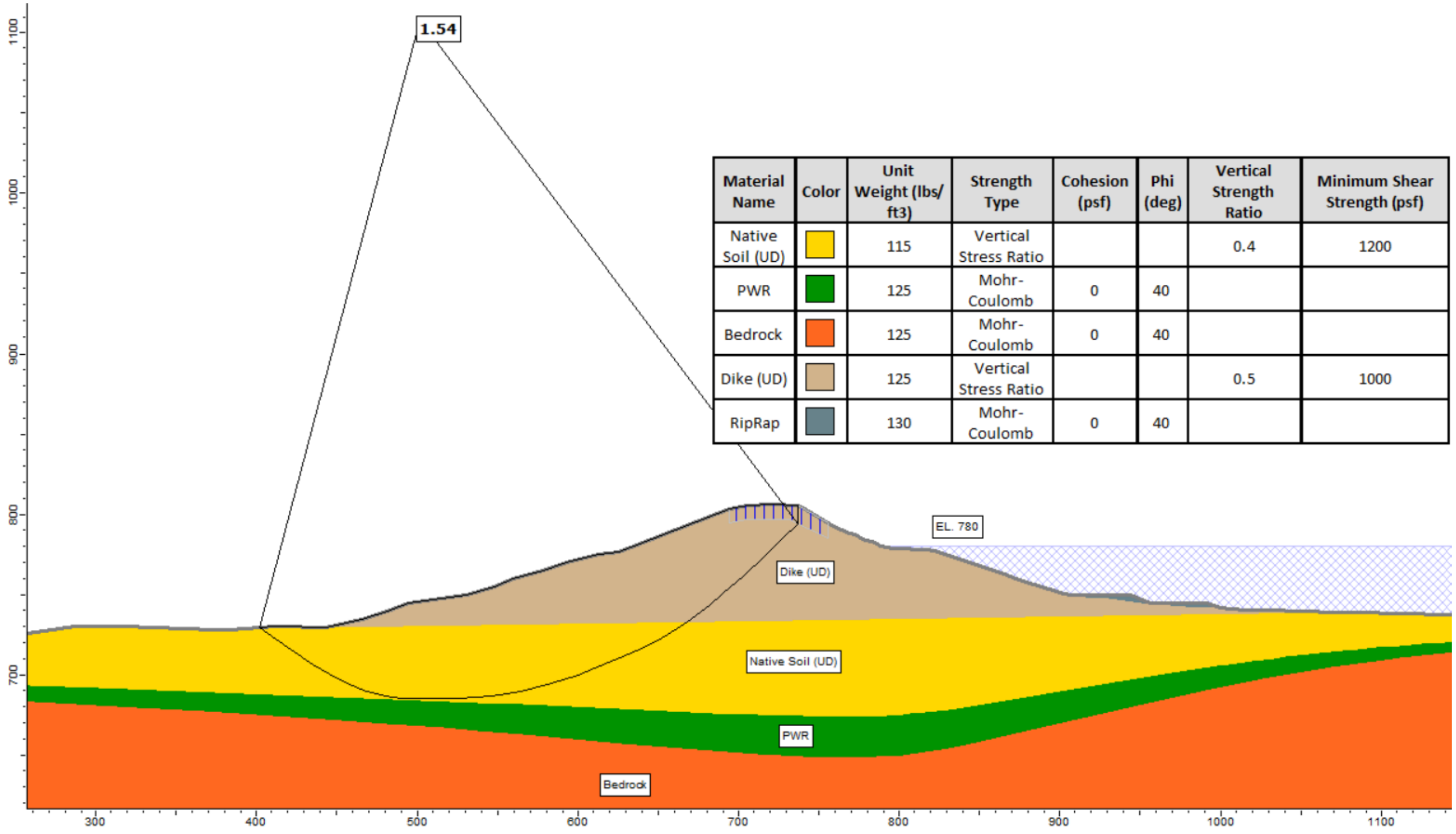
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
PWR	🟩	125	Mohr-Coulomb	0	40		
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
Riprap	⬛	130	Mohr-Coulomb	0	40		

Figure 27- Seismic Slope Stability Analyses Results for Cross Section G (Storage Water Pond Low Pool)



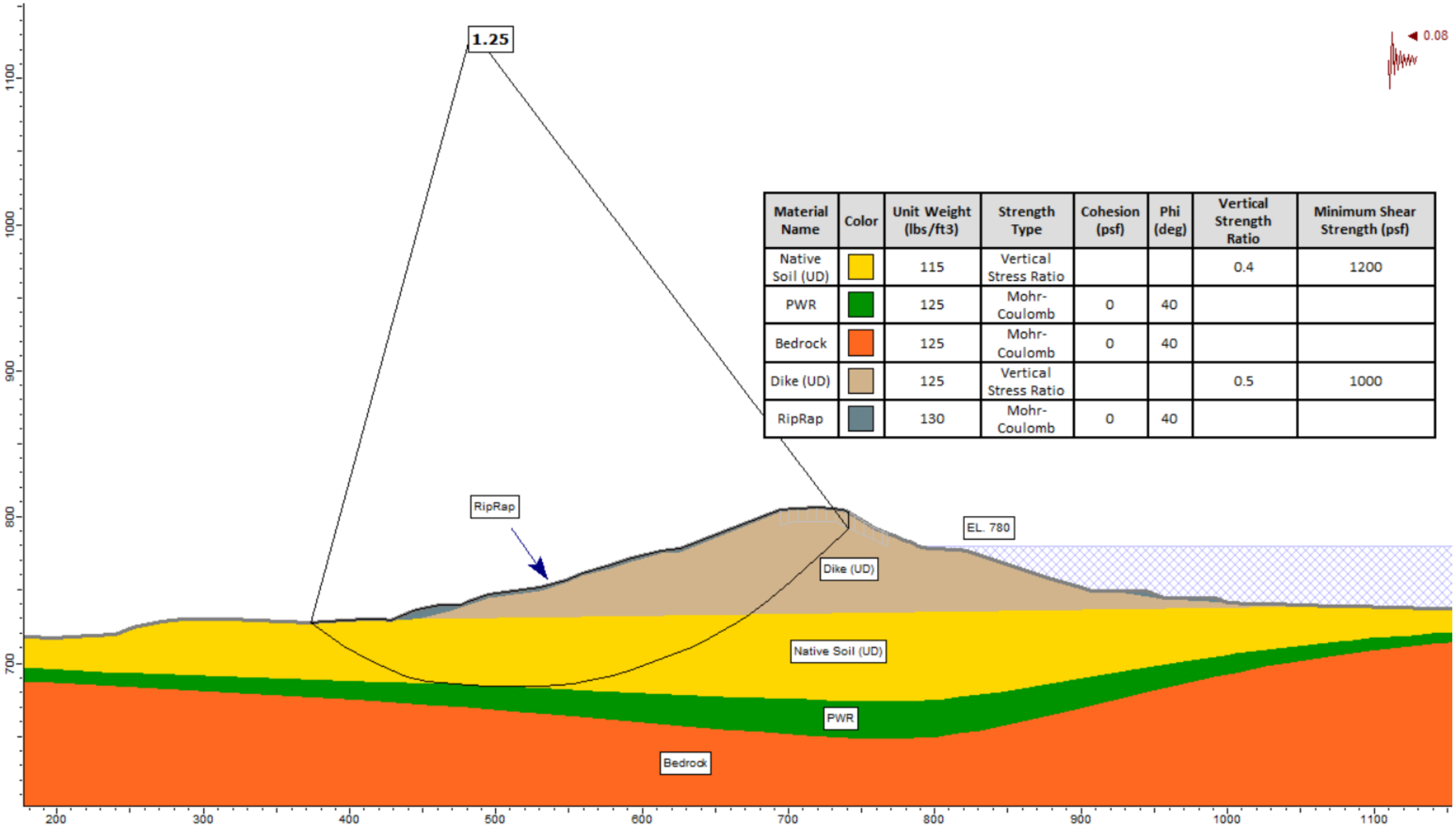
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Soil (D)	🟨	115	Mohr-Coulomb	0	32
PWR	🟩	125	Mohr-Coulomb	0	40
Bedrock	🟧	125	Mohr-Coulomb	0	40
Dike (D)	🟥	125	Mohr-Coulomb	100	32
RipRap	⬛	130	Mohr-Coulomb	0	40

Figure 28- Long-term Static Slope Stability Analyses Results for Cross Section H (AP-1 Empty)



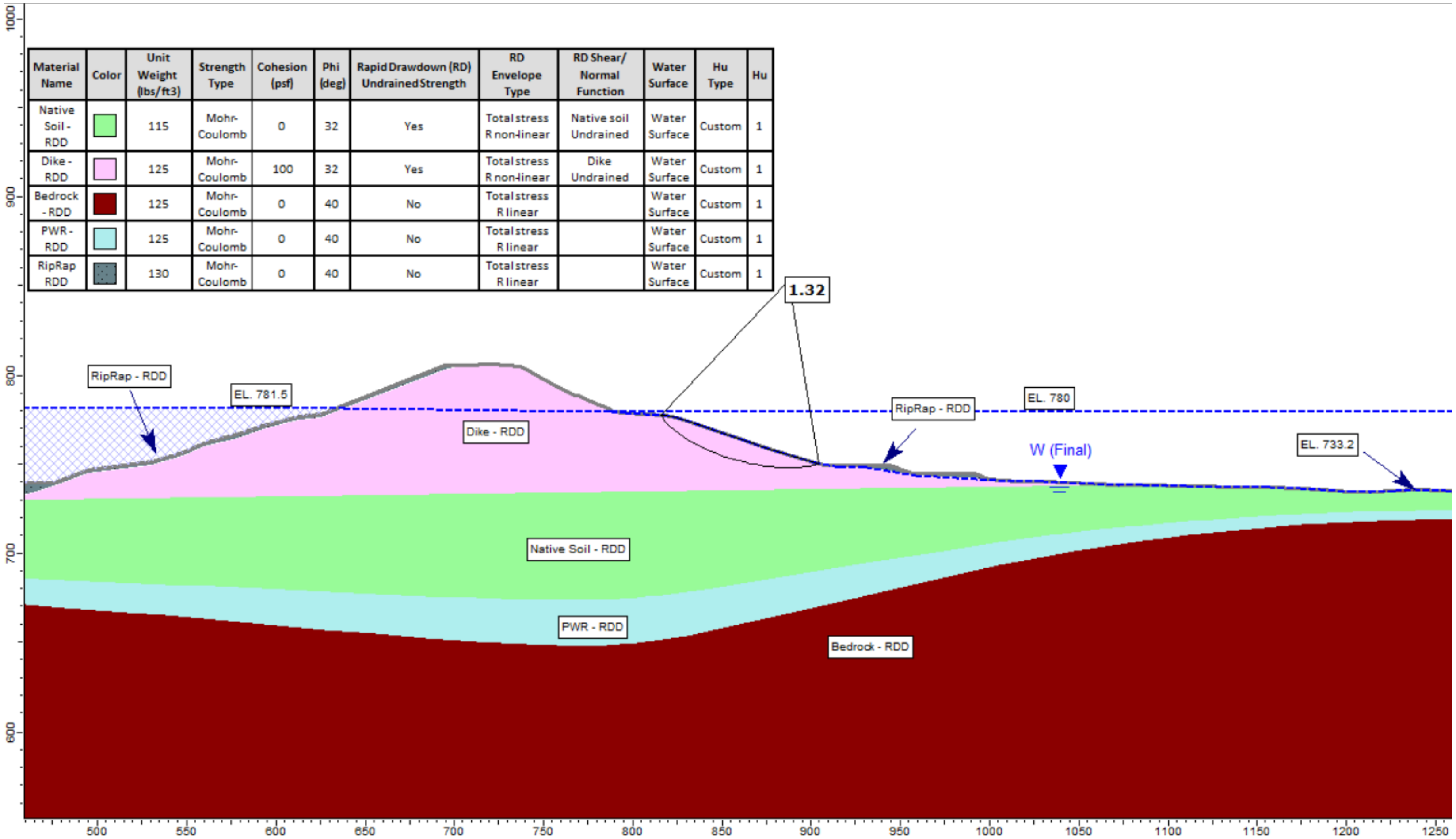
Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
PWR	🟩	125	Mohr-Coulomb	0	40		
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
RipRap	⬛	130	Mohr-Coulomb	0	40		

Figure 29- Short-term Static Slope Stability Analyses Results for Cross Section H (AP-1 Empty)



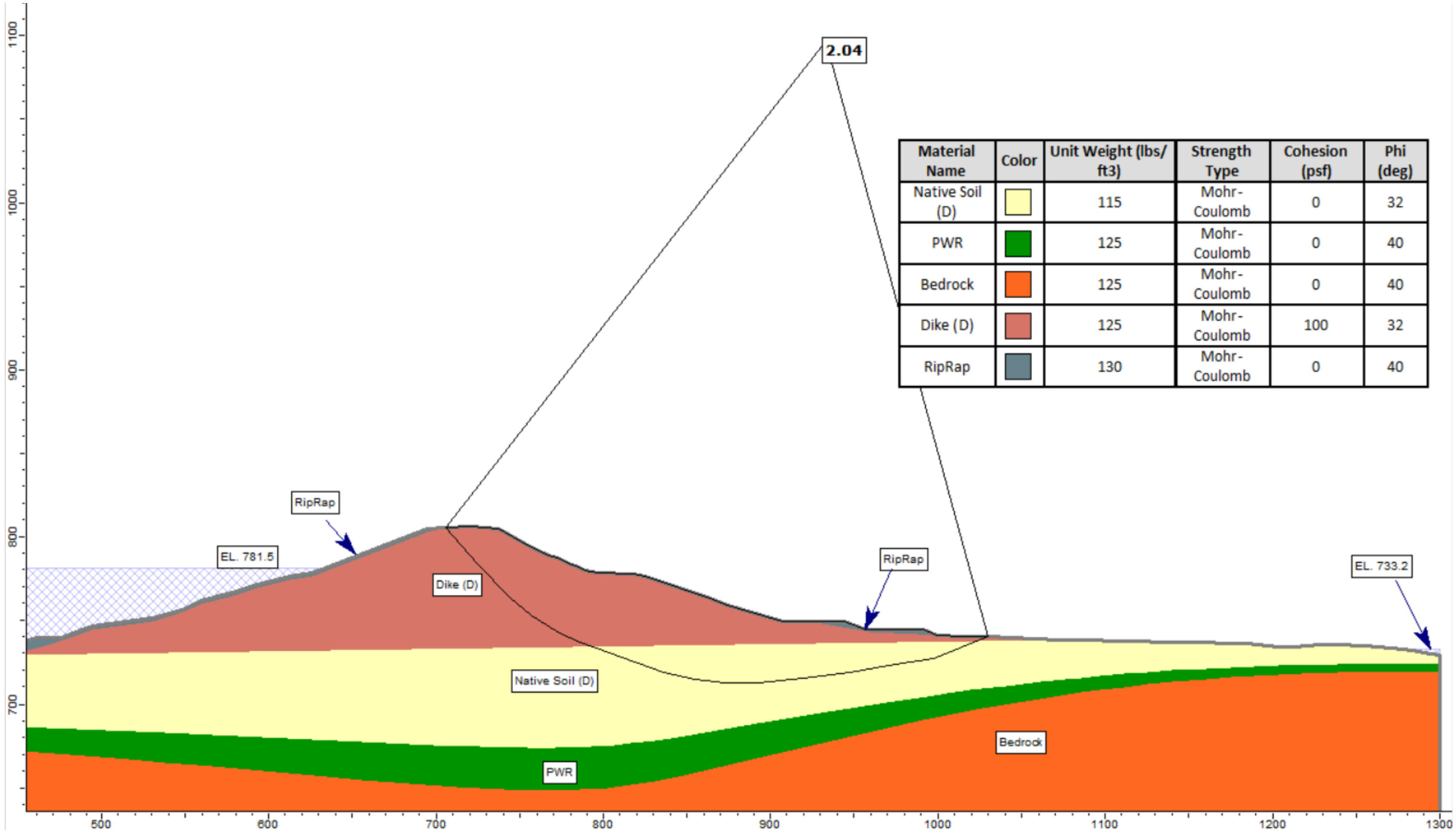
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
PWR	🟩	125	Mohr-Coulomb	0	40		
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
RipRap	🟦	130	Mohr-Coulomb	0	40		

Figure 30- Seismic Slope Stability Analyses Results for Cross Section H (AP-1 Empty)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Envelope Type	RD Shear/ Normal Function	Water Surface	Hu Type	Hu
Native Soil - RDD	🟩	115	Mohr-Coulomb	0	32	Yes	Total stress R non-linear	Native soil Undrained	Water Surface	Custom	1
Dike - RDD	🟪	125	Mohr-Coulomb	100	32	Yes	Total stress R non-linear	Dike Undrained	Water Surface	Custom	1
Bedrock - RDD	🟥	125	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1
PWR - RDD	🟦	125	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1
RipRap RDD	▨	130	Mohr-Coulomb	0	40	No	Total stress R linear		Water Surface	Custom	1

Figure 31- Rapid Drawdown Slope Stability Analyses Results for Cross Section H

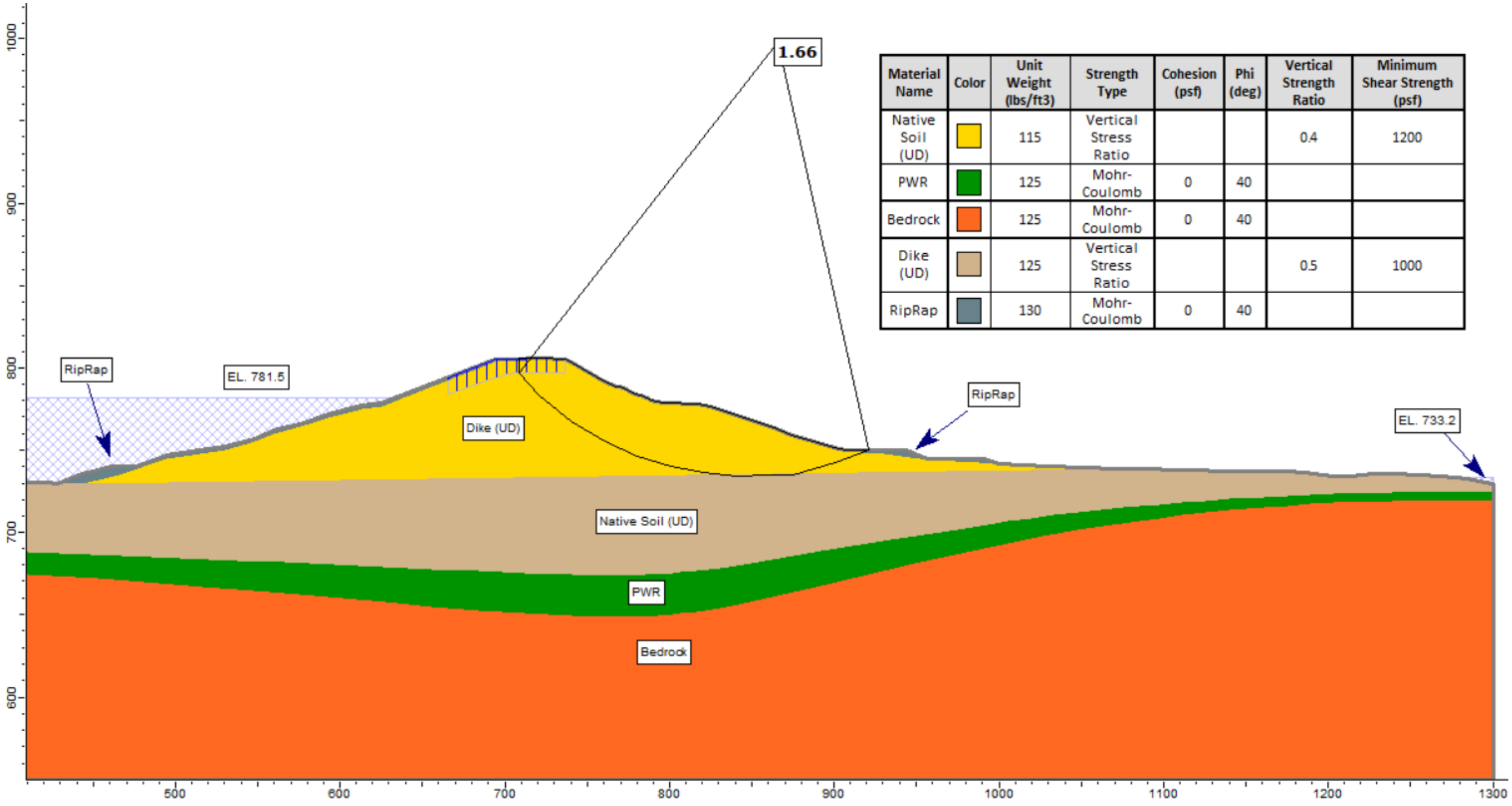


Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Soil (D)	🟨	115	Mohr-Coulomb	0	32
PWR	🟩	125	Mohr-Coulomb	0	40
Bedrock	🟧	125	Mohr-Coulomb	0	40
Dike (D)	🟥	125	Mohr-Coulomb	100	32
RipRap	⬛	130	Mohr-Coulomb	0	40

Figure 32- Long-term Static Slope Stability Analyses Results for Section H (Storage Water Pond Low Pool)

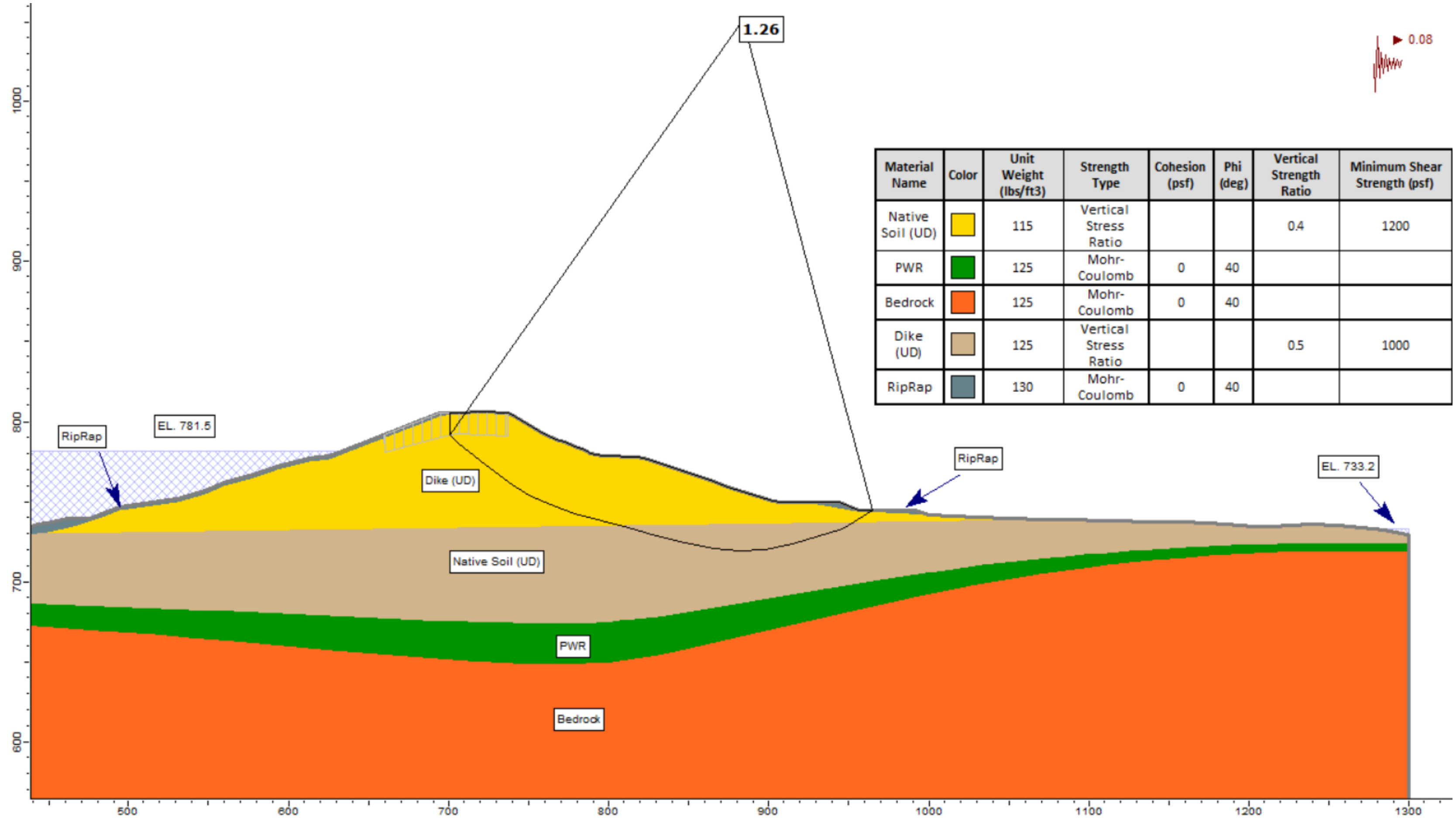
CP: **CG** Date: **11/04/22** APC: **MC** Date: **11/04/22** CA: **JG** Date: **11/17/22**

Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
PWR	🟩	125	Mohr-Coulomb	0	40		
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
RipRap	⬛	130	Mohr-Coulomb	0	40		

Figure 33- Short-term Static Slope Stability Analyses Results for Section H (Storage Water Pond Low Pool)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Native Soil (UD)	🟨	115	Vertical Stress Ratio			0.4	1200
PWR	🟩	125	Mohr-Coulomb	0	40		
Bedrock	🟧	125	Mohr-Coulomb	0	40		
Dike (UD)	🟫	125	Vertical Stress Ratio			0.5	1000
RipRap	⬛	130	Mohr-Coulomb	0	40		

Figure 34- Seismic Slope Stability Analyses Results for Section H (Storage Water Pond Low Pool)

MATERIAL BALANCE
PACKAGE

Geosyntec consultants

CALCULATION PACKAGE COVER SHEET

Client: Georgia Power Company **Project:** Plant Wansley CCR Permitting **Project #:** GW9155

TITLE OF PACKAGE: **MATERIAL BALANCE PACKAGE**

PREPARATION

CALCULATION PREPARED BY:
(Calculation Preparer, CP)

Signature
Name Dalton Kegley
11/07/2022
Date

REVIEW

ASSUMPTIONS & PROCEDURES CHECKED BY:
(Assumptions & Procedures Checker, APC)

Signature Lauren Fitzgerald
Name Lauren Fitzgerald
11/10/2022
Date

COMPUTATIONS CHECKED BY:
(Computation Checker, CC)

Signature Lauren Fitzgerald
Name Lauren Fitzgerald
11/10/2022
Date

BACK-CHECK

BACK-CHECKED BY:
(Calculation Preparer, CP)

Signature
Name Dalton Kegley
11/11/2022
Date

APPROVAL

APPROVED BY:
(Calculation Approver, CA)

Signature
No. PE043417
JEREMY GASSER
Name Jeremy Gasser, P.E.
03/10/2023
Date

REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
1	Submittal to Georgia EPD	03/10/2023	DK	LF	LF	JG

CP: DK Date: 11/7/22 APC: LF Date: 11/10/22 CA: JG Date: 11/18/22

Client: GPC Project: Plant Wansley CCR Permitting Project No: GW9155

MATERIAL BALANCE PACKAGE

1. INTRODUCTION

This calculation package (herein referred to as the Package) was prepared in support of the permit application package submitted to Georgia Environmental Protection Division (GA EPD) to close Ash Pond 1 (AP-1), an existing coal combustion residuals (CCR) surface impoundment at Plant Wansley (Site), located in Heard and Carroll Counties near Carrollton, Georgia.

This Package presents the material balance estimates for AP-1 including: (i) estimated CCR excavation volume; and (ii) estimated native soil excavation volume.

2. METHODOLOGY

The CCR volume (inclusive of bottom ash, fly ash, gypsum, and soil from the gypsum dikes) estimate was calculated by comparing the existing ground (EG) survey (Closure Drawing 05) with the Bottom of CCR surface (Closure Drawing 06).

The EG survey was a compilation of the following:

- Bathymetry of the main pond in AP-1 from November 2019 by ARC Surveying and Mapping.
- Topography data from the October 2021 Survey by SAM, LLC.
- Bathymetry data of the small cove (southern end of AP-1) is from the August 2019 Survey from Jordan Engineering.
- All surfaces were tied to each other to create a single, contiguous surface.

The Bottom of CCR surface was a compilation of the following:

- Georeferencing and digitization of Georgia Power drawing “Plant Wansley Unit No. I Ash Pond”, drawing G-10023 dated 03-01-1974. The drawing is a topographic map from 1974 after construction of the Separator Dike and prior to the filling of AP-1. It was the basis for the initial bottom of CCR surface (#1).
- Creation of a surface with the 24 borings from Geosyntec’s 2017 barge drilling (M- and S-series), 30 CPTs from Geosyntec’s 2019 investigation along the containment structure alignment, and 60 borings (SB-, GP-, and G-M- series) and 32 CPTs from Golder’s 2021-2022 investigation across AP-1. Golder’s investigation had 9 other borings that were determined to be outliers and excluded from the surface. As there were not enough borings to cover the entire AP-1, the digitized surface still makes up the bulk of the bottom of CCR surface. A radius of 150 feet around each point was used to tie the boring picks to the

digitized bottom of CCR (#1). Where the boundaries overlapped, the borings were triangulated to each other, and the resulting triangles check to ensure they reflected a valley-link condition. This surface was then interpolated using AutoCAD Civil3D's natural neighbor method on a 15-foot grid. The data from both investigations was pasted into the digitized surface (#1) to create a revised bottom of CCR (#2).

- As the bottom of CCR (#2) was entirely beneath the surveyed existing ground surface, a 3:1 slope was used to connect the two surfaces from the lateral limits of CCR down to the bottom of CCR (#2) surface, with several locations near borings adjusted to better match the found data. This was combined with bottom of CCR (#2) to create bottom of CCR (#3).
- The bottom of CCR (#3) was checked for protrusions above the EG surface. Any locations where EG was below the surface of bottom of CCR (#3), EG was cropped and then pasted into bottom of CCR (#3) to create a further revised bottom of CCR (#4).
- The bottom of CCR (#4) composite surface is the final product to be used for the CCR volumes. The resulting volume was adjusted to remove both the Gypsum Cell Dikes and the gypsum they contain.

The Native Soil volume estimate was calculated by assuming 6 inches of soil removal across the entire Bottom of CCR surface and using the 3D surface area of the recently revised surface that was used to calculate the CCR volume.

3. RESULTS

Based on the above methodology, in-situ volumes were calculated and presented in Table 1 below.

Table 1. Removal Volume

Material	In-Situ Volume (CY)
CCR	15,874,000
Native Soil	273,000

STORMWATER AND
CONTACT WATER
MANAGEMENT
PACKAGE

Geosyntec
consultants

CALCULATION PACKAGE COVER SHEET

Client: Georgia Power Company **Project:** Plant Wansley CCR Permitting **Project #:** GW9155

TITLE OF PACKAGE: **STORMWATER AND CONTACT WATER MANAGEMENT PACKAGE**

PREPARATION	**CALCULATION PREPARED BY:** (Calculation Preparer, CP)	Signature Name Michael Escobar	11/09/2022 Date
REVIEW	**ASSUMPTIONS & PROCEDURES CHECKED BY:** (Assumptions & Procedures Checker, APC)	Signature Name Maxwell Dugan	11/09/2022 Date
	COMPUTATIONS CHECKED BY: (Computation Checker, CC)	Signature Name Maxwell Dugan	11/09/2022 Date
BACK-CHECK	**BACK-CHECKED BY:** (Calculation Preparer, CP)	Signature Name Michael Escobar	11/11/2022 Date
APPROVAL	**APPROVED BY:** (Calculation Approver, CA)	Signature GEORGIA REGISTERED No. PE043417 PROFESSIONAL ENGINEER JEREMY GASSER Name Jeremy Gasser, P.E.	03/10/2023 Date

REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
1	Submittal to Georgia EPD	03/10/2023	ME	MD	MD	JG

CP: MEE Date: 11/9/2022 APC: MD Date: 11/9/2022 CA: JG Date: 11/17/2022

Client: GPC Project: Plant Wansley CCR Permitting Project No: GW9155

STORMWATER AND CONTACT WATER MANAGEMENT PACKAGE

1. INTRODUCTION

This calculation package (herein referred to as the Package) was prepared in support of the permit application package submitted to Georgia Environmental Protection Division (GA EPD) to close Ash Pond 1 (AP-1), an existing coal combustion residuals (CCR) surface impoundment at Plant Wansley (Site), located in Heard and Carroll Counties near Carrollton, Georgia.

Depending on the actual CCR excavation rate achieved during closure activities, complete CCR removal and final restoration of the pond will be accomplished within approximately ten (10) to fifteen (15) years following the beginning of closure activities.

The major steps to close AP-1 include site preparation, dewatering, construction-phase stormwater and contact water management, excavating and transporting the CCR to a permitted disposal location (i.e., the new on-site CCR landfill), treating CCR contact water via the on-site water treatment plant (WTP) to meet discharge requirements, restoring vegetation on perimeter slopes and base grades for protection while the pond refills naturally.

Implementation of the AP-1 closure will be completed in steps. The general sequence of activities for CCR closure-by-removal:

- Site preparation, including but not limited to, clearing trees, grading, constructing access roadways and laydown construction areas, and installing erosion and sediment controls
- Removal of the full volume of CCR to its bottom in AP-1 as defined by the visual interface between CCR and underlying native soils.
- Removal of a minimum six inches of additional soils after reaching the CCR/native soil interface.
- Placement of all removed materials into the modified on-site CCR landfill.
- Restoration of the base grades of the impoundment with hydroseed.
- Addition of riprap along the Separator Dike for stabilization.

1.1 Removal Volume

Based on the October 2019 bathymetric and LiDAR topographic survey of AP-1, there is an estimated 16 million cubic yards (MCY) of CCR to remove from AP-1. The CCR to be removed is expected to be primarily fly ash, with some seams of bottom ash based on the location (western side of AP-1). Following CCR removal, an additional 6 inches of native soil will be excavated resulting in 0.2 MCY of additional soils to be removed. This results in a total of 16.2 MCY to be removed and disposed of at the on-site landfill. Note that these volumes are estimated based on the best available information (e.g., 1970s topography for the bottom of CCR), as such, and are subject to change based on field verification.

1.2 Excavation Method

The basis for these calculations is to draw down the water within AP-1 and achieve complete CCR removal via conventional excavation.

However, CCR removal via dredging may be desired. Dredging (hydraulic or mechanical) may only be utilized for bulk CCR removal from the CCR Removal Area. The pool elevation of AP-1 must still be drawn down such that final CCR removal and verification be completed in the dry condition (i.e., no free-standing water).

1.3 Site Constraints

The following are Site constraints for this portion of closure construction:

- AP-1 pool elevation may not be drawn down faster than 1 ft per week.
- All CCR contact water must be routed through the WTP and meet effluent requirements of the GA EPD Dewatering Permit prior to discharge.
- All non-contact water must be routed through Non-Contact Water Pond (NCWP) 1 and meet the stormwater discharge requirements of the site's existing Industrial General Permit (IGP) prior to discharge.
- The WTP must be able to provide recovery (i.e., free water removal) for a 24-hour, 25-year storm within a maximum time of 3 weeks.
- Regardless of removal and transportation method, the CCR removal verification process must be completed in the dry condition.

2. WATER MANAGEMENT

Water on the project generally falls into one of two categories: i) contact; and ii) non-contact.

- Contact water is any water that comes in contact or has the potential to contact CCR. This includes free water pooled in areas not certified removed, stormwater that runs over CCR, and interstitial water extracted from CCR. Additionally, any water that comingles with contact water shall be considered contact water.
- Non-contact water is water that is hydraulically isolated from any contact water and CCR.

2.1 WTP

A lined WTP pad has been constructed near the existing outfall structure on the southwest side of AP-1. Georgia Power will procure a WTP Contractor to mobilize a treatment unit for the duration of the project. Prior to the start of construction, the existing outfall structure will be closed and any contact water needing to be discharged from AP-1 must be routed through the WTP. Discharge water from the WTP must meet the requirements of the GA EPD Dewatering Permit and will be conveyed into the existing underground 42-inch AP-1 discharge line.

Standard WTP operational hours will be 60 hours per week (six, 10-hour days). During these 60 hours it is assumed that an up-time of 85% can be achieved. Geosyntec has designed the operational capacity for the WTP (ranging from 2,000 to 6,000 gallons per minute [gpm]) depending on construction requirements. A general overview of the construction and WTP steps is provided in Section 2.3.

2.2 Stormwater Diversion

Throughout construction, stormwater runoff that can be hydraulically isolated from AP-1 or the CCR limits can be managed as non-contact water and does not need to be routed through the WTP prior to discharge. Construction of temporary stormwater diversions and basins may be an effective way to reduce WTP treatment volumes and more efficiently drawdown AP-1 (i.e., less refill). Preliminary non-contact water ponds are described in Section 2.3 below and shown on the Permit Package Drawings. Once CCR Removal Areas have been certified to be free of CCR, water in contact with these areas can be managed as non-contact. A series of dikes and ponds are proposed to gradually remove runoff area from AP-1. Diverted non-contact water shall be routed to the non-contact water pond on the west side of AP-1 through gravity flow or pumping. This pond will be a settling pond to reduce the potential for sediment discharge, with clear, non-contact water skimmed from the top of the water column and discharged at the same location of at the WTP plant, the 42-inch AP-1 discharge line.

The preliminary non-contact water pond construction and sequencing presented in Section 2.3 may be altered if the Contractor proposes their own means and methods, so long as the constraints identified in this document are satisfied and approved by the Purchaser. Non-contact water ponds shall be constructed with maximum berm heights of 25 feet and storage capacities less than 100 acre-feet to avoid classification as jurisdictional dams. Non-contact water ponds receiving direct catchment runoff shall be designed with riprap spillways capable of conveying the 100-year design storm to AP-1 without eroding the embankment.

2.3 AP-1 Construction Sequence

The total estimated volume of free water in AP-1 before excavation of CCR is approximately 3,700 acre-feet with a depth of 47.5 feet from pond bottom to invert of outlet structure. Based on the closure approach, different pool elevations are needed throughout closure construction. **Table 1** details the WTP capacity and AP-1 pool elevations throughout construction. Following the table is a description and additional details for the construction stages. This information is included in **Drawings 17** and **18** of the Permit Package Drawings.

These calculations assumed CCR removal via excavation, while minimizing drawdown time, satisfying the 1-ft per week maximum drawdown rate, and accounting for likely WTP operational efficiency and uptime. Actual drawdown is expected to vary based on actual rainfall, WTP efficiency, uptime, and other factors. Note that final CCR removal method will not be determined until the Contractor is selected and may include either excavation or dredging.

Table 1. Construction Sequence

Stage	Year	WTP Capacity	WSE Start	WSE Stop	Pond Volume Change (M gal)	Stormwater Inflow Volume (M gal)	WTP Volume Treated (M gal)	Construction Description
0	0-1	N/A	781.5	781.5	--	--	--	Site Preparation
1	1-2	4,000	781.5	770.0	529	106	635	Initial Drawdown & Initial CCR Removal
2	2-3	4,000	770.0	750.0	551	106	657	Drawdown & CCR Removal
3	3-4	4,000 to 6,000	750.0	730.0	132	103	235	Continued Drawdown & CCR Removal
4	4-5	6,000 to 2,000	730.0	700.0	--	69	69	Continued Drawdown & Ash Delta CCR Removal
5	5-15	N/A	700.0	781.5	3,559		--	Stabilization and Refill

Stage 0 – Site Preparation (WSE 781.5 to 781.5)

Prior to initiating CCR removal construction the water surface elevation (WSE) within AP-1 will be no lower than the existing 781.5 ft North American Vertical Datum of 1988 (NAVD88, herein all elevations reference this datum). During this duration, the WTP will be constructed. This stage is presented in **Detail 4** on **Drawing 17** of the Permit Drawings.

Stage 1 – Initial Drawdown & Initial CCR Removal (WSE 781.5 to 770.0)

With the completion of the WTP and the start of CCR removal, the WTP will begin operation with an initial capacity of 4,000 gallons per minute (gpm). The intake point for the WTP will be near the system from within the AP-1 pool. Stage 1 is shown visually in **Detail 5** on **Drawing 17** of the Permit Drawings.

Stage 2 – Drawdown & CCR Removal (WSE 770.0 to 750.0)

Once the pool elevation is at least 760 ft, the Contractor will certify CCR removal and construct Contact Water Pond (CWP) 1, near the WTP. CWP 1 will be lined. Conceptually, this is presented in **Detail 6** on **Drawing 17** of the Permit Drawings. With CWP 1 constructed, the WTP Vendor will start pulling water from that pond and not the AP-1 pool. At this point, it will be the Contractor's responsibility to ensure CWP 1 is supplied with water from the pool for the WTP Vendor to withdraw. The maximum operating water surface elevation within CWP 1 shall be 788 ft, and be drawn down following a 25-year, 24-hour storm event within 3 to 5 days (minimum recommended pumping capacity of 3,000 gpm, assuming 24/7 pump operation).

Stage 3 – Continued Drawdown & CCR Removal (WSE 750.0 to 730.0)

After the WSE in the pond drops below 750 ft and the CCR is certified as removed, the WTP Vendor may increase capacity to 6,000 gpm to continue drawdown. WTP intake will be from CWP 1. The Contractor shall pump water from the AP-1 pool to CWP 1 as necessary to maintain operation of the WTP.

As the pool elevation continues to drop, the Contractor will continue CCR removal, generally from west to east. As areas are certified free of CCR, the Contractor is expected to start installing non-contact water ponds, as shown in **Detail 7 and Detail 8** on **Drawing 18** of the Permit Drawings. While the contact water ponds presented in the Permit Drawings are expected to be constructed as designed, it will be the Contractor's responsibility to design and install diversion berms to create non-contact water ponds to lower the demand of the WTP. As free water continues to be drawn down and CCR is removed, it is expected that the Contractor will continue to install interim diversion berms.

Stage 4 – Continued Drawdown & Ash Delta CCR Removal (WSE 730.0 to 700.0)

Below 730.0, the rate of CCR removal is expected to increase because of improved access to the ash delta. The Contractor shall construct CWP 2 to manage and retain contact water runoff from the ash dela, and from the bottom of AP-1 near ash delta. Contact water from CWP 2 shall be pumped directly to the WTP. The water surface elevation within CWP 2 shall be maintained at a normal operating level of 795 ft, and be drawn down following a 25-year, 24-hour storm event within 3 to 5 days (minimum recommended pumping capacity of 3,000 gpm, assuming 24/7 pump operation). Drawdown will continue until there is no pooled water (estimated 700 ft).

Following final drawdown, the work areas shall be maintained in a dry condition with contact water from stormwater runoff, groundwater inflows, and seepage pumped through to Contact Water Ponds for diversion to the WTP. The WTP will be reduced to a capacity of 2,000 gpm, which is sufficient to maintain a dry pond and draw down within three weeks of a 25-year, 24-hour storm event. Excavation and CCR disposal will continue until all CCR is removed and certified, which is presented in **Detail 8** on **Drawing 18** of the Permit Drawings.

Stage 5 – Stabilization and Refill (WSE 700.0 to 781.5)

Following certification of all CCR removal, the WTP will be decommissioned, the outlet structure will be re-opened, and the NPDES pond (formerly AP-1) will be allowed to refill to 781.5 ft via natural processes. This stage is shown in **Detail 9** on **Drawing 18** of the Permit Drawings.

3. POND REFILL

Surface water runoff volumes were evaluated at the Site using historical long-term hourly precipitation records. Computer modeling software and Geographic Information Systems (GIS) Tools were used to define the input parameters and simulate historical conditions in order to evaluate water surface elevations in the pond.

3.1 Model

Rainfall-runoff simulation for the Site and contributing drainage areas was estimated using the EPA Storm Water Management Model (SWMM) as implemented by the PCSWMM software program. EPA SWMM simulates rainfall-runoff and routing through various hydraulic elements. The SWMM model generates runoff hydrographs using a non-linear reservoir algorithm based on Manning's formulation for overland flow. It represents a drainage area as having both pervious and impervious subareas and accounts for soil infiltration using the Green-Ampt infiltration model.

A SWMM model for AP-1 was previously developed and calibrated against AP-1 pool elevation data during a site-wide water management analysis. This calibrated model was used as the foundation for the refill analysis and was subsequently updated to represent post-closure conditions.

Updates to the calibrated model included a new reservoir stage-area relationship for the excavated pond. The starting bottom elevation of the excavated pond is 700.0 ft. Refill was considered complete when flow was registered passing through the outlet structure, which has an invert elevation 781.5 ft.

3.2 Analysis

Using historical precipitation data from USGS, three pond refill scenarios were modeled to generate an expected refill period. The representative pond refill period was 10.5 years (3,818 days) for the scenario beginning 15 June 1948 and ending 28 November 1958. Reruns of the model beginning 1 January 1978 and 1 January 2020 resulted in similar refill periods of 8.1 years and 10.6 years, respectively.

FINAL CLOSURE STORMWATER MANAGEMENT PACKAGE

CALCULATION PACKAGE COVER SHEET

Client: Georgia Power Company **Project:** Plant Wansley CCR Permitting **Project #:** GW9155

TITLE OF PACKAGE: **FINAL CLOSURE STORMWATER MANAGEMENT PACKAGE**

PREPARATION	**CALCULATION PREPARED BY:** (Calculation Preparer, CP)	Signature Name Minell Enslin	10/31/2022 Date
REVIEW	**ASSUMPTIONS & PROCEDURES CHECKED BY:** (Assumptions & Procedures Checker, APC)	Signature Name Michael Escobar	10/31/2022 Date
	COMPUTATIONS CHECKED BY: (Computation Checker, CC)	Signature Name Michael Escobar	10/31/2022 Date
BACK-CHECK	**BACK-CHECKED BY:** (Calculation Preparer, CP)	Signature Name Minell Enslin	11/11/2022 Date
APPROVAL	**APPROVED BY:** (Calculation Approver, CA)	Signature GEORGIA REGISTERED No. PE043417 PROFESSIONAL ENGINEER JEREMY GASSER Name Jeremy Gasser, P.E.	03/10/2023 Date

REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
1	Submittal to Georgia EPD	03/10/2023	ME	ME	ME	JG

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Client: **GPC** Project: **Plant Wansley CCR Permitting** Project No: **GW9155**

FINAL CLOSURE STORMWATER MANAGEMENT PACKAGE

PURPOSE

This calculation package (herein referred to as the Package) was prepared in support of the permit application package for the permanent closure of Ash Pond 1 (AP-1) at Plant Wansley (Site) (**Figure 1**).

The purpose of this Package is to present the erosion and sediment design of the temporary drainage channels within AP-1 for post-closure conditions. The post-closure condition refers to the period after removal of coal combustion residual (CCR) from AP-1 is complete through the refill period whereby the pond will fill by direct precipitation and run-on from surrounding areas. The slopes of AP-1 will be hydroseeded and additional temporary drainage channels are proposed for areas of high erosion potential.

OVERVIEW

Following certification of closure, the Closure-by-Removal Area will be re-submerged forming a pond within the previous footprint of AP-1. The outlet from AP-1 will be retained and re-opened following certification of closure. Drainage infrastructure installed during Phase I construction on the south side of AP-1 will also be retained. Depending on the actual CCR excavation rate achieved during closure activities, complete CCR removal and final restoration of the pond will be accomplished within approximately ten (10) to fifteen (15) years following the beginning of closure activities.

This Package presents the design criteria, analysis methodology, design parameters, computations, and modeling results for the components of the temporary drainage channels in the post-closure condition.

DESIGN CRITERIA

The temporary drainage channels are designed to meet the criteria identified from the following documents as well as design considerations based on general engineering practices from industry technical literature:

- “Manual for Erosion and Sediment Control in Georgia” (Erosion and Sediment Control Manual) [Georgia Soil and Water Conservation Commission (GSWCC), 2016]

- "Drainage Design for Highways" (Drainage Manual) [Georgia Department of Transportation (GDOT), 2018]

The GSWCC references the Georgia Stormwater Management Manual (GSMM) for post construction practices. However, the temporary drainage channels are not considered to be post-construction controls as the channels will be submerged after the removal of CCR during refill of the pond within the previous footprint of AP-1.

Temporary Drainage Channels

Temporary drainage channels were selected by reviewing the excavation surface contours in AP-1 and identifying channels with slopes generally greater than 4%. The channels were considered to start at the edge of existing CCR and terminate where the slope transitions to a shallower slope within the main surface water channel in the middle of AP-1.

The temporary drainage channel cross-sections were designed using guidance for channel stabilization BMPs in the Erosion and Sediment Control Manual [GSWCC, 2016]. Section 6 (Channel Stabilization Ch) in the Erosion and Sediment Control Manual states that "The required channel cross-section and grade are determined by the design capacity, the materials in which the channel is to be constructed, and the requirements for maintenance." The hydraulic capacities of the temporary drainage channels were designed using guidance in the Erosion and Sediment Control Manual, which states that "The capacity for open channels shall be determined by procedures applicable to the purposes to be served" and that "Manning's formula shall be used to determine velocities in channels." The temporary drainage channels were designed to convey runoff from the 25-year, 24-hour precipitation event (i.e., design event) and to maintain a minimum of 0.5 feet (ft) of freeboard during the peak discharge from the design event.

Temporary Drainage Channels Outlet Protection

Outlet protection was designed as riprap aprons in accordance with guidance provided for rock outlet protection in the GSWCC, Storm Drain Outlet Protection. Per the GSWCC, "This standard applies to all storm drain outlets, road culverts, paved channel outlets, etc., discharging into natural or constructed channels". The GSWCC states that the capacity will be sized per the peak stormflow from the 25-year, 24-hour frequency storm event. Riprap gradation was selected based on the temporary drainage channel outlet discharge rate and velocity for the 25-yr, 24-hr storm event.

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Riprap aprons were designed in accordance with the Storm Drain Outlet Protection (St) section of the GSWCC. Apron length and minimum D_{50} were designed based on the minimum and maximum tailwater conditions and Figure 6-34.1 and 6-34.2 of the GSWCC. Apron width was designed according to the tailwater condition. The GSWCC states that if the outlet "discharges directly into a well-defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank (whichever is less).

In accordance with the GSWCC, the riprap outlet protection will be underlain by a geotextile separator, per AASHTO M299-06 Section 8, to serve as a filter to prevent underlying soil from eroding and undermining the riprap.

The following sections present the hydrologic and hydraulic modeling methodologies used to estimate the size of the temporary drainage channels, as well as the results.

METHODOLOGY

Surface water flow rates, depths, and volumes were calculated using hydrologic and hydraulic procedures presented in the Urban Hydrology for Small Wetlands Technical Release 55 (TR-55) [Soil Conservation Service (SCS), 1986]; Manning's kinematic equation; and other recognized engineering procedures encoded in HydroCAD^{TM} software [HydroCAD^{TM}, 2018].

DESIGN PARAMETERS

- Channel Drainage Areas: **Figure 2** presents the drainage area delineation of the Site for the temporary drainage channels during the refill period, which includes run-on from surrounding areas to the pond. Drainage areas for the refill period were generally delineated to include upland areas above the pond, areas between the top of CCR and the existing water surface elevation (elevation of 781.5 ft), and below the existing water surface elevation. Drainage areas for run-on were delineated using the topography maps in the Permit Drawings. The delineations terminate at the end of the temporary drainage channels, which outlet to the shallower areas of the pond to prevent excessive erosion. **Table 1** presents the acreages of the delineated drainage areas to the temporary drainage channels.

- Rainfall Distribution and Depths: **Figure 3** [SCS, 1986] shows the location of the Site on the rainfall distribution map of the United States. The Site is in both Heard and Carroll County, Georgia, which are categorized as having a Type II Rainfall Distribution. Rainfall depths for the design storm events and for calculating times of concentration (TOC) are:

(i) 3.91 in. for the 2-yr, 24-hr storm; (ii) 5.38 in. for the 10-yr, 24-hr storm; (iii) 6.35 in. for the 25-yr, 24-hr storm; and (iv) 7.93 in. for the 100-yr, 24-hr storm [NOAA, 2017]. The precipitation frequency estimates obtained from the National Oceanic and Atmospheric Administration (NOAA) are shown in Attachment 1.

- Hydrologic Soil Group (HSG): Attachment 2 presents the soils map and descriptions for the different soil classifications for the vicinity of the Site [USDA, 2022]. The major soil units found within the area consisted of Appling (HSG B) and Madison (HSG B) associations. Soil in the northern site corner consisted of Louisa (HSG D) association. HSG B and D were used for the drainage areas draining to AP-1. Additionally, the soil designation for drainage areas below the CCR line are assumed to be HSG B. For the Phase I aggregate portions, an HSG of D was assumed due to the compacted and engineered soil.

- Curve Numbers: Land cover of each area was assessed using aerial photographs publicly available from Google Earth. **Table 1** presents the curve numbers (CNs) for the drainage areas contributing to the surface water management system for the post-development condition. The CNs corresponding to the land cover and HSG were selected based on Table 2-2 of TR-55 and interpretations within the HydroCAD^{TM} Manual [HydroCAD^{TM}, 2018], relevant excerpts of which are provided in Attachment 3. The following table summarizes the CNs chosen for the analyses performed in this package.

Area Description	Condition	HSG	CN
Woods [1]	Fair	B	60
Woods [1]	Fair	D	79
Aggregate [2]	-	D	96
Grassed Slopes	Good condition	B	61
Fallow Bare Soil	-	B	86

Notes.
1: CNs of 60 and 79 for the Wooded drainage areas were selected from HydroCAD^{TM}.
2: CN of 96 for gravel pad surfaces, including roads without right of way, was selected from HydroCAD^{TM}.

- Times of Concentration: **Table 2** presents the characteristics of the flow paths used to calculate the TOCs for the drainage areas. Computations for travel time for sheet flow are performed using the equation for Manning's kinematic solution [SCS, 1986]:

$$T_t = \frac{0.007(nL)^{0.8}}{P^{0.5}S^{0.4}} \qquad (1)$$

where:

T_t = travel time (hr);
n = Manning's roughness coefficient for sheet flow equal to 0.011 for "Smooth surfaces" for bare soils, gravel laydown areas, and road aggregate surfaces, 0.150 for "Grass: Short" for grassed slopes, and [SCS, 1986]. For the northern drainage areas, site-specific Manning's roughness coefficients were chosen based on previous modeling efforts (ranging from 0.291-0.351);
L = flow length (ft);
P = 2-yr, 24-hr rainfall depth (in.); and
S = land slope (ft/ft).

After a maximum of 100 ft, sheet flow is assumed to become shallow concentrated flow (i.e., upland flow). Travel times for shallow concentrated flow were estimated from TR-55 [SCS, 1986] as follows:

$$T_t = \frac{L}{3600V} \qquad (2)$$

$$V = KS^{0.5} \qquad (3)$$

where:

T_t = travel time (hr);
L = flow length (ft);
V = average velocity (ft/second, or fps);
K = velocity factor (fps) equal to 20.3 for gravel laydown areas and road aggregate surfaces. For bare soil, a velocity factor of 10.0 was used and for woodland conditions, a velocity factor of 5.0 was used [SCS, 1986]; and
S = land slope (ft/ft).

A minimum TOC of 6 minutes was applied for drainage areas where the calculated TOC was less than 6 minutes, based on recommendations from TR-55 [SCS, 1986].

COMPUTATIONS

Temporary Drainage Channels

The locations of temporary drainage channels are depicted in **Figure 2** for the post-closure condition. **Table 3** presents the temporary drainage channel characteristics.

The temporary drainage channels were generally designed with trapezoidal cross-sections with bottom widths ranging from 3 ft to 4 ft, 3H:1V side slopes, and longitudinal slopes ranging from of 4% to 15%. The channels were designed as riprap channels with a minimum depth of 2.5 ft.

Riprap lining and sizing for the temporary drainage channels were designed using the Erosion and Sediment Control Manual [GSWCC, 2016] Appendix C and the Georgia Drainage Manual [GDOT, 2016], Section 5.4.2 which references the Federal Highway Administration's HEC15 procedure [USDOT, 2005].

Equations from Chapter 6 of HEC15 [USDOT, 2005] were used to estimate the Manning's roughness coefficient for each temporary drainage channel. The HEC15 method requires an iterative process assuming a flow depth and Manning's roughness coefficient. By adjusting the flow depth and solving for Manning's roughness coefficient values, the iterative process determines the design specific Manning's roughness coefficient values for each temporary drainage channel and results are presented in **Table 3**.

The permissible shear stress for the proposed channel lining was estimated and compared to the shear forces exerted by the design flow event to check the stability of the proposed channel linings using Equations 7, 8, and 9.

Reynolds number is defined as:

$$R_e = \frac{V_* * D_{50}}{\nu} \qquad \text{(7) (HEC15 Eq. 6.9)}$$

$$V_* = \sqrt{g * d * S} \qquad \text{(8) (HEC15 Eq. 6.10)}$$

Where R_e = particle Reynolds number (dimensionless)

V_* = shear velocity (ft/s)

D_{50} = average riprap diameter (ft)

ν = kinematic viscosity, 1.217×10^{-5} at 60 °F

Shear velocity is defined as:

$$V_* = \sqrt{g * d * S}$$ (9) (HEC15 Eq. 6.10)

Where V_* = shear velocity (ft/s)
g = gravitational acceleration (32.2 ft/s^2)
d = maximum channel depth (ft)
S = channel slope (ft/ft)

Shield's parameter (F*) used in Equation 10 was estimated using the table below (HEC15 Table 6.1) and Equations 7 and 8, which relates Reynolds number (R_e) and factor of safety to Shield's parameter. A factor of safety of 1.2 was applied to the minimum riprap size based on the calculated flow parameters and recommendations included in HEC15.

HEC15 Table 6.1 Shield's Parameter

R_e	F*	SF
$\leq 4x10^4$	0.047	1
$4x10^4$<Re<$2x10^5$	Linear interpolation	1.2
$\geq 2x10^5$	0.15	1.5

Permissible shear stress as a function of mean riprap size (D_{50}) is defined as:

$$D_{50} \geq \frac{SF*d*S}{F^{*}*(SG-1)}$$ (10) (HEC15 Eq. 6.8)

Where SF = safety factor, 1.2
d = maximum channel depth (ft)
SG = specific gravity of rock (dimensionless)
S = average channel gradient (ft/ft)
F* = Shield's parameter

The resulting minimum D_{50} riprap size for each temporary drainage channel is presented in **Table 5** and example calculations are presented in Attachment 5. The D_{50} riprap size is then compared to the GDOT average sizes to determine the GDOT Gradation type [GSWCC, 2016].

The GDOT classification system for riprap gradation types are as follows:

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Gradation	GDOT Riprap Size (inches)	
	Type 1	Type 3
Min	7	5
Avg (D_{50})	12	9
Max	24	12

Temporary Drainage Channels Outlet Protection

Riprap outlet protection was designed to prevent erosion downstream of the temporary drainage channels. Outlet protection was generally designed as riprap aprons in accordance with guidance provided for rock outlet protection in the GSWCC. The aprons widths were sized to extend across the temporary drainage channel bottom and up the channel banks to an elevation one foot above the maximum flow depth.

RESULTS

Temporary Drainage Channels

Calculations and modeling results for the 25-yr, 24-hr design storm event for the temporary drainage channels are presented in Attachment 4. **Table 4** presents the hydraulic calculations, and that the calculated freeboard depths are greater than 0.5 ft for the 25-yr, 24-hr storm event.

Table 5 presents the characteristics for the lining of the temporary drainage channels. The roughness coefficient for the channels (GDOT Type 1 and 3 riprap) ranged from 0.048 to 0.074.

Temporary Drainage Channels Outlet Protection

Table 5 also provides a summary of the results of computations for outlet protection riprap width, minimum median stone size (d_{50}) and corresponding riprap type, thickness, and length required for the 25-yr, 24-hr storm event. Annotated figures provided by the GSWCC for the determination of apron length and d_{50} are provided in Attachment 6. The minimum riprap apron lengths for temporary drainage channels ranged from 10 to 30 ft and with GDOT Type 1 and 3 riprap.

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SUMMARY AND CONCLUSIONS

The post-development surface water management system analyzed as part of the CCR permit submittal for Plant Wansley activities consists of temporary drainage channels. The system was designed to meet design criteria developed from the Manual for Erosion and Sediment Control in Georgia (Green Book), the GDOT Drainage Design for Highways, and other accepted engineering practices. In general, the surface water management system was designed for the collection and conveyance of flows from the 25-yr, 24-hr storm event with 0.5 ft of freeboard. Based on the calculations and modeling results, the temporary drainage channel designs comply with the required design criteria.

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FIGURES

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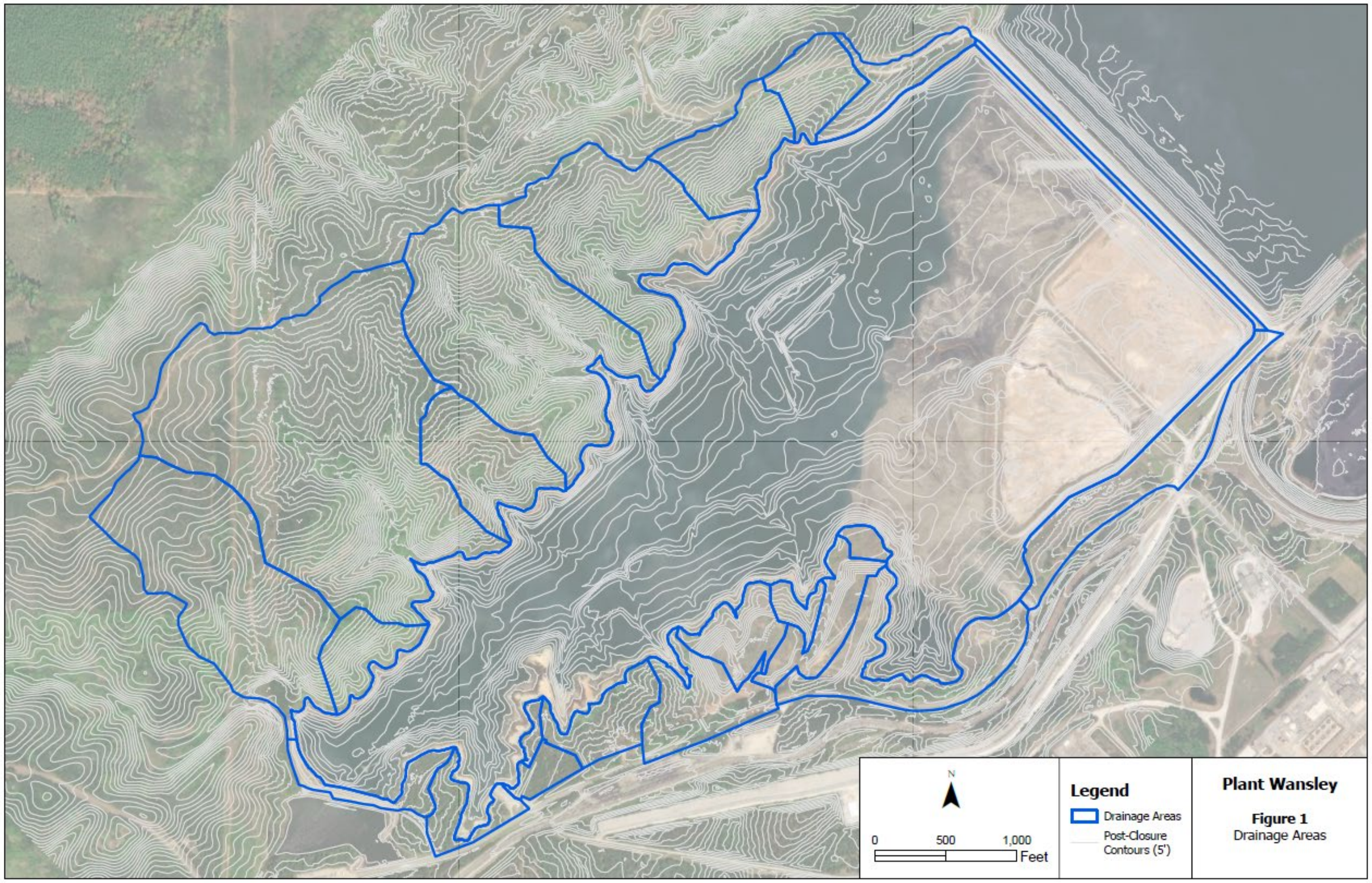

Figure 1. Drainage Areas

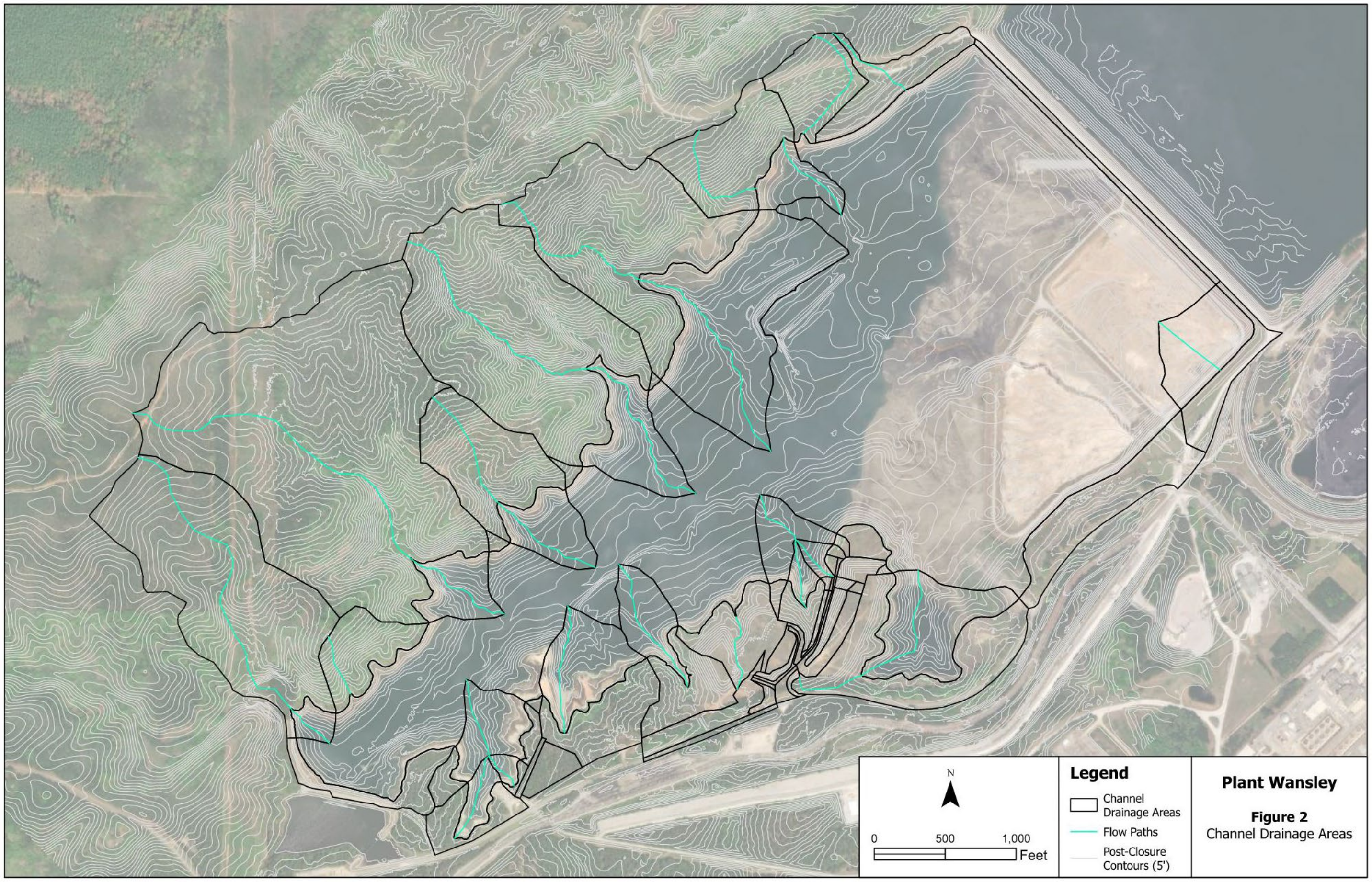

Figure 2. Channel Drainage Areas

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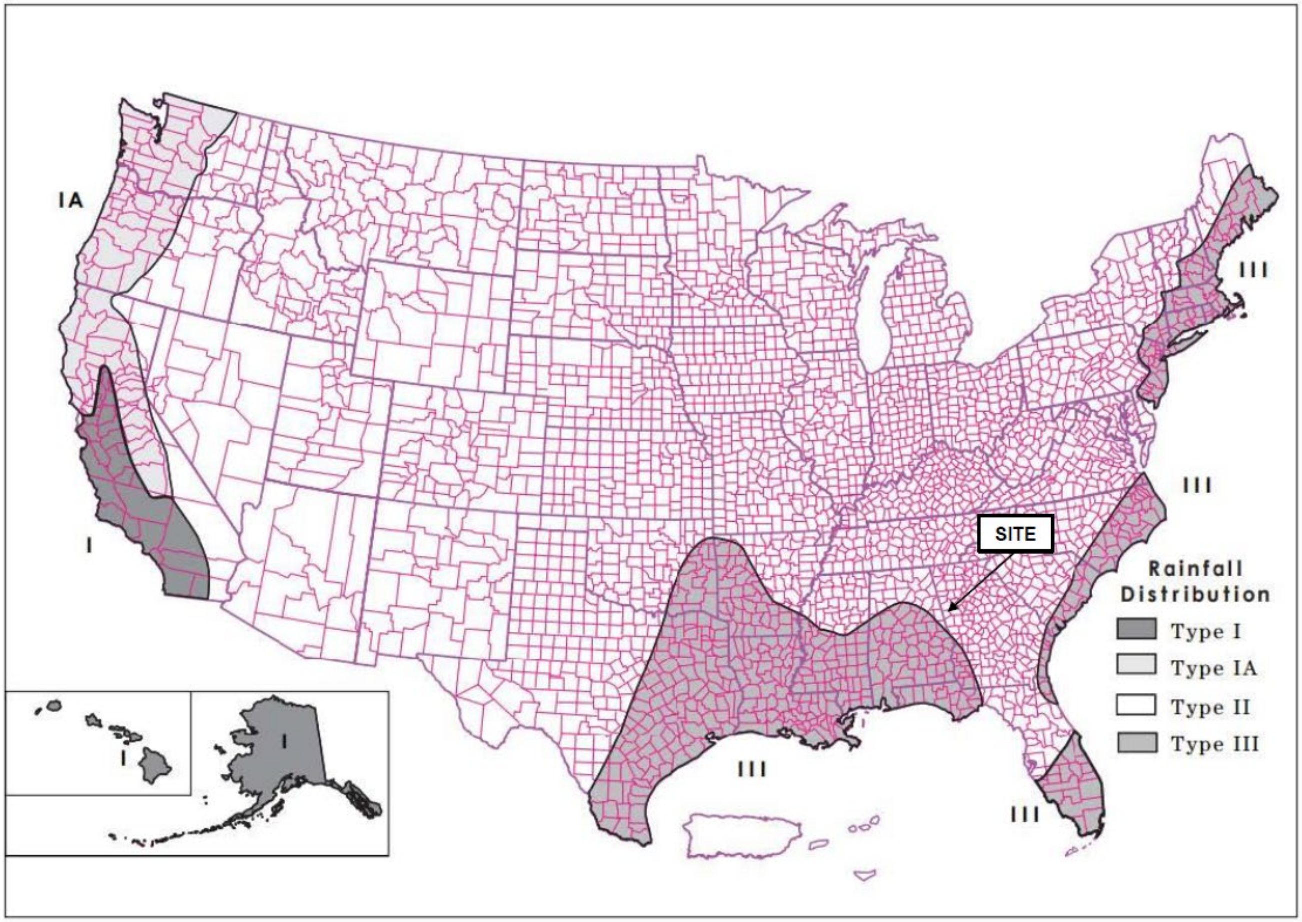

Figure 3. Rainfall Distribution

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TABLES

Table 1. Post-Closure Condition Subcatchment Drainage Areas and Curve Numbers (CN)

Subcatchment ID	Area (acres)	Total Area (%)	Total Area (acres)	Land Use Description	CN	Weighted CN
S-200	1.86	67%	2.76	Aggregate	96	85
	0.90	33%		Grassed Slope	61	
S-202	0.17	45%	0.39	Aggregate	96	77
	0.21	55%		Grassed Slope	61	
S-203	0.42	57%	0.74	Aggregate	96	81
	0.32	43%		Grassed Slope	61	
S-204	0.10	20%	0.49	Aggregate	96	68
	0.39	80%		Grassed Slope	61	
S-206	0.04	27%	0.15	Aggregate	96	70
	0.11	73%		Grassed Slope	61	
S-207	1.90	84%	2.27	Aggregate	96	90
	0.37	16%		Grassed Slope	61	
S-209 and S-201	0.98	100%	0.98	Grassed Slope	61	61
S-208	1.05	73%	1.43	Aggregate	96	87
	0.38	27%		Grassed Slope	61	
S-Roadside	0.77	19%	4.01	Aggregate	96	68
	3.23	81%		Grassed Slope	61	
14S	3.35	62%	5.38	Woods	60	70
	2.03	38%		Bare Soil	86	
13S	0.30	28%	1.06	Woods	60	79
	0.76	72%		Bare Soil	86	
1314S	0.82	11%	7.36	Woods	60	79
	1.20	16%		Woods	60	
	5.34	73%		Bare Soil	86	
12S	6.98	47%	14.89	Woods	60	74
	7.91	53%		Bare Soil	86	
11S	5.65	54%	10.51	Woods	60	72
	4.86	46%		Bare Soil	86	
10S	2.15	65%	3.33	Woods	60	69
	1.18	35%		Bare Soil	86	
9S	0.19	14%	1.31	Woods	60	78
	0.19	15%		Woods	60	
	0.93	71%		Bare Soil	86	
1N	36.43	96%	37.96	Woods	79	79
	1.52	4%		Bare Soil	86	
2N	79.40	94%	84.34	Woods	60	62
	4.94	6%		Bare Soil	86	
3N	12.93	70%	18.53	Woods	60	68
	5.59	30%		Bare Soil	86	
4N	42.54	84%	50.58	Woods	60	64
	8.05	16%		Bare Soil	86	
5N	29.50	54%	54.42	Woods	60	72
	24.92	46%		Bare Soil	86	
6N	11.31	74%	15.32	Woods	60	67
	4.00	26%		Bare Soil	86	
7S	7.69	100%	7.69	Bare Soil	86	86
8S	11.39	52%	21.93	Grassed Slope	61	73
	10.54	48%		Bare Soil	86	
910S	0.24	6%	4.18	Woods	60	85
	3.94	94%		Bare Soil	86	

See Figure 1 for drainage areas.

Table 2. Subcatchment Times of Concentration

Subcatchment ID	Land Designation	Sheet Flow Path (ft)	Shallow Concentrated Flow Path (ft)	Slope (sheet)	Slope (shallow)
S-200	Direct Entry = 6 minutes (1)				
S-202	Direct Entry = 6 minutes (1)				
S-203	Direct Entry = 6 minutes (1)				
S-204	Direct Entry = 6 minutes (1)				
S-206	Direct Entry = 6 minutes (1)				
S-207	Direct Entry = 6 minutes (1)				
S-209 and S-201	Direct Entry = 6 minutes (1)				
S-208	Direct Entry = 6 minutes (1)				
S-Roadside	Direct Entry = 6 minutes (1)				
14S	Woods	100	135	0.070	0.111
	Bare Soil	-	658	-	0.040
13S	Woods	100	-	0.120	-
	Bare Soil	-	295	-	0.068
1314S	Woods	100	38.381994	0.090	0.078
	Woods	100	146.862302	0.030	0.082
	Bare Soil	-	568	-	0.046
12S	Woods	100	378	0.040	0.079
	Bare Soil	-	928	-	0.047
11S	Woods	100	364	0.050	0.102
	Bare Soil	-	1036	-	0.037
10S	Woods	100	223	0.120	0.135
	Bare Soil	-	503	-	0.075
9S	Woods	100	-	0.020	-
	Woods	100	-	0.020	-
	Bare Soil	-	380	-	0.092
1N	Woods	100	2240	0.060	0.070
	Bare Soil		375	-	0.104
2N	Woods	100	2440	0.050	0.064
	Bare Soil	-	849	-	0.064
3N	Woods	100	794	0.040	0.141
	Bare Soil	-	865	-	0.067
4N	Woods	100	1674	0.100	0.091
	Bare Soil	-	1363	-	0.050
5N	Woods	100	1239	0.030	0.111
	Bare Soil	-	1705	-	0.046
6N	Woods	100	735	0.050	0.129
	Bare Soil	-	718	-	0.072
7S	Direct Entry = 6 minutes (1)				
8S	Grassed Slope	100	429	0.200	0.077
	Bare Soil		891		0.040
910S	Woods	100	-	0.020	-
	Bare Soil		435		0.083

Notes:
1. A minimum time of concentration of 6 minutes was selected for subcatchments where the calculated time of concentration was less than 6 minutes, based on recommendations from TR-55 [1986].
2. See Figure 1 for drainage areas.

Table 3. Temporary Channel Design Summary

Channel ID	Channel Characteristics									
	Section Shape	Minimum Channel Depth (ft)	Start Invert Elevation (ft)	End Invert Elevation (ft)	Length (ft)	Longitudinal Slope (ft/ft)	Manning's n(1)	Minimum Bottom Width (ft)	Side Slope M_1:1	Side Slope M_2:1
CH-01	Trapezoidal	2.5	800.0	755.0	455	0.099	0.048	3.0	3.0	3.0
CH-02	Trapezoidal	3.0	800.0	734.0	923	0.072	0.050	4.0	3.0	3.0
CH-03	Trapezoidal	2.5	800.0	729.0	941	0.075	0.058	3.0	3.0	3.0
CH-04	Trapezoidal	3.0	800.0	720.0	1,425	0.056	0.053	4.0	3.0	3.0
CH-05	Trapezoidal	3.0	800.0	718.0	1,795	0.046	0.076	4.0	3.0	3.0
CH-06	Trapezoidal	2.5	798.0	746.0	718	0.072	0.057	3.0	3.0	3.0
CH-07	Trapezoidal	3.0	810.0	728.0	553	0.148	0.049	3.0	3.0	3.0
CH-08	Trapezoidal	3.0	780.0	744.0	891	0.040	0.078	3.0	3.0	3.0
CH-09	Trapezoidal	3.0	800.0	760.0	525	0.076	0.058	3.0	3.0	3.0
CH-10	Trapezoidal	2.0	800.0	760.0	667	0.060	0.074	3.0	3.0	3.0
CH-09_10	Trapezoidal	2.5	760.0	724.0	435	0.083	0.054	3.0	3.0	3.0
CH-11	Trapezoidal	2.5	800.0	727.0	1,050	0.070	0.055	3.0	3.0	3.0
CH-12	Trapezoidal	2.5	800.0	731.0	995	0.069	0.056	3.0	3.0	3.0
CH-13	Trapezoidal	2.5	800.0	766.0	285	0.119	0.058	3.0	3.0	3.0
CH-14	Trapezoidal	2.0	780.0	766.0	658	0.021	0.076	3.0	3.0	3.0
CH-13_14	Trapezoidal	2.5	766.0	741.0	568	0.044	0.058	3.0	3.0	3.0

Notes:
1. Calculations for Manning's n are shown in Table 5.

Table 4. Post-Closure Condition Channel Hydraulic Results

Channel ID	Hydraulic Calculations - 25-yr, 24-hr			
	Peak Inflow Rate (cfs)	Peak flow Depth (ft)	Peak Flow Velocity (fps)	Channel Freeboard (ft)
CH-01	103	1.5	9.1	1.0
CH-02	111	1.7	7.5	1.3
CH-03	43	1.1	6.3	1.4
CH-04	89	1.6	6.5	1.5
CH-05	123	2.2	5.0	0.8
CH-06	41	1.1	5.6	1.4
CH-07	61	1.1	9.0	1.9
CH-08	97	2.2	4.4	0.8
CH-09	33	1.0	5.3	2.0
CH-10	13	0.7	3.7	1.3
CH-09_10	58	1.3	6.7	1.2
CH-11	53	1.3	6.0	1.2
CH-12	49	1.2	5.8	1.3
CH-13	21	0.7	5.5	1.8
CH-14	19	1.2	2.4	0.8
CH-13_14	52	1.4	4.9	1.1

Table 5. Riprap Channel Lining Results

	Channel Characteristics		25-yr, 24-hr Hydraulic Calculations for Channel Lining									Outlet Protection Design						
CHANNEL ID	Minimum Bottom Width (ft)	Side Slope (H:V)	Peak Flow Depth (ft)	Peak Velocity (ft/s)	Minimum d50 (in)	d50 Used (in)	Shear Velocity (ft/s)	Maximum Stone Size (in)	Manning's Roughness Coefficient	Minimum Required Thickness (in)	GDOT Type	Upstream Apron Width (ft)	Upstream Apron Width (ft)	Apron Length (ft)	d50 (Calculated) (in.)	d50 (Used) (in.)	dmax (in.)	Riprap Thickness (in.)
CH-01	3.0	3.0	1.5	9.1	12.0	12.0	2.20	24	0.048	36	GDOT Type 1 Rip Rap	13	13	30	12	12	24	36.0
CH-02	4.0	3.0	1.7	7.5	10.7	12.0	1.91	24	0.050	36	GDOT Type 1 Rip Rap	14	14	30	12	12	24	36.0
CH-03	3.0	3.0	1.1	6.3	8.0	9.0	1.67	12	0.058	18	GDOT Type 3 Rip Rap	10	10	30	12	12	24	36.0
CH-04	4.0	3.0	1.6	6.5	8.6	9.0	1.68	12	0.053	18	GDOT Type 3 Rip Rap	14	14	30	12	12	24	36.0
CH-05	4.0	3.0	2.2	5.0	9.5	12.0	1.82	24	0.076	36	GDOT Type 1 Rip Rap	18	18	30	12	12	24	36.0
CH-06	3.0	3.0	1.1	5.6	8.4	9.0	1.63	12	0.057	18	GDOT Type 3 Rip Rap	10	10	30	12	12	24	36.0
CH-07	3.0	3.0	1.1	9.0	12.5	16.0	2.26	24	0.049	36	GDOT Type 3 Rip Rap	10	10	30	12	12	24	36.0
CH-08	3.0	3.0	2.2	4.4	8.7	9.0	1.70	12	0.078	18	GDOT Type 3 Rip Rap	17	17	30	12	12	24	36.0
CH-09 (1)	3.0	3.0	1.0	5.3	8.0	9.0	1.59	12	0.058	18	GDOT Type 3 Rip Rap	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CH-10 (1)	3.0	3.0	0.7	3.7	4.9	9.0	1.22	12	0.074	18	GDOT Type 3 Rip Rap	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CH-09_10	3.0	3.0	1.3	6.7	9.7	12.0	1.83	24	0.054	36	GDOT Type 1 Rip Rap	11	11	30	12	12	24	36.0
CH-11	3.0	3.0	1.3	6.0	8.6	9.0	1.69	12	0.055	18	GDOT Type 3 Rip Rap	11	11	30	12	12	24	36.0
CH-12	3.0	3.0	1.2	5.8	8.5	9.0	1.66	12	0.056	18	GDOT Type 3 Rip Rap	11	11	30	12	12	24	36.0
CH-13 (1)	3.0	3.0	0.7	5.5	8.6	9.0	1.67	12	0.058	18	GDOT Type 3 Rip Rap	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CH-14 (1)	3.0	3.0	1.2	2.4	3.8	9.0	0.91	12	0.076	18	GDOT Type 3 Rip Rap	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CH-13_14	3.0	3.0	1.4	4.9	7.0	9.0	1.43	12	0.058	18	GDOT Type 3 Rip Rap	12	12	30	12	12	24	36.0

Notes:

1. Outlet protection not shown for the channel as it has a downstream connected channel with rip rap apron

ATTACHMENTS

ATTACHMENT 1

NOAA PRECIPITATION DATA

NOAA Atlas 14, Volume 9, Version 2
Location name: Franklin, Georgia, USA*
Latitude: 33.4147°, Longitude: -85.0453°
Elevation: 811.48 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.400** (0.329-0.490)	**0.459** (0.377-0.562)	**0.559** (0.458-0.687)	**0.646** (0.527-0.796)	**0.772** (0.611-0.975)	**0.873** (0.675-1.11)	**0.977** (0.731-1.26)	**1.09** (0.781-1.43)	**1.24** (0.856-1.66)	**1.36** (0.914-1.84)
10-min	**0.586** (0.482-0.717)	**0.672** (0.553-0.824)	**0.819** (0.671-1.00)	**0.947** (0.771-1.17)	**1.13** (0.895-1.43)	**1.28** (0.988-1.63)	**1.43** (1.07-1.85)	**1.59** (1.14-2.10)	**1.82** (1.25-2.43)	**1.99** (1.34-2.69)
15-min	**0.715** (0.588-0.875)	**0.820** (0.674-1.00)	**0.999** (0.819-1.23)	**1.15** (0.941-1.42)	**1.38** (1.09-1.74)	**1.56** (1.21-1.98)	**1.75** (1.31-2.26)	**1.94** (1.39-2.56)	**2.21** (1.53-2.97)	**2.43** (1.63-3.28)
30-min	**1.04** (0.857-1.27)	**1.20** (0.984-1.47)	**1.46** (1.20-1.79)	**1.69** (1.38-2.08)	**2.02** (1.60-2.55)	**2.28** (1.77-2.91)	**2.56** (1.91-3.31)	**2.85** (2.04-3.75)	**3.24** (2.24-4.35)	**3.56** (2.39-4.81)
60-min	**1.37** (1.13-1.68)	**1.57** (1.29-1.93)	**1.92** (1.57-2.36)	**2.23** (1.82-2.74)	**2.68** (2.13-3.40)	**3.05** (2.36-3.90)	**3.45** (2.58-4.47)	**3.86** (2.78-5.10)	**4.45** (3.08-5.97)	**4.91** (3.30-6.64)
2-hr	**1.70** (1.41-2.06)	**1.95** (1.61-2.36)	**2.38** (1.97-2.89)	**2.77** (2.28-3.37)	**3.35** (2.69-4.21)	**3.82** (3.00-4.84)	**4.33** (3.28-5.58)	**4.88** (3.55-6.39)	**5.65** (3.96-7.53)	**6.26** (4.27-8.39)
3-hr	**1.92** (1.60-2.31)	**2.19** (1.82-2.64)	**2.67** (2.22-3.22)	**3.11** (2.57-3.76)	**3.76** (3.05-4.72)	**4.32** (3.41-5.44)	**4.91** (3.75-6.29)	**5.55** (4.07-7.24)	**6.45** (4.56-8.57)	**7.18** (4.93-9.58)
6-hr	**2.36** (1.99-2.81)	**2.67** (2.25-3.19)	**3.23** (2.71-3.86)	**3.74** (3.13-4.49)	**4.52** (3.69-5.61)	**5.17** (4.12-6.46)	**5.87** (4.53-7.45)	**6.63** (4.92-8.57)	**7.70** (5.52-10.1)	**8.58** (5.97-11.3)
12-hr	**2.90** (2.47-3.42)	**3.27** (2.78-3.86)	**3.91** (3.31-4.63)	**4.49** (3.78-5.33)	**5.34** (4.40-6.55)	**6.05** (4.87-7.47)	**6.80** (5.31-8.54)	**7.61** (5.72-9.73)	**8.74** (6.33-11.4)	**9.65** (6.80-12.6)
24-hr	**3.45** (2.96-4.03)	**3.91** (3.36-4.58)	**4.70** (4.02-5.51)	**5.38** (4.58-6.32)	**6.35** (5.26-7.66)	**7.13** (5.78-8.67)	**7.93** (6.24-9.81)	**8.76** (6.64-11.1)	**9.90** (7.25-12.7)	**10.8** (7.71-14.0)
2-day	**3.97** (3.45-4.59)	**4.56** (3.95-5.28)	**5.53** (4.78-6.41)	**6.35** (5.46-7.38)	**7.48** (6.25-8.90)	**8.37** (6.85-10.0)	**9.26** (7.36-11.3)	**10.2** (7.80-12.7)	**11.4** (8.45-14.5)	**12.3** (8.94-15.9)
3-day	**4.38** (3.82-5.03)	**4.96** (4.32-5.71)	**5.95** (5.17-6.85)	**6.79** (5.87-7.85)	**7.99** (6.73-9.47)	**8.94** (7.38-10.7)	**9.91** (7.95-12.1)	**10.9** (8.45-13.6)	**12.3** (9.21-15.6)	**13.4** (9.78-17.1)
4-day	**4.71** (4.12-5.38)	**5.30** (4.63-6.06)	**6.30** (5.50-7.23)	**7.18** (6.23-8.25)	**8.44** (7.15-9.98)	**9.46** (7.85-11.3)	**10.5** (8.48-12.8)	**11.6** (9.06-14.4)	**13.2** (9.92-16.7)	**14.4** (10.6-18.3)
7-day	**5.49** (4.85-6.23)	**6.17** (5.44-7.00)	**7.34** (6.46-8.35)	**8.38** (7.33-9.55)	**9.89** (8.47-11.6)	**11.1** (9.33-13.2)	**12.4** (10.1-15.0)	**13.8** (10.9-17.0)	**15.7** (12.0-19.7)	**17.2** (12.8-21.8)
10-day	**6.20** (5.50-7.00)	**6.96** (6.17-7.85)	**8.26** (7.30-9.34)	**9.41** (8.28-10.7)	**11.1** (9.55-13.0)	**12.5** (10.5-14.7)	**13.9** (11.4-16.7)	**15.4** (12.2-18.9)	**17.5** (13.4-21.9)	**19.2** (14.4-24.2)
20-day	**8.41** (7.54-9.39)	**9.29** (8.32-10.4)	**10.8** (9.63-12.1)	**12.1** (10.7-13.6)	**13.9** (12.1-16.1)	**15.4** (13.2-18.0)	**17.0** (14.1-20.1)	**18.6** (14.9-22.5)	**20.9** (16.2-25.8)	**22.6** (17.2-28.2)
30-day	**10.4** (9.34-11.5)	**11.4** (10.2-12.6)	**13.0** (11.7-14.5)	**14.4** (12.9-16.1)	**16.4** (14.3-18.7)	**18.0** (15.4-20.7)	**19.6** (16.3-23.0)	**21.2** (17.1-25.4)	**23.4** (18.3-28.7)	**25.1** (19.2-31.1)
45-day	**12.9** (11.7-14.2)	**14.1** (12.8-15.6)	**16.1** (14.6-17.8)	**17.7** (16.0-19.7)	**19.9** (17.5-22.5)	**21.6** (18.6-24.7)	**23.2** (19.5-27.0)	**24.9** (20.2-29.6)	**27.0** (21.2-32.8)	**28.5** (22.0-35.2)
60-day	**15.1** (13.7-16.5)	**16.6** (15.1-18.2)	**18.9** (17.2-20.8)	**20.8** (18.8-22.9)	**23.3** (20.4-26.0)	**25.0** (21.6-28.4)	**26.7** (22.5-30.9)	**28.4** (23.1-33.5)	**30.4** (24.1-36.7)	**31.8** (24.8-39.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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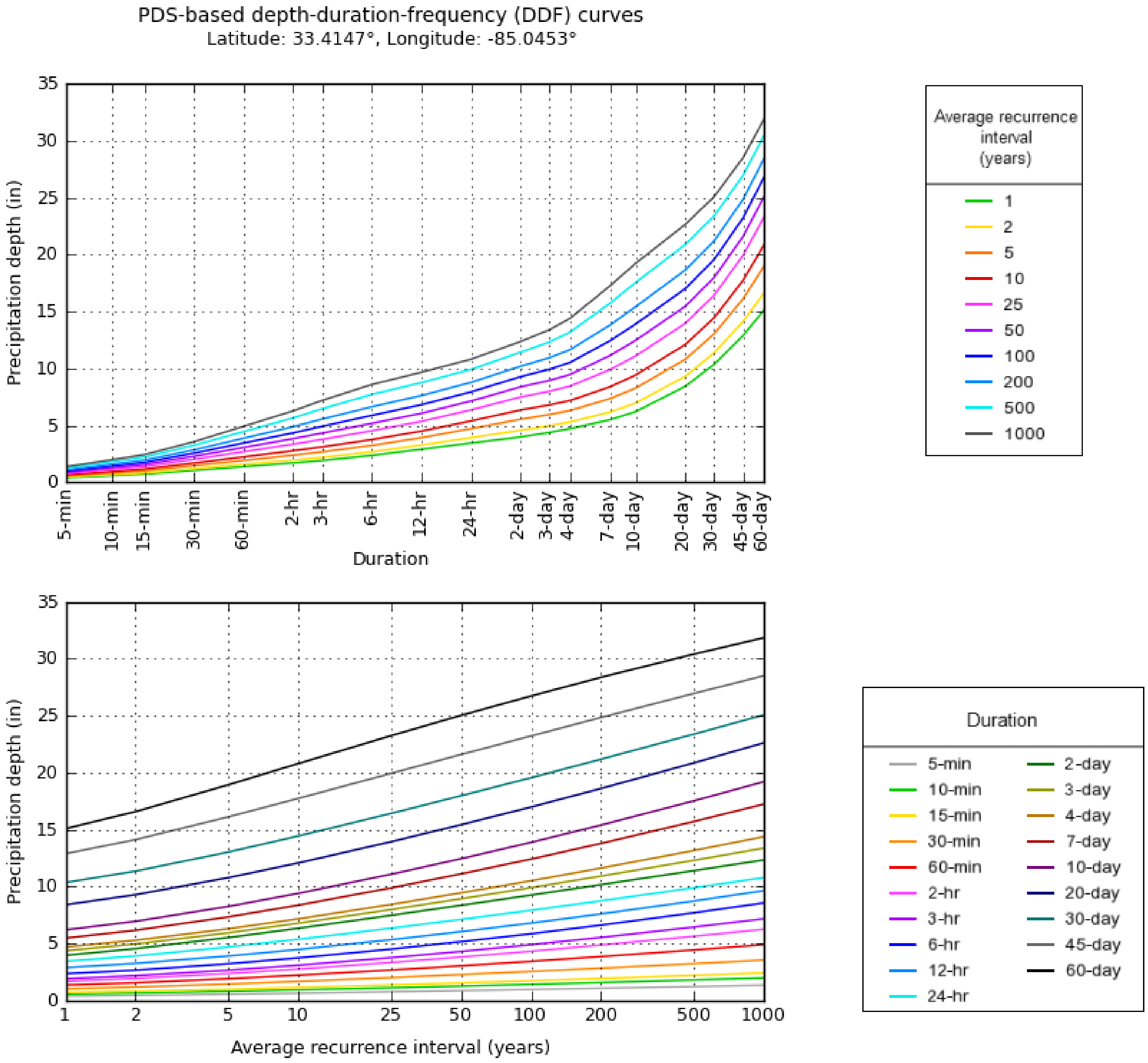
PF graphical



NOAA Atlas 14, Volume 9, Version 2 Created (GMT): Tue Nov 14 22:01:07 2017

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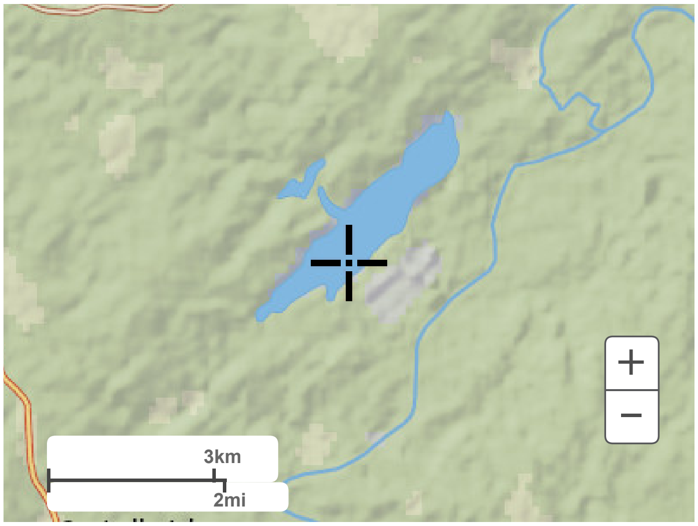
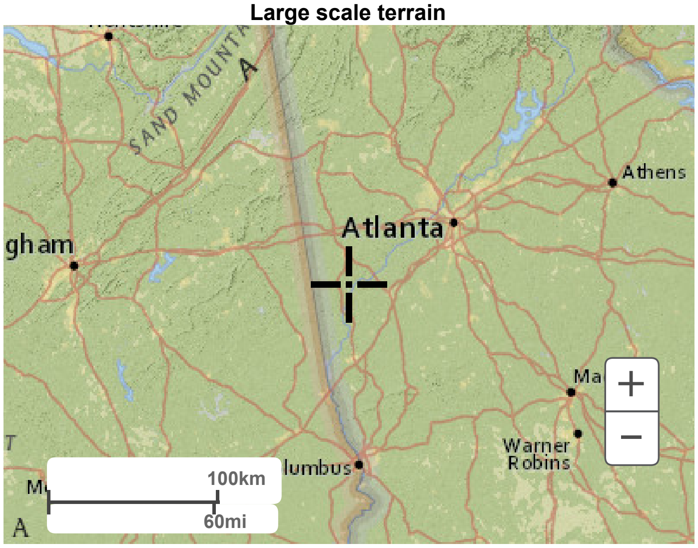
Maps & aerials

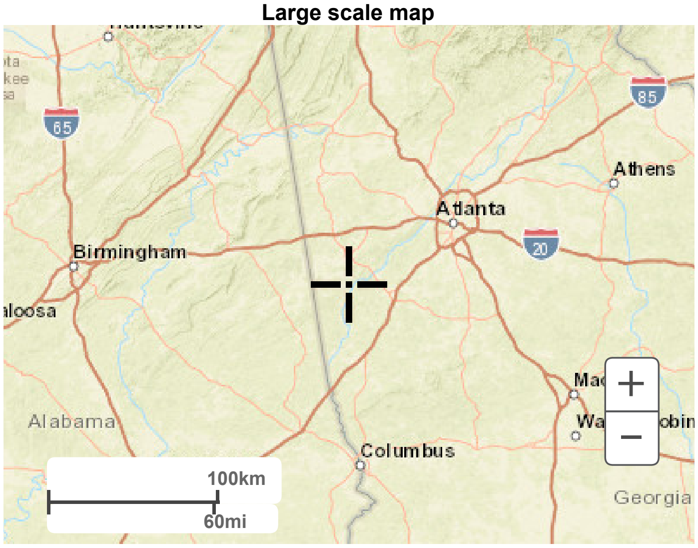
Small scale terrain



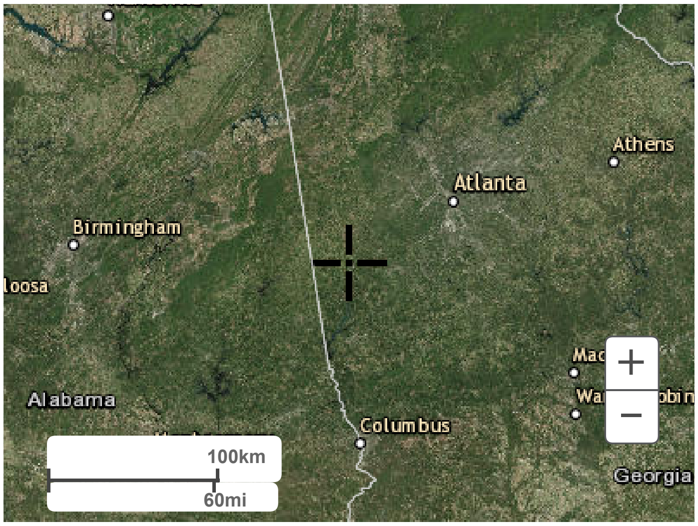
Large scale terrain



Large scale map



Large scale aerial



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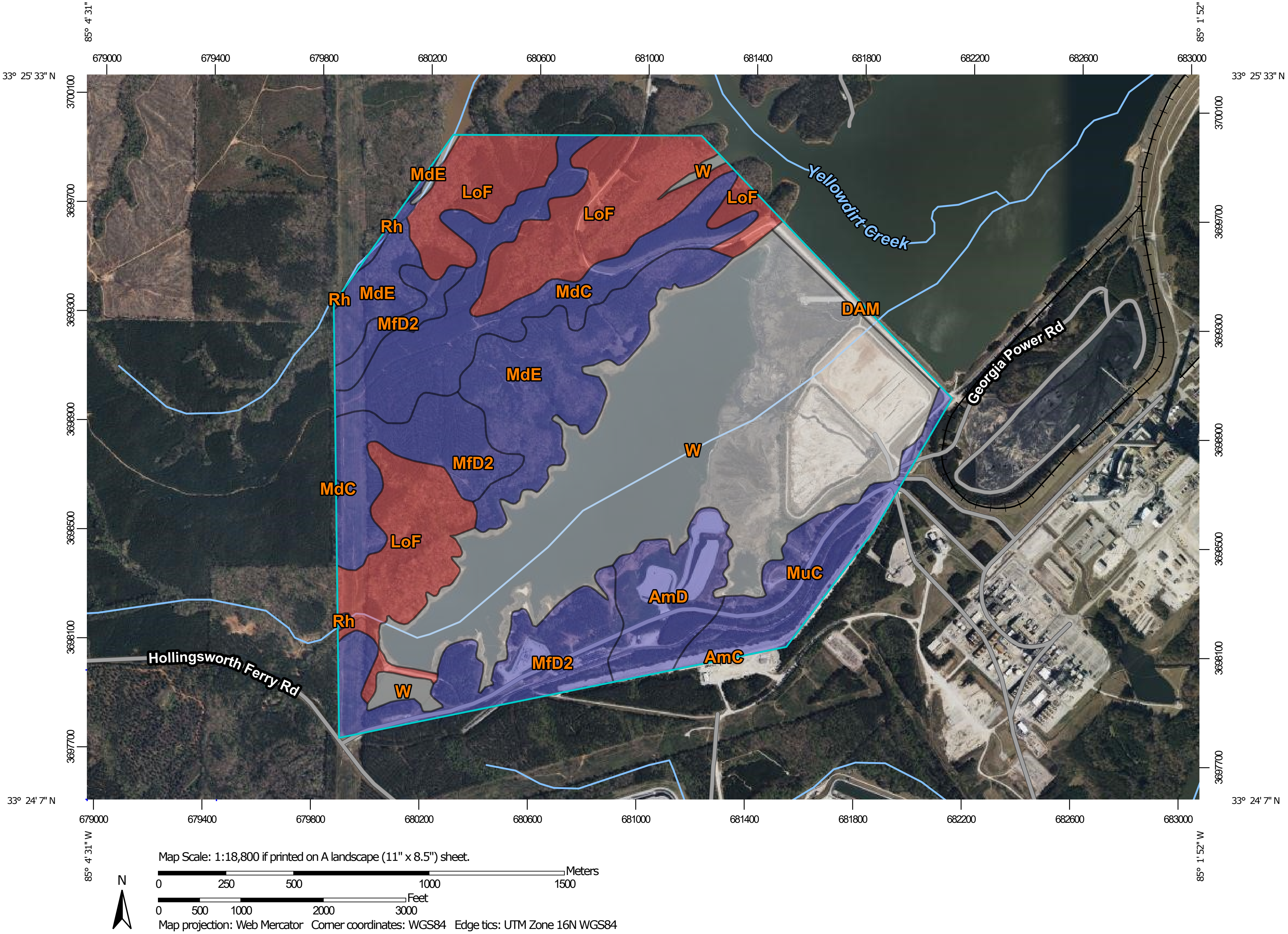
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

ATTACHMENT 2

NRCS WSS SOIL MAP AND SOIL DESCRIPTIONS

Hydrologic Soil Group—Coweta, Heard, and Troup Counties, Georgia



Map Scale: 1:18,800 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

▭ Area of Interest (AOI)

Soils

Soil Rating Polygons

🟪 A

🟩 A/D

🟦 B

🟫 B/D

🟦 C

🟨 C/D

🟥 D

⬜ Not rated or not available

Soil Rating Lines

〰 A

〰 A/D

〰 B

〰 B/D

〰 C

〰 C/D

〰 D

〰 Not rated or not available

Soil Rating Points

■ A

■ A/D

■ B

■ B/D

■ C

■ C/D

■ D

□ Not rated or not available

Water Features

〰 Streams and Canals

Transportation

┼┼┼ Rails

〰 Interstate Highways

〰 US Routes

〰 Major Roads

〰 Local Roads

Background

▨ Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Coweta, Heard, and Troup Counties, Georgia
Survey Area Data: Version 17, Sep 14, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 10, 2022—Apr 20, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AmC	Appling sandy loam, 6 to 10 percent slopes	B	0.4	0.0%
AmD	Appling sandy loam, 10 to 15 percent slopes	B	44.6	4.9%
DAM	Dam		6.6	0.7%
LoF	Louisa gravelly fine sandy loam, 15 to 40 percent slopes	D	166.0	18.1%
MdC	Madison gravelly sandy loam, 6 to 10 percent slopes	B	84.1	9.2%
MdE	Madison gravelly sandy loam, 15 to 25 percent slopes	B	101.3	11.0%
MfD2	Madison gravelly sandy clay loam, 10 to 15 percent slopes, eroded	B	122.4	13.3%
MuC	Madison-Urban land complex, 2 to 10 percent slopes	B	48.8	5.3%
Rh	Riverview loam	B	2.8	0.3%
W	Water		340.8	37.1%
Totals for Area of Interest			**917.8**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

ATTACHMENT 3

TABLE 2-2 OF TR-55,
EXCERPT FROM FROM HYDROCAD^{TM}

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

---

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

---

[1] Average runoff condition, and I_a=0.2S

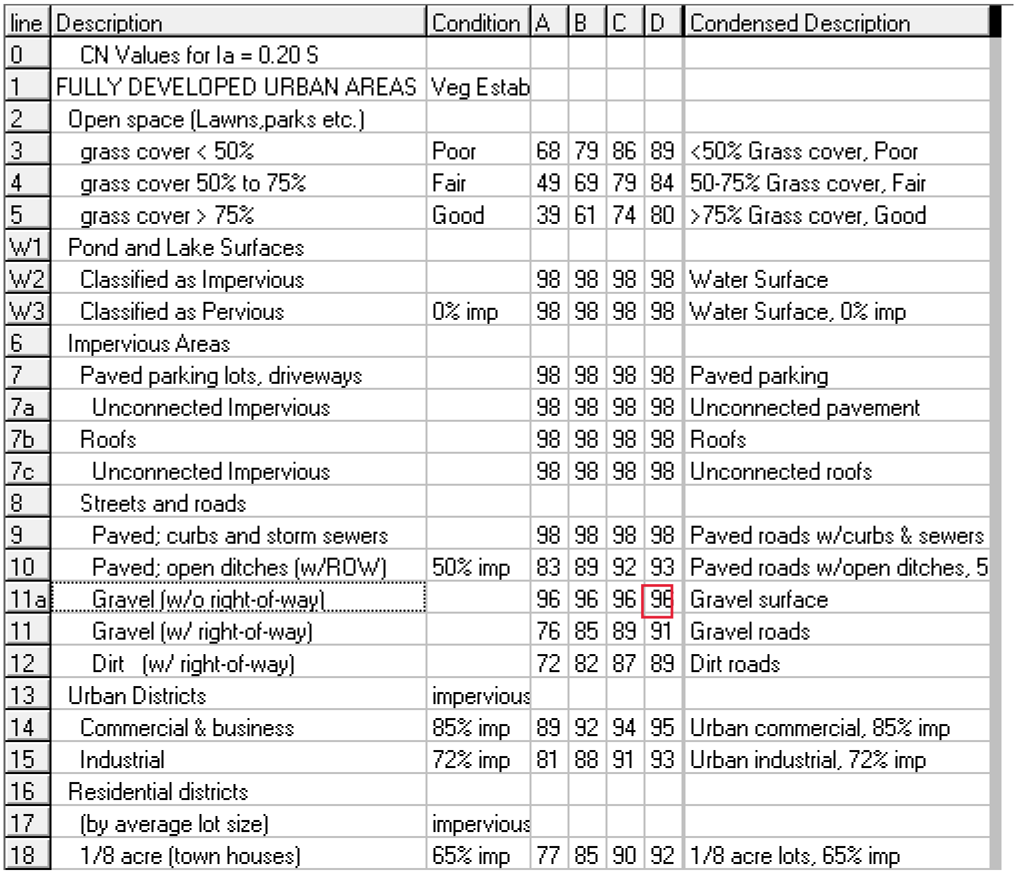
[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

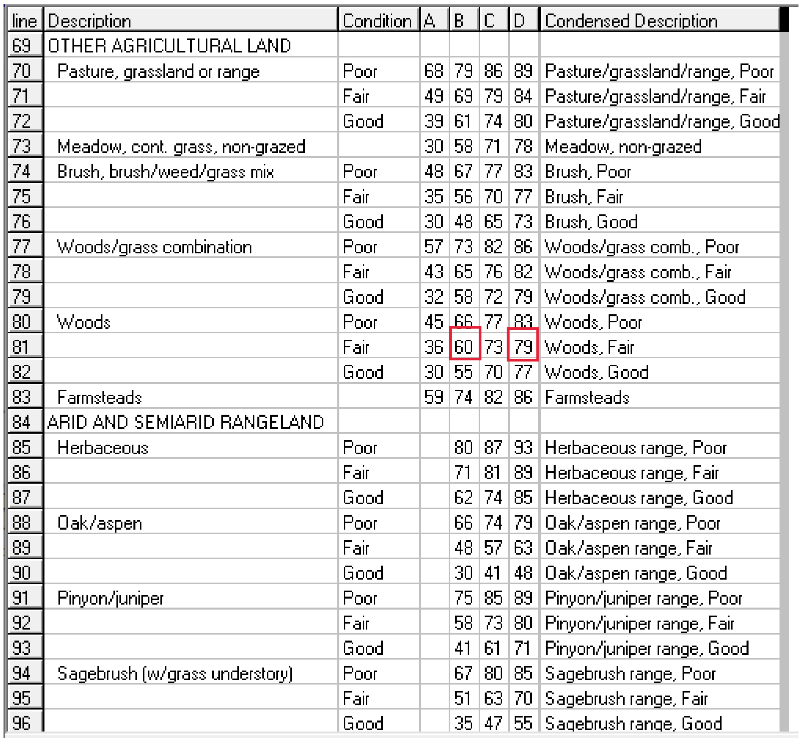
Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Curve Number Table Excerpt from HydroCad



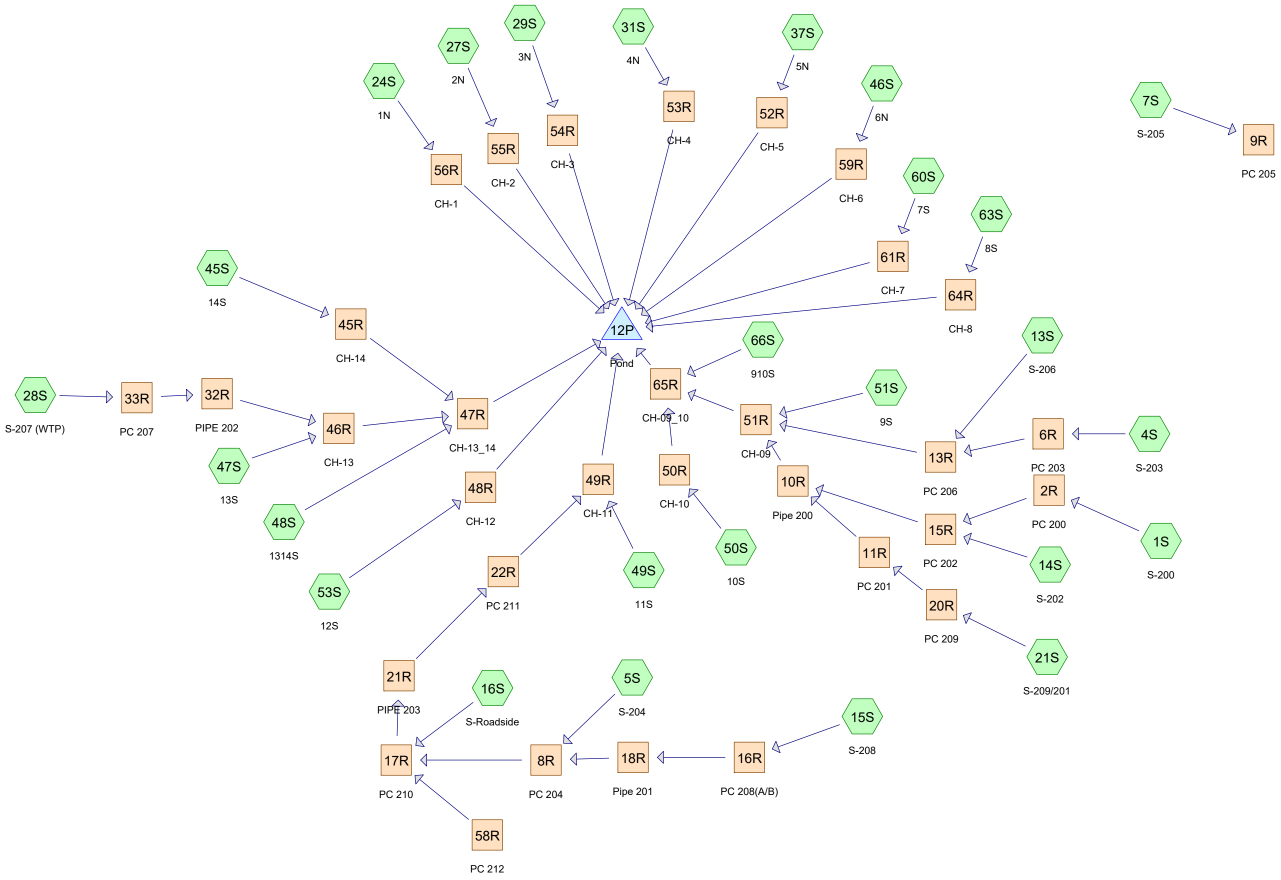
line	Description	Condition	A	B	C	D	Condensed Description
0	CN Values for Ia = 0.20 S						
1	FULLY DEVELOPED URBAN AREAS	Veg Estab					
2	Open space (Lawns,parks etc.)						
3	grass cover < 50%	Poor	68	79	86	89	<50% Grass cover, Poor
4	grass cover 50% to 75%	Fair	49	69	79	84	50-75% Grass cover, Fair
5	grass cover > 75%	Good	39	61	74	80	>75% Grass cover, Good
W1	Pond and Lake Surfaces						
W2	Classified as Impervious		98	98	98	98	Water Surface
W3	Classified as Pervious	0% imp	98	98	98	98	Water Surface, 0% imp
6	Impervious Areas						
7	Paved parking lots, driveways		98	98	98	98	Paved parking
7a	Unconnected Impervious		98	98	98	98	Unconnected pavement
7b	Roofs		98	98	98	98	Roofs
7c	Unconnected Impervious		98	98	98	98	Unconnected roofs
8	Streets and roads						
9	Paved; curbs and storm sewers		98	98	98	98	Paved roads w/curbs & sewers
10	Paved; open ditches (w/ROW)	50% imp	83	89	92	93	Paved roads w/open ditches, 5
11a	Gravel (w/o right-of-way)		96	96	96	96	Gravel surface
11	Gravel (w/ right-of-way)		76	85	89	91	Gravel roads
12	Dirt (w/ right-of-way)		72	82	87	89	Dirt roads
13	Urban Districts	impervious					
14	Commercial & business	85% imp	89	92	94	95	Urban commercial, 85% imp
15	Industrial	72% imp	81	88	91	93	Urban industrial, 72% imp
16	Residential districts						
17	(by average lot size)	impervious					
18	1/8 acre (town houses)	65% imp	77	85	90	92	1/8 acre lots, 65% imp

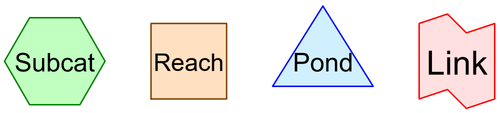


line	Description	Condition	A	B	C	D	Condensed Description
69	OTHER AGRICULTURAL LAND						
70	Pasture, grassland or range	Poor	68	79	86	89	Pasture/grassland/range, Poor
71		Fair	49	69	79	84	Pasture/grassland/range, Fair
72		Good	39	61	74	80	Pasture/grassland/range, Good
73	Meadow, cont. grass, non-grazed		30	58	71	78	Meadow, non-grazed
74	Brush, brush/weed/grass mix	Poor	48	67	77	83	Brush, Poor
75		Fair	35	56	70	77	Brush, Fair
76		Good	30	48	65	73	Brush, Good
77	Woods/grass combination	Poor	57	73	82	86	Woods/grass comb., Poor
78		Fair	43	65	76	82	Woods/grass comb., Fair
79		Good	32	58	72	79	Woods/grass comb., Good
80	Woods	Poor	45	66	77	83	Woods, Poor
81		Fair	36	60	73	79	Woods, Fair
82		Good	30	55	70	77	Woods, Good
83	Farmsteads		59	74	82	86	Farmsteads
84	ARID AND SEMIARID RANGELAND						
85	Herbaceous	Poor		80	87	93	Herbaceous range, Poor
86		Fair		71	81	89	Herbaceous range, Fair
87		Good		62	74	85	Herbaceous range, Good
88	Oak/aspen	Poor		66	74	79	Oak/aspen range, Poor
89		Fair		48	57	63	Oak/aspen range, Fair
90		Good		30	41	48	Oak/aspen range, Good
91	Pinyon/juniper	Poor		75	85	89	Pinyon/juniper range, Poor
92		Fair		58	73	80	Pinyon/juniper range, Fair
93		Good		41	61	71	Pinyon/juniper range, Good
94	Sagebrush (w/grass understory)	Poor		67	80	85	Sagebrush range, Poor
95		Fair		51	63	70	Sagebrush range, Fair
96		Good		35	47	55	Sagebrush range, Good

ATTACHMENT 4

TEMPORARY DRAINAGE CHANNELS HYDROCAD RESULTS





Routing Diagram for AP-1 Hydraulics_North and South DAs_11.08
Prepared by SCCM, Printed 11/11/2022
HydroCAD® 10.00 s/n 03895 © 2012 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.182	86	10Sa New DA - bare soil below CCR (50S)
2.151	60	10Sa Woods (50S)
4.862	86	11S New DA - bare soil below CCR (49S)
5.646	60	11Sa (49S)
3.234	61	11Sb >75% Grass cover, Good, HSG B (16S)
0.774	96	11Sc gravel laydown and road (16S)
0.394	61	11Sd >75% Grass cover, Good, HSG B (5S)
0.096	96	11Se gravel laydown and road (5S)
0.378	61	11Sg >75% Grass cover, Good, HSG B (15S)
1.048	96	11Sh and 11Sf aggregate parking area (15S)
7.913	86	12S New DA -below CCR bare soil (53S)
6.975	60	12Sa (53S)
5.344	86	1314S New DA - bare soil below CCR (48S)
2.019	60	1314Sa and 1314Sb Woods (48S)
0.297	60	13Sa Woods (47S)
0.370	61	13Sb grassed slope (28S)
1.897	96	13Sc Aggregate Surface (28S)
1.523	86	1N New DA - bare soil Below CCr (24S)
36.432	79	1Na Woods (24S)
79.398	60	2Na Woods (27S)
5.593	86	3N bare soil below CCR (29S)
12.935	60	3Na Woods (29S)
8.049	86	4N bare soil - below CCR (31S)
42.536	60	4Na Woods (31S)
24.925	86	5N New DA - bare soil below CCR (37S)
29.500	60	5Na Woods (37S)
4.001	86	6N bare soil below CCR (46S)
11.314	60	6Na Woods (46S)
7.685	86	7S bare soil below CCR (60S)
10.537	86	8S bare soil below CCR (63S)
11.393	61	8Sa Grassed slope (63S)
3.943	86	910S- bare soil (66S)
0.236	60	910Sa Woods (66S)
0.927	86	9S - bare soil below CCR (51S)
0.976	61	9Sc >75% Grass cover, Good, HSG B (21S)
0.213	61	9Se >75% Grass cover, Good, HSG B (14S)
0.173	96	9Sf and 9sd gravel laydown (14S)
0.107	61	9Sg >75% Grass cover, Good, HSG B (13S)
0.040	96	9Sh Gravel Road (13S)
0.316	61	9Si >75% Grass cover, Good, HSG B (4S)
0.424	96	9Sj aggreagate parking (4S)
1.861	96	9Sk gravel laydown (1S)

Area Listing (all nodes) (continued)

Area (acres)	CN	Description (subcatchment-numbers)
0.899	61	9Sl >75% Grass cover, Good, HSG B (1S)
0.384	60	9Sm and 9Sa Woods (51S)
0.198	61	>75% Grass cover, Good, HSG B (7S)
2.028	86	Below CCR Removal (45S)
0.765	86	New DA - 13S bare soil below CCR (47S)
4.940	86	New DA - bare soil below CCR 2N (27S)
3.353	60	Woods (45S)
0.367	96	aggreagate road (7S)
352.551	**70**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
6.715	HSG B	1S, 4S, 5S, 7S, 13S, 14S, 15S, 16S, 21S
0.000	HSG C	
0.000	HSG D	
345.836	Other	1S, 4S, 5S, 7S, 13S, 14S, 15S, 16S, 24S, 27S, 28S, 29S, 31S, 37S, 45S, 46S, 47S, 48S, 49S, 50S, 51S, 53S, 60S, 63S, 66S
352.551		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatch Numbers
0.000	0.000	0.000	0.000	1.182	1.182	10Sa New DA - bare soil below CCR	
0.000	0.000	0.000	0.000	2.151	2.151	10Sa Woods	
0.000	0.000	0.000	0.000	4.862	4.862	11S New DA - bare soil below CCR	
0.000	0.000	0.000	0.000	5.646	5.646	11Sa	
0.000	3.234	0.000	0.000	0.000	3.234	11Sb >75% Grass cover, Good	
0.000	0.000	0.000	0.000	0.774	0.774	11Sc gravel laydown and road	
0.000	0.394	0.000	0.000	0.000	0.394	11Sd >75% Grass cover, Good	
0.000	0.000	0.000	0.000	0.096	0.096	11Se gravel laydown and road	
0.000	0.378	0.000	0.000	0.000	0.378	11Sg >75% Grass cover, Good	
0.000	0.000	0.000	0.000	1.048	1.048	11Sh and 11Sf aggregate parking area	
0.000	0.000	0.000	0.000	7.913	7.913	12S New DA -below CCR bare soil	
0.000	0.000	0.000	0.000	6.975	6.975	12Sa	
0.000	0.000	0.000	0.000	5.344	5.344	1314S New DA - bare soil below CCR	
0.000	0.000	0.000	0.000	2.019	2.019	1314Sa and 1314Sb Woods	
0.000	0.000	0.000	0.000	0.297	0.297	13Sa Woods	
0.000	0.000	0.000	0.000	0.370	0.370	13Sb grassed slope	
0.000	0.000	0.000	0.000	1.897	1.897	13Sc Aggregate Surface	
0.000	0.000	0.000	0.000	1.523	1.523	1N New DA - bare soil Below CCr	
0.000	0.000	0.000	0.000	36.432	36.432	1Na Woods	
0.000	0.000	0.000	0.000	79.398	79.398	2Na Woods	
0.000	0.000	0.000	0.000	5.593	5.593	3N bare soil below CCR	
0.000	0.000	0.000	0.000	12.935	12.935	3Na Woods	
0.000	0.000	0.000	0.000	8.049	8.049	4N bare soil - below CCR	
0.000	0.000	0.000	0.000	42.536	42.536	4Na Woods	
0.000	0.000	0.000	0.000	24.925	24.925	5N New DA - bare soil below CCR	
0.000	0.000	0.000	0.000	29.500	29.500	5Na Woods	
0.000	0.000	0.000	0.000	4.001	4.001	6N bare soil below CCR	
0.000	0.000	0.000	0.000	11.314	11.314	6Na Woods	
0.000	0.000	0.000	0.000	7.685	7.685	7S bare soil below CCR	
0.000	0.000	0.000	0.000	10.537	10.537	8S bare soil below CCR	
0.000	0.000	0.000	0.000	11.393	11.393	8Sa Grassed slope	
0.000	0.000	0.000	0.000	3.943	3.943	910S- bare soil	
0.000	0.000	0.000	0.000	0.236	0.236	910Sa Woods	
0.000	0.000	0.000	0.000	0.927	0.927	9S - bare soil below CCR	
0.000	0.976	0.000	0.000	0.000	0.976	9Sc >75% Grass cover, Good	
0.000	0.213	0.000	0.000	0.000	0.213	9Se >75% Grass cover, Good	
0.000	0.000	0.000	0.000	0.173	0.173	9Sf and 9sd gravel laydown	
0.000	0.107	0.000	0.000	0.000	0.107	9Sg >75% Grass cover, Good	
0.000	0.000	0.000	0.000	0.040	0.040	9Sh Gravel Road	
0.000	0.316	0.000	0.000	0.000	0.316	9Si >75% Grass cover, Good	

Ground Covers (all nodes) (continued)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatch Numbers
0.000	0.000	0.000	0.000	0.424	0.424	9Sj aggreagate parking	
0.000	0.000	0.000	0.000	1.861	1.861	9Sk gravel laydown	
0.000	0.899	0.000	0.000	0.000	0.899	9Sl >75% Grass cover, Good	
0.000	0.000	0.000	0.000	0.384	0.384	9Sm and 9Sa Woods	
0.000	0.198	0.000	0.000	0.000	0.198	>75% Grass cover, Good	
0.000	0.000	0.000	0.000	2.028	2.028	Below CCR Removal	
0.000	0.000	0.000	0.000	0.765	0.765	New DA - 13S bare soil below CCR	
0.000	0.000	0.000	0.000	4.940	4.940	New DA - bare soil below CCR 2N	
0.000	0.000	0.000	0.000	3.353	3.353	Woods	
0.000	0.000	0.000	0.000	0.367	0.367	aggreagate road	
0.000	**6.715**	**0.000**	**0.000**	**345.836**	**352.551**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	10R	795.25	794.83	67.0	0.0063	0.009	34.4	0.0	0.0
2	18R	824.62	823.75	66.0	0.0132	0.009	17.5	0.0	0.0
3	21R	809.01	808.52	49.0	0.0100	0.012	36.0	0.0	0.0
4	32R	798.77	798.00	71.0	0.0108	0.009	17.5	0.0	0.0

```
                    Time span=0.00-26.00 hrs, dt=0.03 hrs, 868 points
                         Runoff by SCS TR-20 method, UH=SCS
          Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment 1S: S-200                 Runoff Area=2.760 ac   0.00% Impervious   Runoff Depth=4.63"
                                    Flow Length=130'   Tc=6.0 min   CN=85   Runoff=21.56 cfs  1.066 af

Subcatchment 4S: S-203                 Runoff Area=0.740 ac   0.00% Impervious   Runoff Depth=4.20"
                       Flow Length=20'   Slope=0.0200 '/'   Tc=6.0 min   CN=81   Runoff=5.36 cfs  0.259 af

Subcatchment 5S: S-204                 Runoff Area=0.490 ac   0.00% Impervious   Runoff Depth=2.89"
                                     Flow Length=100'   Tc=6.0 min   CN=68   Runoff=2.52 cfs  0.118 af

Subcatchment 7S: S-205                 Runoff Area=0.565 ac   0.00% Impervious   Runoff Depth=4.53"
                                     Flow Length=150'   Tc=6.0 min   CN=84   Runoff=4.34 cfs  0.213 af

Subcatchment 13S: S-206                Runoff Area=0.147 ac   0.00% Impervious   Runoff Depth=3.18"
                       Flow Length=28'   Slope=0.0430 '/'   Tc=6.0 min   CN=71   Runoff=0.83 cfs  0.039 af

Subcatchment 14S: S-202                Runoff Area=0.386 ac   0.00% Impervious   Runoff Depth=3.79"
                                     Flow Length=160'   Tc=6.0 min   CN=77   Runoff=2.56 cfs  0.122 af

Subcatchment 15S: S-208                Runoff Area=1.426 ac   0.00% Impervious   Runoff Depth=4.85"
                                    Flow Length=140'   Tc=6.0 min   CN=87   Runoff=11.51 cfs  0.577 af

Subcatchment 16S: S-Roadside           Runoff Area=4.008 ac   0.00% Impervious   Runoff Depth=2.89"
                                                    Tc=6.0 min   CN=68   Runoff=20.63 cfs  0.966 af

Subcatchment 21S: S-209/201            Runoff Area=0.976 ac   0.00% Impervious   Runoff Depth=2.24"
                       Flow Length=80'   Slope=0.3330 '/'   Tc=6.0 min   CN=61   Runoff=3.87 cfs  0.182 af

Subcatchment 24S: 1N                  Runoff Area=37.955 ac   0.00% Impervious   Runoff Depth=3.99"
                             Flow Length=2,715'   Tc=42.6 min   CN=79   Runoff=103.48 cfs  12.632 af

Subcatchment 27S: 2N                  Runoff Area=84.338 ac   0.00% Impervious   Runoff Depth>2.33"
                             Flow Length=3,389'   Tc=51.2 min   CN=62   Runoff=111.34 cfs  16.398 af

Subcatchment 28S: S-207 (WTP)          Runoff Area=2.267 ac   0.00% Impervious   Runoff Depth=5.19"
                     Flow Length=220'   Slope=0.0200 '/'   Tc=6.0 min   CN=90   Runoff=19.10 cfs  0.980 af

Subcatchment 29S: 3N                  Runoff Area=18.528 ac   0.00% Impervious   Runoff Depth=2.89"
                                Flow Length=1,759'   Tc=33.5 min   CN=68   Runoff=42.50 cfs  4.466 af

Subcatchment 31S: 4N                  Runoff Area=50.585 ac   0.00% Impervious   Runoff Depth=2.52"
                               Flow Length=3,137'   Tc=38.9 min   CN=64   Runoff=89.07 cfs  10.607 af

Subcatchment 37S: 5N                  Runoff Area=54.425 ac   0.00% Impervious   Runoff Depth=3.28"
                             Flow Length=3,044'   Tc=42.1 min   CN=72   Runoff=122.58 cfs  14.884 af

Subcatchment 45S: 14S                  Runoff Area=5.381 ac   0.00% Impervious   Runoff Depth=3.09"
                                  Flow Length=893'   Tc=18.7 min   CN=70   Runoff=19.09 cfs  1.384 af
```

Subcatchment 46S: 6N Runoff Area=15.315 ac 0.00% Impervious Runoff Depth=2.80"
Flow Length=1,553' Tc=24.8 min CN=67 Runoff=41.24 cfs 3.570 af

Subcatchment 47S: 13S Runoff Area=1.062 ac 0.00% Impervious Runoff Depth=3.99"
Flow Length=395' Tc=11.4 min CN=79 Runoff=6.13 cfs 0.353 af

Subcatchment 48S: 1314S Runoff Area=7.363 ac 0.00% Impervious Runoff Depth=3.99"
Flow Length=953' Tc=33.7 min CN=79 Runoff=23.61 cfs 2.450 af

Subcatchment 49S: 11S Runoff Area=10.508 ac 0.00% Impervious Runoff Depth=3.28"
Flow Length=1,392' Tc=24.4 min CN=72 Runoff=34.03 cfs 2.874 af

Subcatchment 50S: 10S Runoff Area=3.333 ac 0.00% Impervious Runoff Depth=2.99"
Flow Length=826' Tc=14.7 min CN=69 Runoff=12.99 cfs 0.830 af

Subcatchment 51S: 9S Runoff Area=1.311 ac 0.00% Impervious Runoff Depth=3.89"
Flow Length=580' Tc=40.9 min CN=78 Runoff=3.59 cfs 0.425 af

Subcatchment 53S: 12S Runoff Area=14.888 ac 0.00% Impervious Runoff Depth=3.48"
Flow Length=1,416' Tc=26.4 min CN=74 Runoff=48.69 cfs 4.319 af

Subcatchment 60S: 7S Runoff Area=7.685 ac 0.00% Impervious Runoff Depth=4.74"
Flow Length=553' Tc=6.0 min CN=86 Runoff=61.04 cfs 3.037 af

Subcatchment 63S: 8S Runoff Area=21.930 ac 0.00% Impervious Runoff Depth=3.38"
Flow Length=1,420' Tc=14.6 min CN=73 Runoff=97.15 cfs 6.179 af

Subcatchment 66S: 910S Runoff Area=4.179 ac 0.00% Impervious Runoff Depth=4.63"
Flow Length=991' Tc=26.8 min CN=85 Runoff=17.81 cfs 1.614 af

Reach 2R: PC 200 Avg. Flow Depth=0.75' Max Vel=5.31 fps Inflow=21.56 cfs 1.066 af
n=0.038 L=560.0' S=0.0458 '/' Capacity=165.41 cfs Outflow=20.81 cfs 1.066 af

Reach 6R: PC 203 Avg. Flow Depth=0.35' Max Vel=3.63 fps Inflow=5.36 cfs 0.259 af
n=0.038 L=512.0' S=0.0495 '/' Capacity=171.98 cfs Outflow=5.03 cfs 0.259 af

Reach 8R: PC 204 Avg. Flow Depth=0.62' Max Vel=4.33 fps Inflow=13.72 cfs 0.695 af
n=0.030 L=596.0' S=0.0231 '/' Capacity=148.67 cfs Outflow=12.95 cfs 0.695 af

Reach 9R: PC 205 Avg. Flow Depth=0.34' Max Vel=3.11 fps Inflow=4.34 cfs 0.213 af
n=0.030 L=265.0' S=0.0235 '/' Capacity=149.96 cfs Outflow=4.18 cfs 0.213 af

Reach 10R: Pipe 200 Avg. Flow Depth=1.24' Max Vel=9.80 fps Inflow=26.27 cfs 1.370 af
34.4" Round Pipe n=0.009 L=67.0' S=0.0063 '/' Capacity=67.57 cfs Outflow=26.18 cfs 1.370 af

Reach 11R: PC 201 Avg. Flow Depth=0.35' Max Vel=2.60 fps Inflow=3.68 cfs 0.182 af
n=0.038 L=78.0' S=0.0253 '/' Capacity=65.22 cfs Outflow=3.61 cfs 0.182 af

Reach 13R: PC 206 Avg. Flow Depth=0.32' Max Vel=4.54 fps Inflow=5.66 cfs 0.298 af
n=0.038 L=79.0' S=0.0858 '/' Capacity=226.38 cfs Outflow=5.61 cfs 0.298 af

Reach 15R: PC 202 Avg. Flow Depth=0.65' Max Vel=7.06 fps Inflow=22.92 cfs 1.188 af
n=0.038 L=85.0' S=0.0941 '/' Capacity=237.06 cfs Outflow=22.83 cfs 1.188 af

```
Reach 16R: PC 208(A/B)                   Avg. Flow Depth=0.59'   Max Vel=4.10 fps   Inflow=11.51 cfs  0.577 af
                          n=0.038   L=124.0'   S=0.0355 '/'   Capacity=145.56 cfs   Outflow=11.27 cfs  0.577 af

Reach 17R: PC 210                        Avg. Flow Depth=1.17'   Max Vel=4.07 fps   Inflow=31.20 cfs  1.661 af
                            n=0.030   L=98.0'   S=0.0102 '/'   Capacity=98.87 cfs   Outflow=30.86 cfs  1.661 af

Reach 18R: Pipe 201                     Avg. Flow Depth=0.90'   Max Vel=10.43 fps   Inflow=11.27 cfs  0.577 af
           17.5"  Round Pipe   n=0.009   L=66.0'   S=0.0132 '/'   Capacity=16.16 cfs   Outflow=11.26 cfs  0.577 af

Reach 20R: PC 209                         Avg. Flow Depth=0.66'   Max Vel=2.83 fps   Inflow=3.87 cfs  0.182 af
                            n=0.038   L=325.0'   S=0.0247 '/'   Capacity=33.09 cfs   Outflow=3.68 cfs  0.182 af

Reach 21R: PIPE 203                      Avg. Flow Depth=1.37'   Max Vel=9.82 fps   Inflow=30.86 cfs  1.661 af
           36.0"  Round Pipe   n=0.012   L=49.0'   S=0.0100 '/'   Capacity=72.26 cfs   Outflow=30.78 cfs  1.661 af

Reach 22R: PC 211                        Avg. Flow Depth=1.18'   Max Vel=3.98 fps   Inflow=30.78 cfs  1.661 af
                            n=0.030   L=67.0'   S=0.0097 '/'   Capacity=96.41 cfs   Outflow=30.52 cfs  1.661 af

Reach 32R: PIPE 202                     Avg. Flow Depth=1.46'   Max Vel=10.00 fps   Inflow=17.85 cfs  0.980 af
           17.5"  Round Pipe   n=0.009   L=71.0'   S=0.0108 '/'   Capacity=14.66 cfs   Outflow=14.66 cfs  0.980 af

Reach 33R: PC 207                        Avg. Flow Depth=0.92'   Max Vel=2.89 fps   Inflow=19.10 cfs  0.980 af
                           n=0.038   L=422.0'   S=0.0100 '/'   Capacity=88.38 cfs   Outflow=17.85 cfs  0.980 af

Reach 45R: CH-14                         Avg. Flow Depth=1.16'   Max Vel=2.36 fps   Inflow=19.09 cfs  1.384 af
                           n=0.074   L=657.6'   S=0.0213 '/'   Capacity=57.90 cfs   Outflow=17.63 cfs  1.383 af

Reach 46R: CH-13                         Avg. Flow Depth=0.72'   Max Vel=5.53 fps   Inflow=20.78 cfs  1.333 af
                          n=0.058   L=285.0'   S=0.1193 '/'   Capacity=290.07 cfs   Outflow=20.68 cfs  1.333 af

Reach 47R: CH-13_14                      Avg. Flow Depth=1.43'   Max Vel=4.88 fps   Inflow=51.53 cfs  5.167 af
                          n=0.058   L=568.2'   S=0.0440 '/'   Capacity=176.16 cfs   Outflow=50.66 cfs  5.167 af

Reach 48R: CH-12                         Avg. Flow Depth=1.23'   Max Vel=5.83 fps   Inflow=48.69 cfs  4.319 af
                          n=0.056   L=995.0'   S=0.0693 '/'   Capacity=229.06 cfs   Outflow=47.66 cfs  4.319 af

Reach 49R: CH-11                         Avg. Flow Depth=1.26'   Max Vel=6.02 fps   Inflow=52.97 cfs  4.535 af
                        n=0.055   L=1,050.0'   S=0.0695 '/'   Capacity=233.52 cfs   Outflow=51.16 cfs  4.534 af

Reach 50R: CH-10                         Avg. Flow Depth=0.66'   Max Vel=3.74 fps   Inflow=12.99 cfs  0.830 af
                          n=0.058   L=667.0'   S=0.0600 '/'   Capacity=123.98 cfs   Outflow=12.33 cfs  0.830 af

Reach 51R: CH-09                         Avg. Flow Depth=1.01'   Max Vel=5.29 fps   Inflow=33.11 cfs  2.093 af
                          n=0.058   L=525.0'   S=0.0762 '/'   Capacity=353.82 cfs   Outflow=32.13 cfs  2.093 af

Reach 52R: CH-5                       Avg. Flow Depth=2.22'   Max Vel=5.00 fps   Inflow=122.58 cfs  14.884 af
                    n=0.076   L=1,795.0'   S=0.0457 '/'   Capacity=231.94 cfs   Outflow=117.88 cfs  14.874 af

Reach 53R: CH-4                         Avg. Flow Depth=1.55'   Max Vel=6.52 fps   Inflow=89.07 cfs  10.607 af
                     n=0.053   L=1,425.0'   S=0.0561 '/'   Capacity=368.70 cfs   Outflow=87.80 cfs  10.604 af
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Reach 54R: CH-3                   Avg. Flow Depth=1.07'   Max Vel=6.32 fps   Inflow=42.50 cfs  4.466 af
                  n=0.050   L=941.0'   S=0.0755 '/'   Capacity=267.60 cfs   Outflow=42.05 cfs  4.466 af

Reach 55R: CH-2                 Avg. Flow Depth=1.66'   Max Vel=7.49 fps   Inflow=111.34 cfs  16.398 af
                n=0.054   L=923.0'   S=0.0715 '/'   Capacity=408.40 cfs   Outflow=111.10 cfs  16.395 af

Reach 56R: CH-1                 Avg. Flow Depth=1.51'   Max Vel=9.11 fps   Inflow=103.48 cfs  12.632 af
                n=0.048   L=455.0'   S=0.0989 '/'   Capacity=319.14 cfs   Outflow=103.35 cfs  12.632 af

Reach 58R: PC 212                                         Avg. Flow Depth=0.00'   Max Vel=0.00 fps
                    n=0.030   L=70.0'   S=0.0393 '/'   Capacity=194.00 cfs   Outflow=0.00 cfs  0.000 af

Reach 59R: CH-6                   Avg. Flow Depth=1.14'   Max Vel=5.61 fps   Inflow=41.24 cfs  3.570 af
                  n=0.057   L=718.2'   S=0.0724 '/'   Capacity=229.95 cfs   Outflow=40.69 cfs  3.570 af

Reach 61R: CH-7                   Avg. Flow Depth=1.07'   Max Vel=9.02 fps   Inflow=61.04 cfs  3.037 af
                  n=0.049   L=552.6'   S=0.1484 '/'   Capacity=584.47 cfs   Outflow=59.17 cfs  3.037 af

Reach 64R: CH-8                   Avg. Flow Depth=2.18'   Max Vel=4.41 fps   Inflow=97.15 cfs  6.179 af
                  n=0.078   L=891.2'   S=0.0404 '/'   Capacity=191.57 cfs   Outflow=91.44 cfs  6.179 af

Reach 65R: CH-09_10               Avg. Flow Depth=1.26'   Max Vel=6.69 fps   Inflow=57.46 cfs  4.537 af
                  n=0.054   L=435.2'   S=0.0827 '/'   Capacity=259.44 cfs   Outflow=56.67 cfs  4.537 af

Pond 12P: Pond                                                        Inflow=626.75 cfs  90.313 af
                                                                     Primary=626.75 cfs  90.313 af

     Total Runoff Area = 352.551 ac   Runoff Volume = 90.544 af   Average Runoff Depth = 3.08"
                               100.00% Pervious = 352.551 ac     0.00% Impervious = 0.000 ac
```

Summary for Subcatchment 1S: S-200

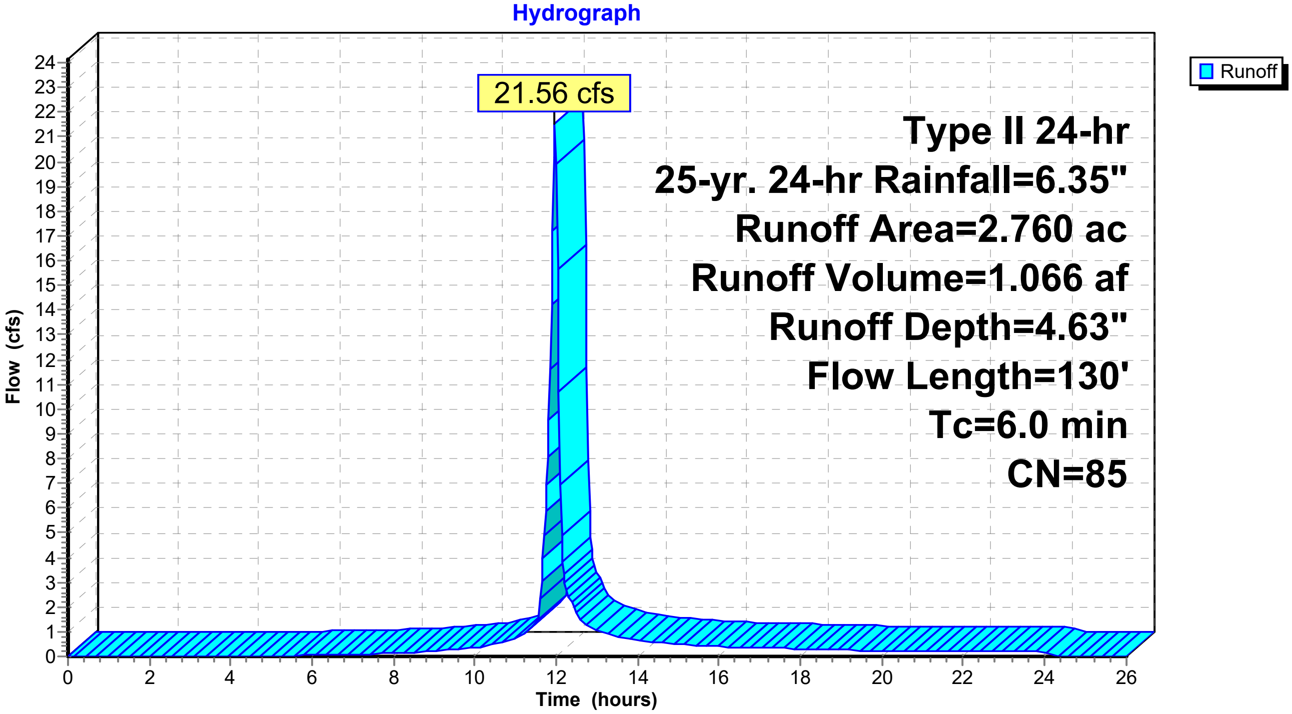
Runoff = 21.56 cfs @ 11.97 hrs, Volume= 1.066 af, Depth= 4.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	1.861	96	9Sk gravel laydown
*	0.899	61	9SI >75% Grass cover, Good, HSG B
	2.760	85	Weighted Average
	2.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	90	0.0200	1.49		**Sheet Flow, Gravel Laydown Area** Smooth surfaces n= 0.011 P2= 3.91"
0.1	30	0.3330	4.04		**Shallow Concentrated Flow, Grassed Slopes** Short Grass Pasture Kv= 7.0 fps
0.5	10	0.3300	0.36		**Sheet Flow, grassed slope** Grass: Short n= 0.150 P2= 3.91"
1.6	130	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1S: S-200



Summary for Subcatchment 4S: S-203

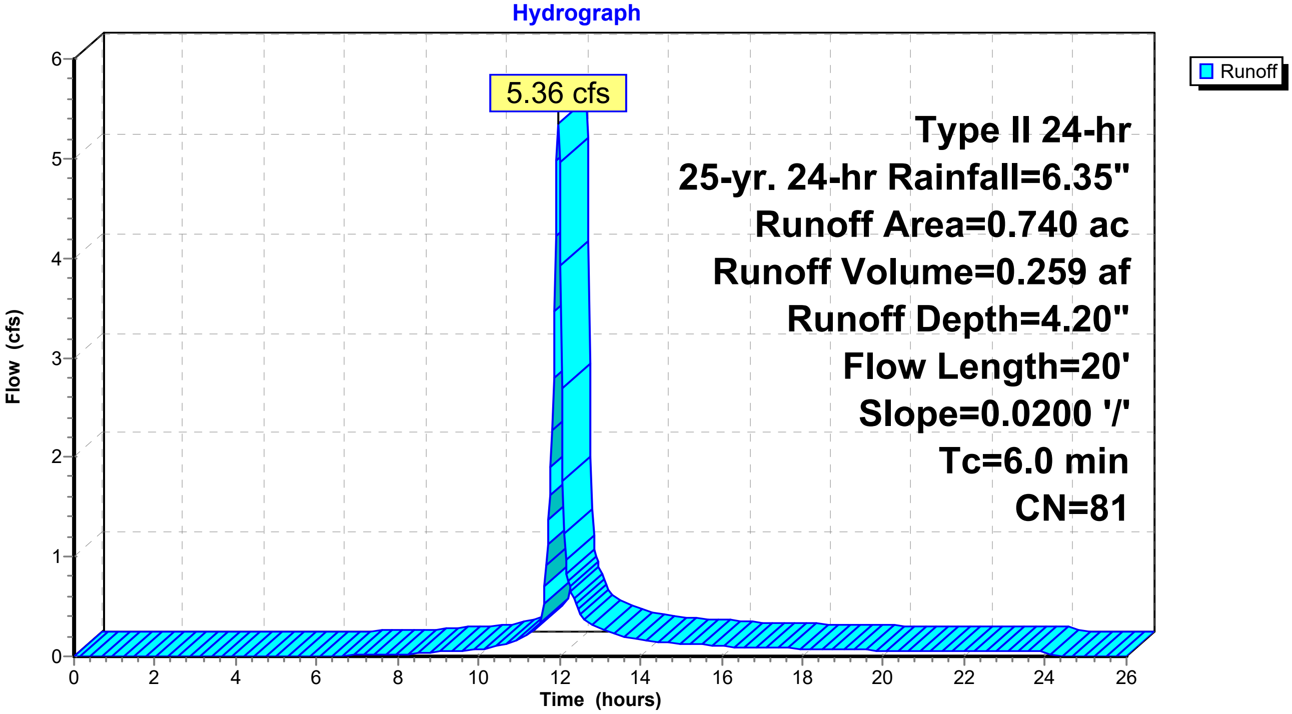
Runoff = 5.36 cfs @ 11.97 hrs, Volume= 0.259 af, Depth= 4.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.424	96	9Sj aggreagate parking
*	0.316	61	9Si >75% Grass cover, Good, HSG B
	0.740	81	Weighted Average
	0.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	20	0.0200	1.10		**Sheet Flow, aggregate parking** Smooth surfaces n= 0.011 P2= 3.91"
0.3	20	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 4S: S-203



Summary for Subcatchment 5S: S-204

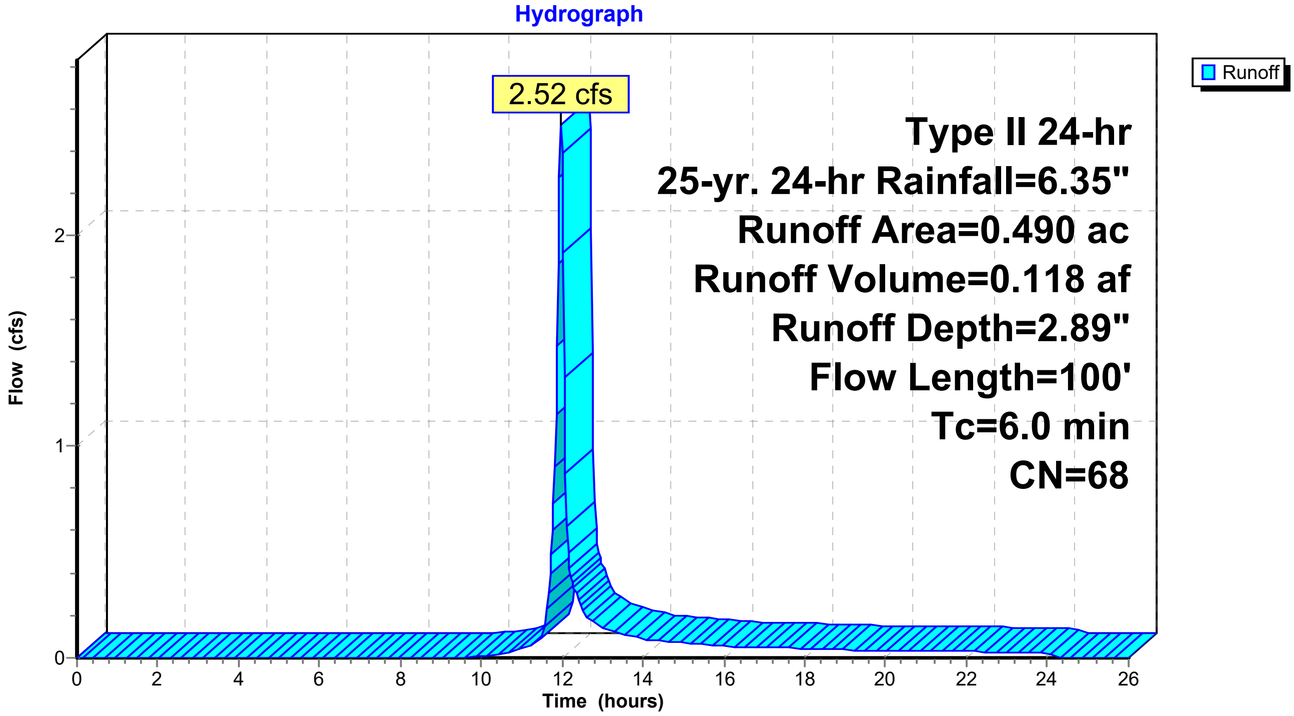
Runoff = 2.52 cfs @ 11.97 hrs, Volume= 0.118 af, Depth= 2.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.096	96	11Se gravel laydown and road
*	0.394	61	11Sd >75% Grass cover, Good, HSG B
	0.490	68	Weighted Average
	0.490		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	90	0.1000	2.83		**Sheet Flow, aggregate road ramp** Smooth surfaces n= 0.011 P2= 3.91"
0.5	10	0.3300	0.36		**Sheet Flow, grassed slope** Grass: Short n= 0.150 P2= 3.91"
1.0	100	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 5S: S-204



Summary for Subcatchment 7S: S-205

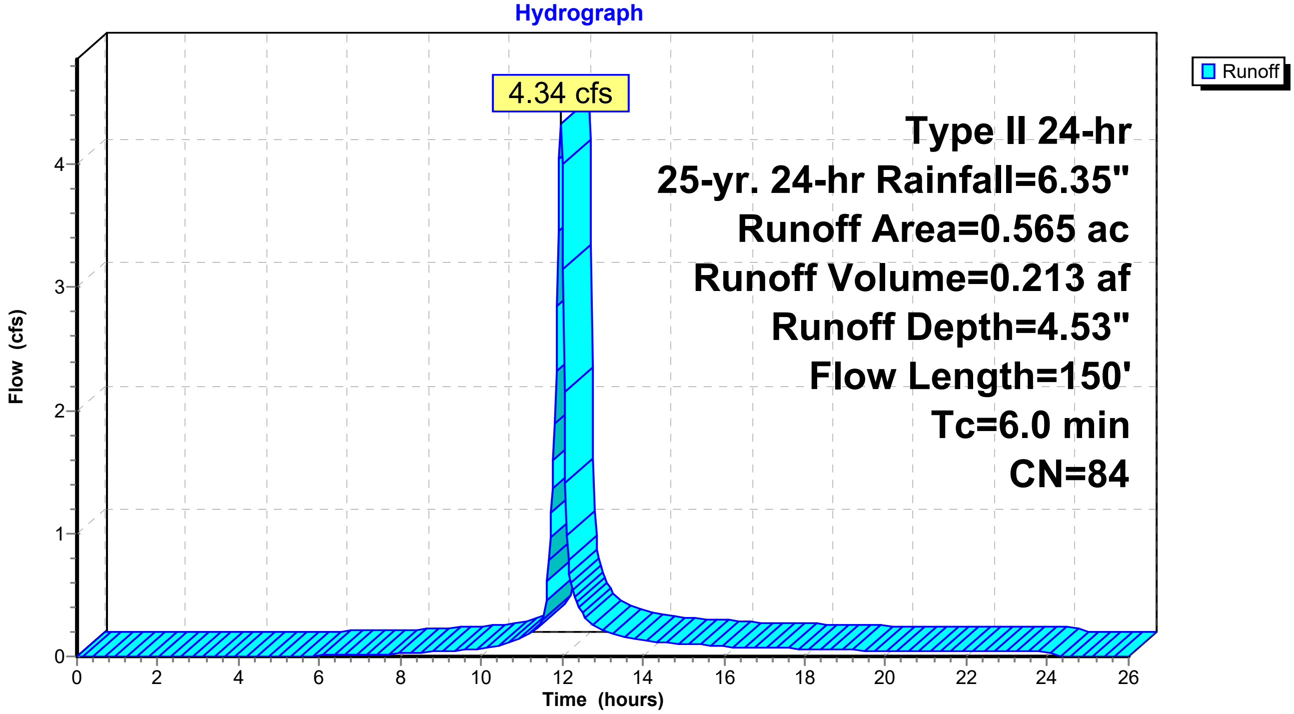
Runoff = 4.34 cfs @ 11.97 hrs, Volume= 0.213 af, Depth= 4.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.367	96	aggreagate road
	0.198	61	>75% Grass cover, Good, HSG B
	0.565	84	Weighted Average
	0.565		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	90	0.0880	2.69		**Sheet Flow, aggregate roadway** Smooth surfaces n= 0.011 P2= 3.91"
0.2	50	0.3300	4.02		**Shallow Concentrated Flow, Grassed Slope** Short Grass Pasture Kv= 7.0 fps
0.5	10	0.3300	0.36		**Sheet Flow, grassed slope** Grass: Short n= 0.150 P2= 3.91"
1.3	150	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 7S: S-205



Summary for Subcatchment 13S: S-206

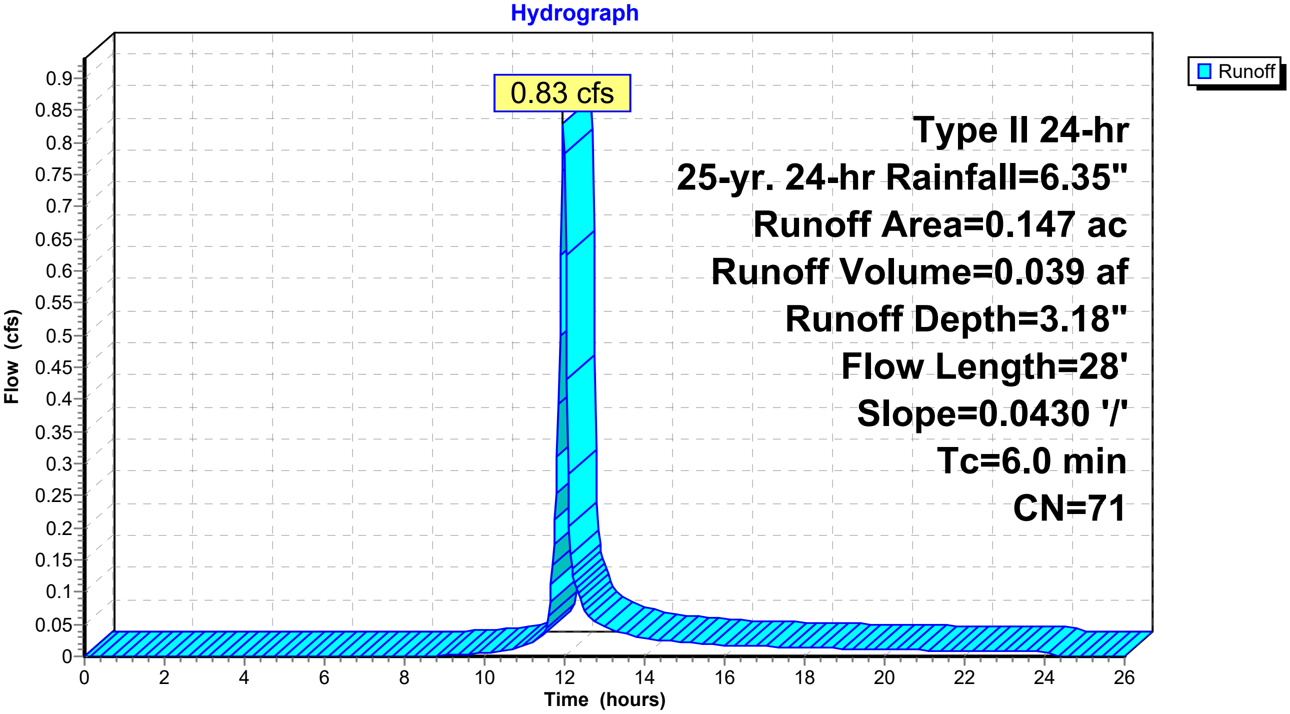
Runoff = 0.83 cfs @ 11.97 hrs, Volume= 0.039 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.040	96	9Sh Gravel Road
*	0.107	61	9Sg >75% Grass cover, Good, HSG B
	0.147	71	Weighted Average
	0.147		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	28	0.0430	1.60		**Sheet Flow, Gravel Road** Smooth surfaces n= 0.011 P2= 3.91"
0.3	28	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 13S: S-206



Summary for Subcatchment 14S: S-202

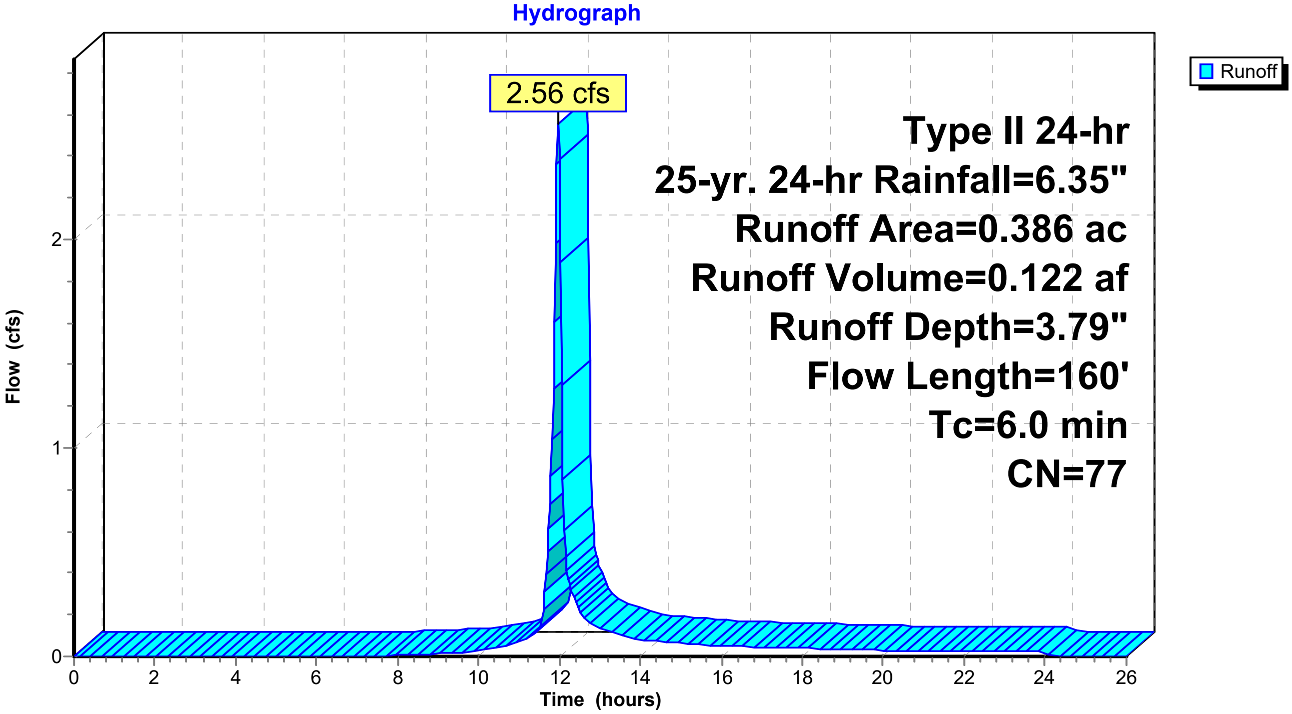
Runoff = 2.56 cfs @ 11.97 hrs, Volume= 0.122 af, Depth= 3.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.173	96	9Sf and 9sd gravel laydown
*	0.213	61	9Se >75% Grass cover, Good, HSG B
	0.386	77	Weighted Average
	0.386		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	60	0.0200	1.37		**Sheet Flow, gravel laydown** Smooth surfaces n= 0.011 P2= 3.91"
0.2	60	0.3330	4.04		**Shallow Concentrated Flow, Grassed Slope** Short Grass Pasture Kv= 7.0 fps
1.4	40	0.3300	0.48		**Sheet Flow, grassed slope** Grass: Short n= 0.150 P2= 3.91"
2.3	160	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 14S: S-202



Summary for Subcatchment 15S: S-208

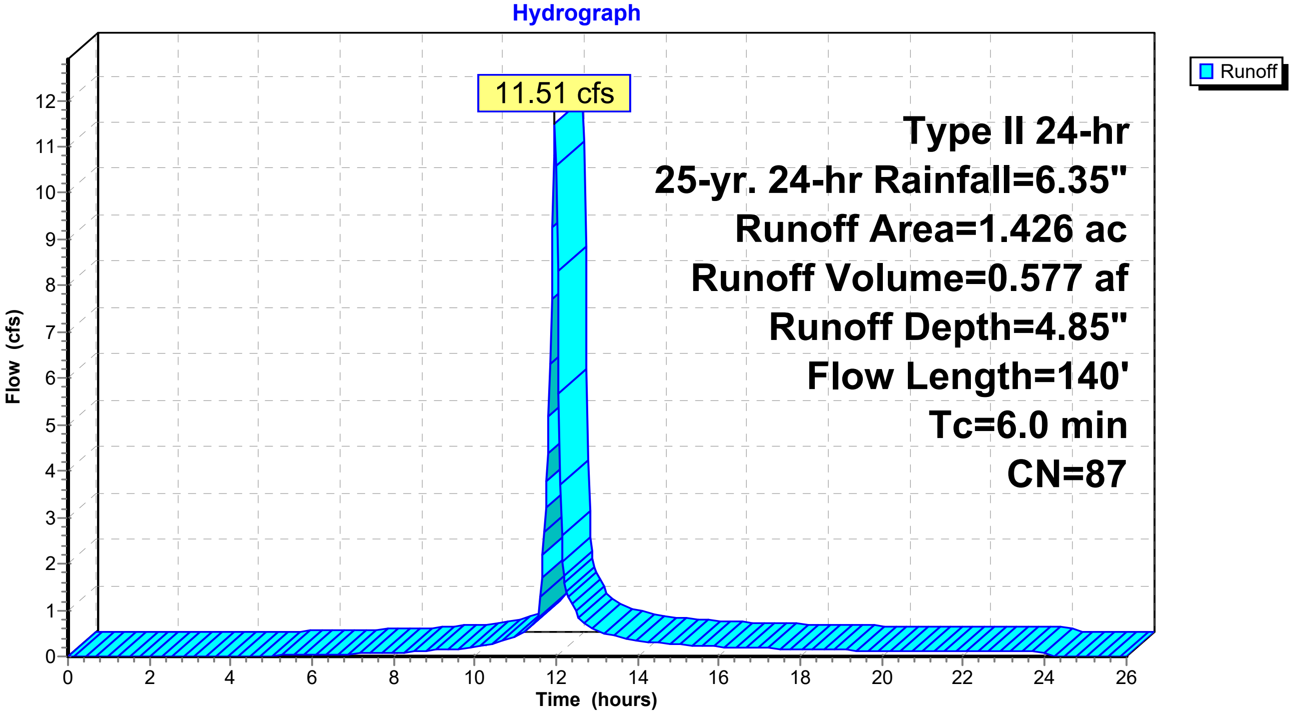
Runoff = 11.51 cfs @ 11.97 hrs, Volume= 0.577 af, Depth= 4.85"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	1.048	96	11Sh and 11Sf aggregate parking area
*	0.378	61	11Sg >75% Grass cover, Good, HSG B
	1.426	87	Weighted Average
	1.426		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	100	0.0200	1.52		**Sheet Flow, aggregate parking area** Smooth surfaces n= 0.011 P2= 3.91"
0.1	10	0.0200	2.87		**Shallow Concentrated Flow, aggregate parking area** Paved Kv= 20.3 fps
0.1	30	0.3330	4.04		**Shallow Concentrated Flow, Grassed Slope** Short Grass Pasture Kv= 7.0 fps
1.3	140	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 15S: S-208



Summary for Subcatchment 16S: S-Roadside

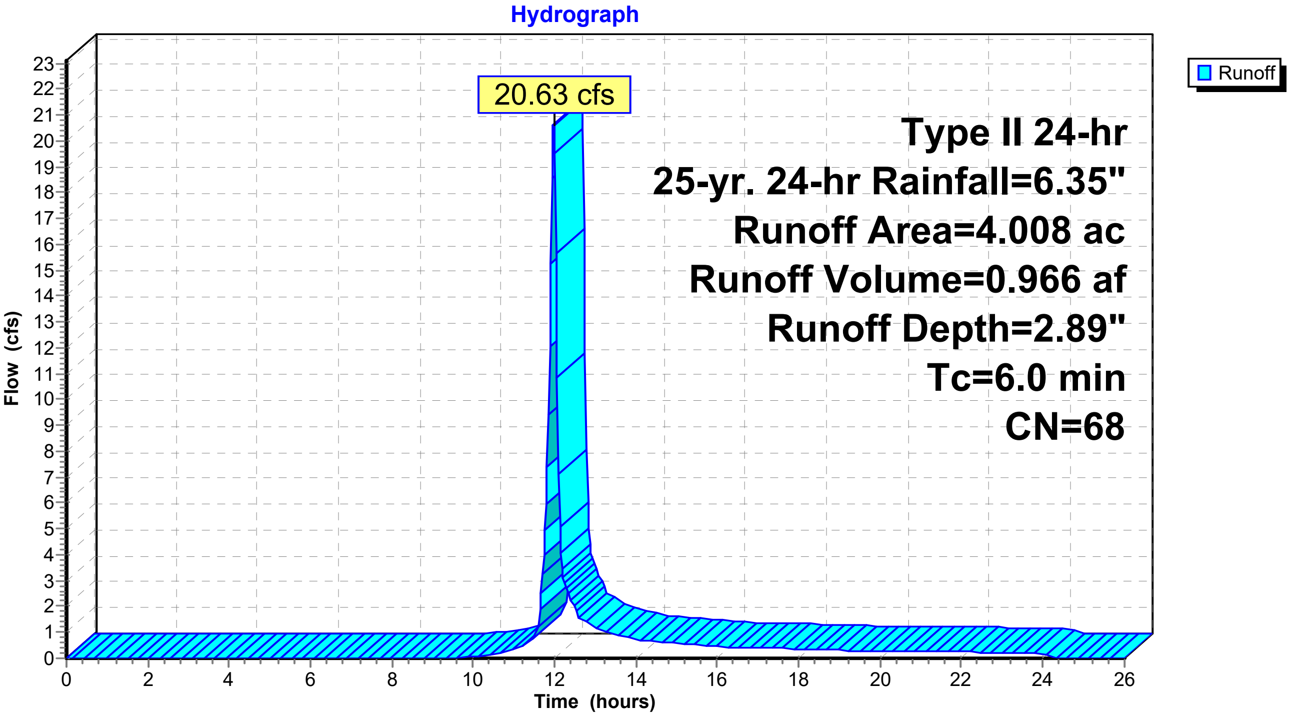
Runoff = 20.63 cfs @ 11.97 hrs, Volume= 0.966 af, Depth= 2.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.774	96	11Sc gravel laydown and road
*	3.234	61	11Sb >75% Grass cover, Good, HSG B
	4.008	68	Weighted Average
	4.008		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 16S: S-Roadside



Summary for Subcatchment 21S: S-209/201

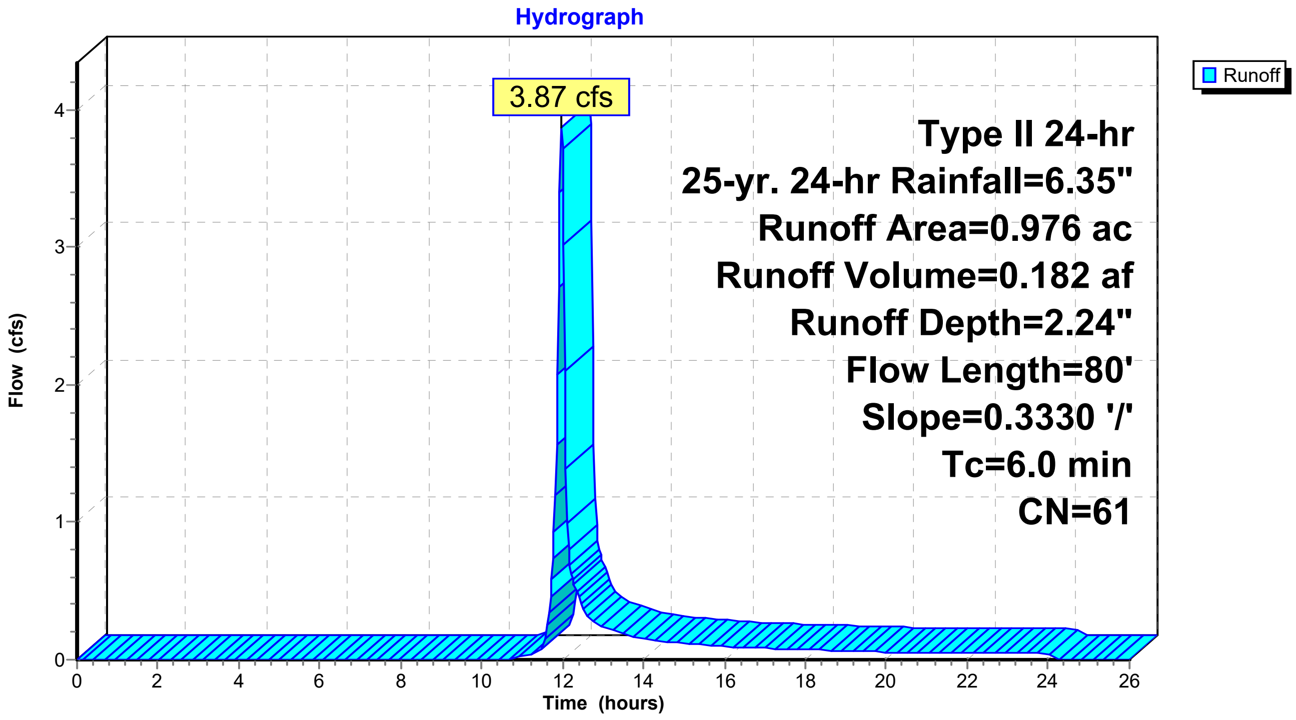
Runoff = 3.87 cfs @ 11.98 hrs, Volume= 0.182 af, Depth= 2.24"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.976	61	9Sc >75% Grass cover, Good, HSG B
	0.976		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	80	0.3330	0.55		**Sheet Flow, Grassed Slope** Grass: Short n= 0.150 P2= 3.91"
2.4	80	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 21S: S-209/201



Summary for Subcatchment 24S: 1N

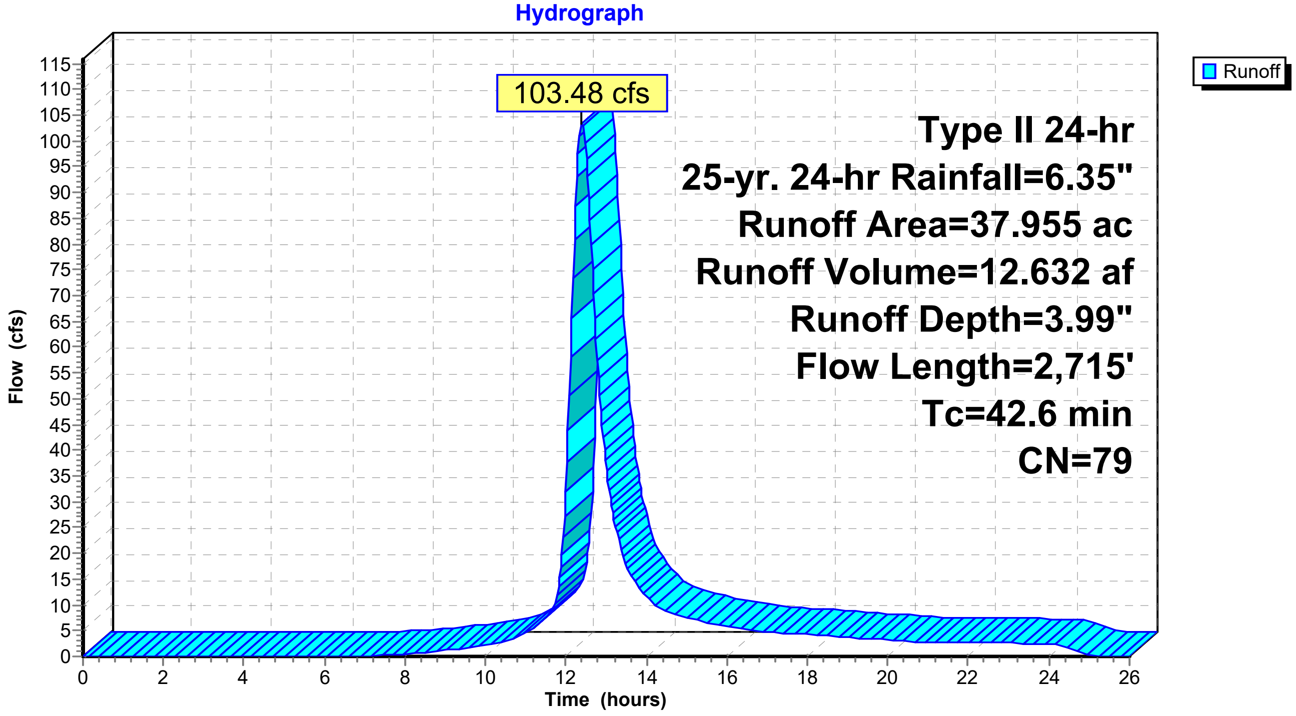
Runoff = 103.48 cfs @ 12.39 hrs, Volume= 12.632 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	36.432	79	1Na Woods
*	1.523	86	1N New DA - bare soil Below CCr
	37.955	79	Weighted Average
	37.955		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	100	0.0600	0.13		**Sheet Flow, 1Na Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
28.2	2,240	0.0700	1.32		**Shallow Concentrated Flow, 1Na Woods** Woodland Kv= 5.0 fps
1.9	375	0.1040	3.22		**Shallow Concentrated Flow, 1N bare soil - below CCR** Nearly Bare & Untilled Kv= 10.0 fps
42.6	2,715	Total			

Subcatchment 24S: 1N



Summary for Subcatchment 27S: 2N

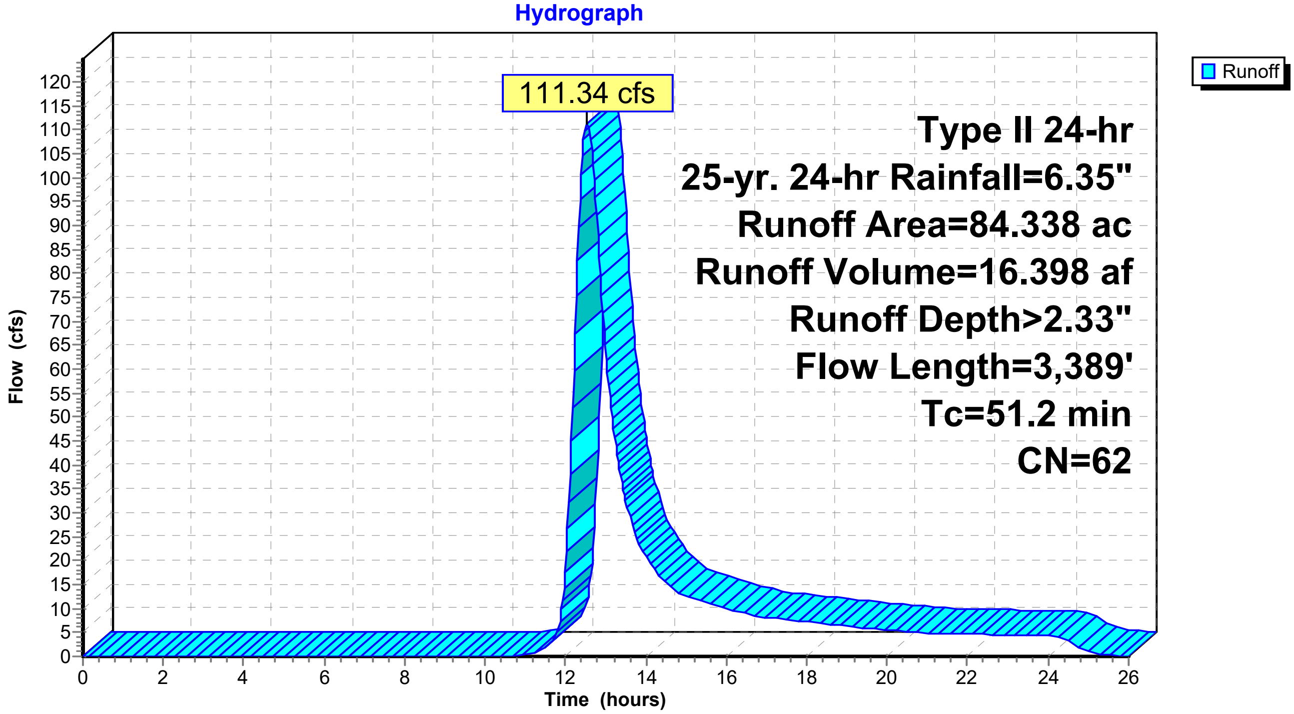
Runoff = 111.34 cfs @ 12.55 hrs, Volume= 16.398 af, Depth> 2.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	79.398	60	2Na Woods
*	4.940	86	New DA - bare soil below CCR 2N
	84.338	62	Weighted Average
	84.338		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0500	0.12		**Sheet Flow, 2Na Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
32.1	2,440	0.0640	1.26		**Shallow Concentrated Flow, 2Na Woods** Woodland Kv= 5.0 fps
5.6	849	0.0640	2.53		**Shallow Concentrated Flow, 2S Bare Soil below CCR** Nearly Bare & Untilled Kv= 10.0 fps
51.2	3,389	Total			

Subcatchment 27S: 2N



Summary for Subcatchment 28S: S-207 (WTP)

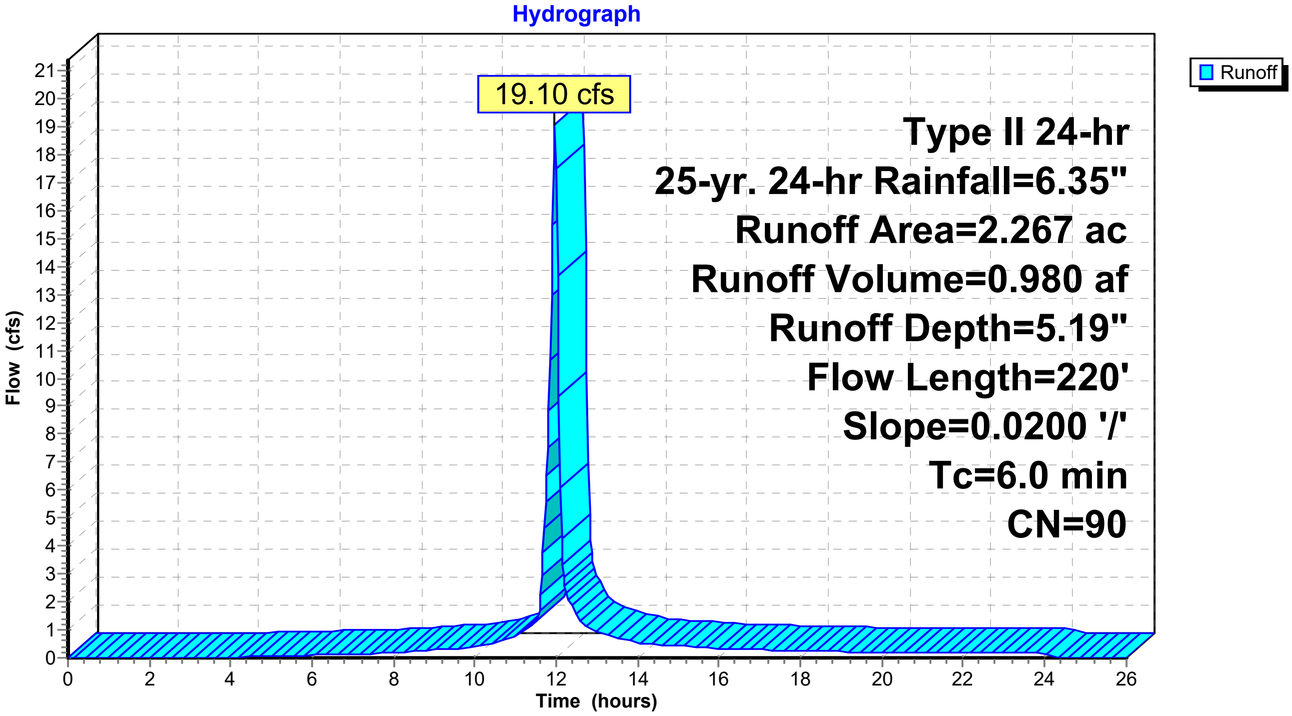
Runoff = 19.10 cfs @ 11.97 hrs, Volume= 0.980 af, Depth= 5.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	1.897	96	13Sc Aggregate Surface
*	0.370	61	13Sb grassed slope
	2.267	90	Weighted Average
	2.267		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	100	0.0200	1.52		**Sheet Flow, Aggregate Surface, 2%** Smooth surfaces n= 0.011 P2= 3.91"
0.7	120	0.0200	2.87		**Shallow Concentrated Flow, Aggregate Surface, 2%** Paved Kv= 20.3 fps
1.8	220	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 28S: S-207 (WTP)



Summary for Subcatchment 29S: 3N

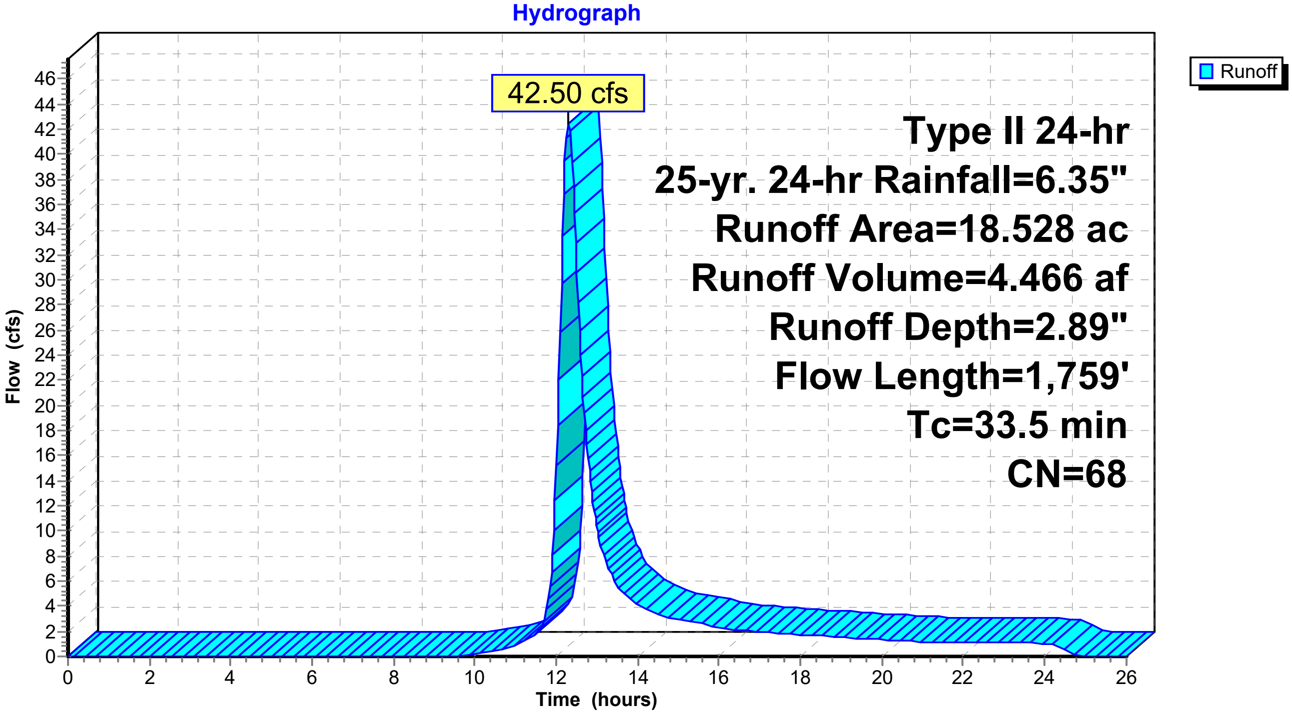
Runoff = 42.50 cfs @ 12.30 hrs, Volume= 4.466 af, Depth= 2.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	12.935	60	3Na Woods
*	5.593	86	3N bare soil below CCR
	18.528	68	Weighted Average
	18.528		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	100	0.0400	0.11		**Sheet Flow, 3Na Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
13.2	794	0.0400	1.00		**Shallow Concentrated Flow, 3Na Woods** Woodland Kv= 5.0 fps
5.6	865	0.0670	2.59		**Shallow Concentrated Flow, 3N bare soil below CCR** Nearly Bare & Untilled Kv= 10.0 fps
33.5	1,759	Total			

Subcatchment 29S: 3N



Summary for Subcatchment 31S: 4N

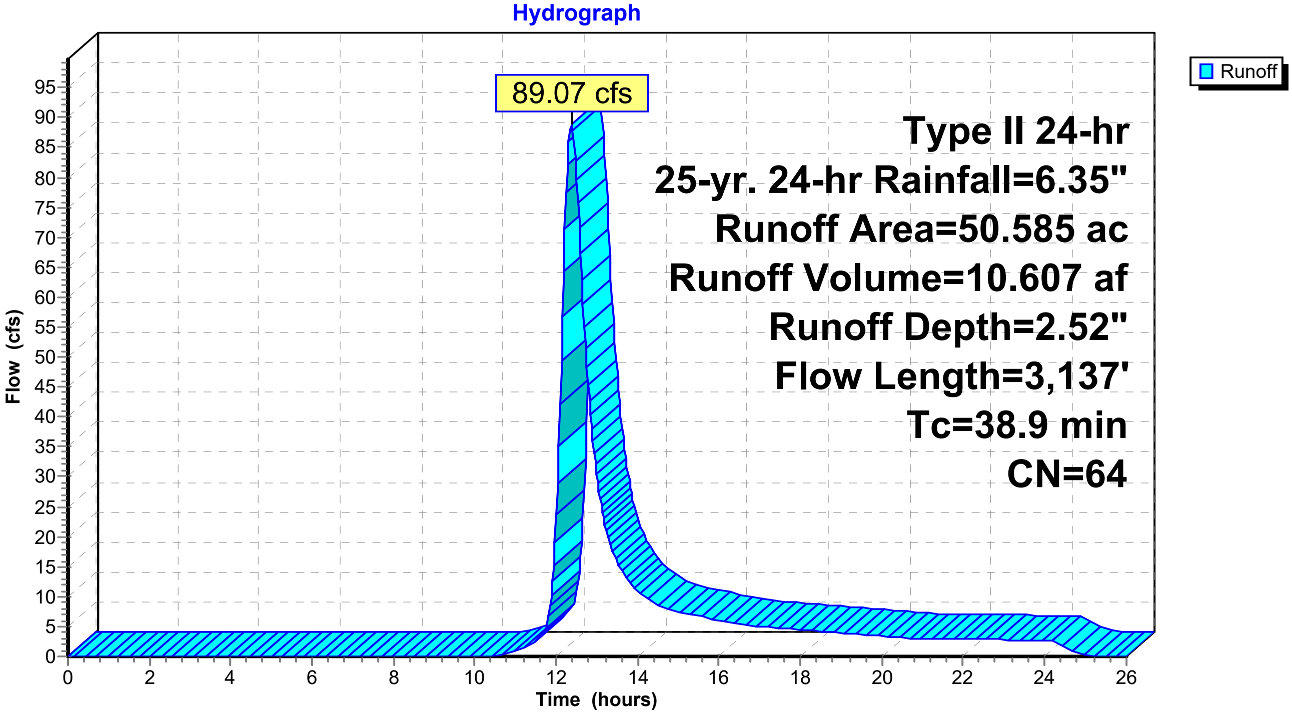
Runoff = 89.07 cfs @ 12.37 hrs, Volume= 10.607 af, Depth= 2.52"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	42.536	60	4Na Woods
*	8.049	86	4N bare soil - below CCR
	50.585	64	Weighted Average
	50.585		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	100	0.1000	0.16		**Sheet Flow, 4Na Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
18.5	1,674	0.0910	1.51		**Shallow Concentrated Flow, 4Na Woods** Woodland Kv= 5.0 fps
10.2	1,363	0.0500	2.24		**Shallow Concentrated Flow, 4N bare soil below CCR** Nearly Bare & Untilled Kv= 10.0 fps
38.9	3,137	Total			

Subcatchment 31S: 4N



Summary for Subcatchment 37S: 5N

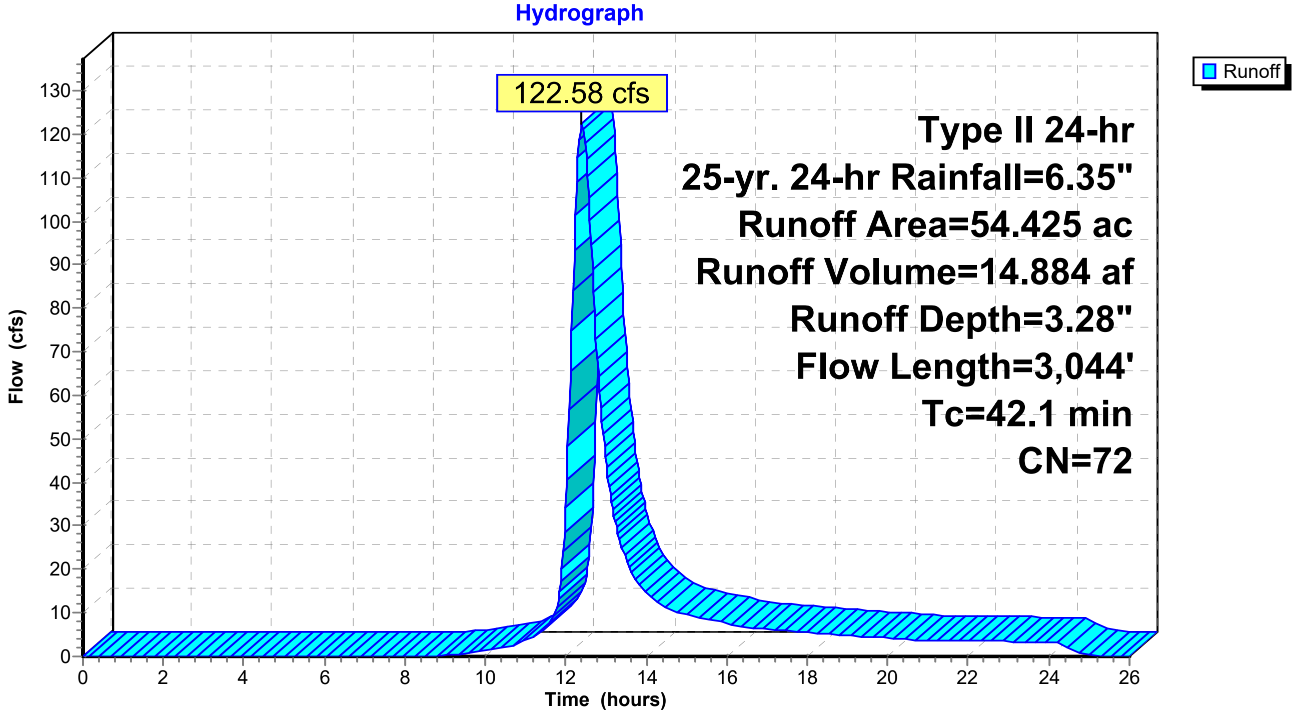
Runoff = 122.58 cfs @ 12.39 hrs, Volume= 14.884 af, Depth= 3.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	29.500	60	5Na Woods
*	24.925	86	5N New DA - bare soil below CCR
	54.425	72	Weighted Average
	54.425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	100	0.0300	0.10		**Sheet Flow, 5Na Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
12.4	1,239	0.1110	1.67		**Shallow Concentrated Flow, 5Na Woods** Woodland Kv= 5.0 fps
13.2	1,705	0.0460	2.14		**Shallow Concentrated Flow, 5N bare soil** Nearly Bare & Untilled Kv= 10.0 fps
42.1	3,044	Total			

Subcatchment 37S: 5N



Summary for Subcatchment 45S: 14S

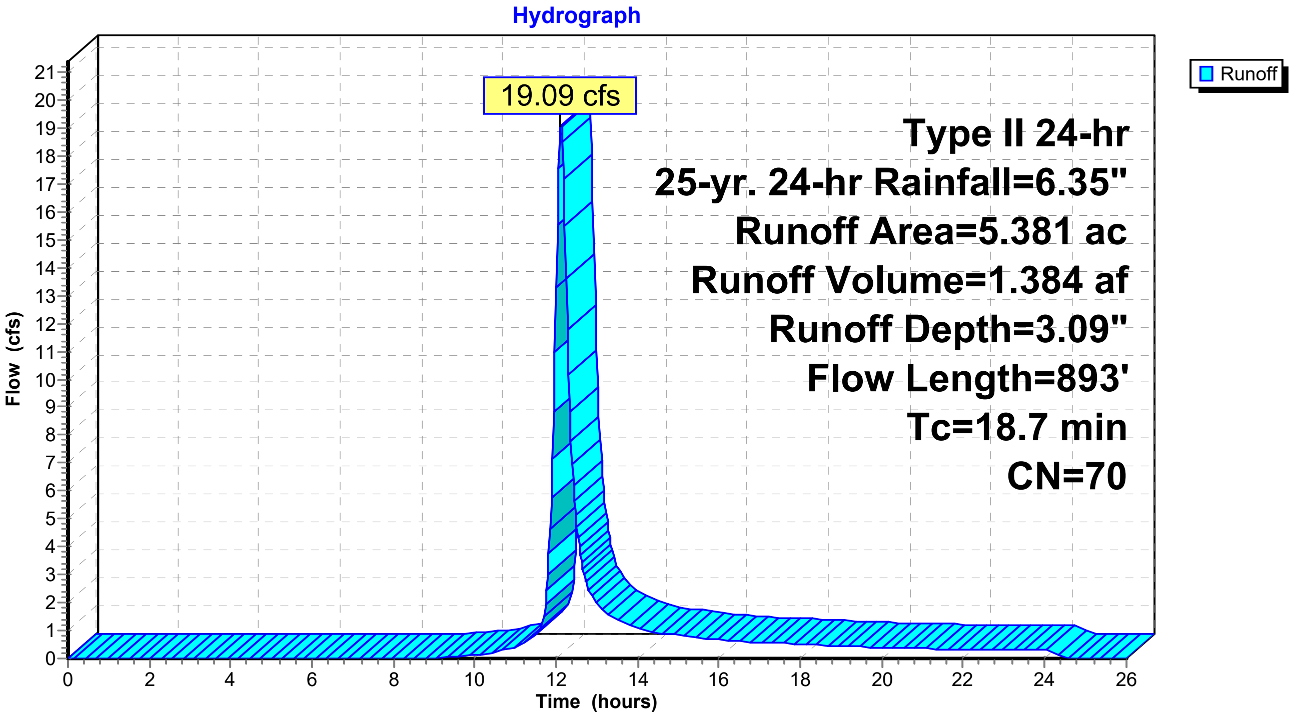
Runoff = 19.09 cfs @ 12.12 hrs, Volume= 1.384 af, Depth= 3.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	3.353	60	Woods
*	2.028	86	Below CCR Removal
	5.381	70	Weighted Average
	5.381		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	100	0.0700	0.14		**Sheet Flow, 14Sa Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
1.4	135	0.1110	1.67		**Shallow Concentrated Flow, 14Sa Woods** Woodland Kv= 5.0 fps
5.5	658	0.0400	2.00		**Shallow Concentrated Flow, New DA - 14S bare soil, below CCR** Nearly Bare & Untilled Kv= 10.0 fps
18.7	893	Total			

Subcatchment 45S: 14S



Summary for Subcatchment 46S: 6N

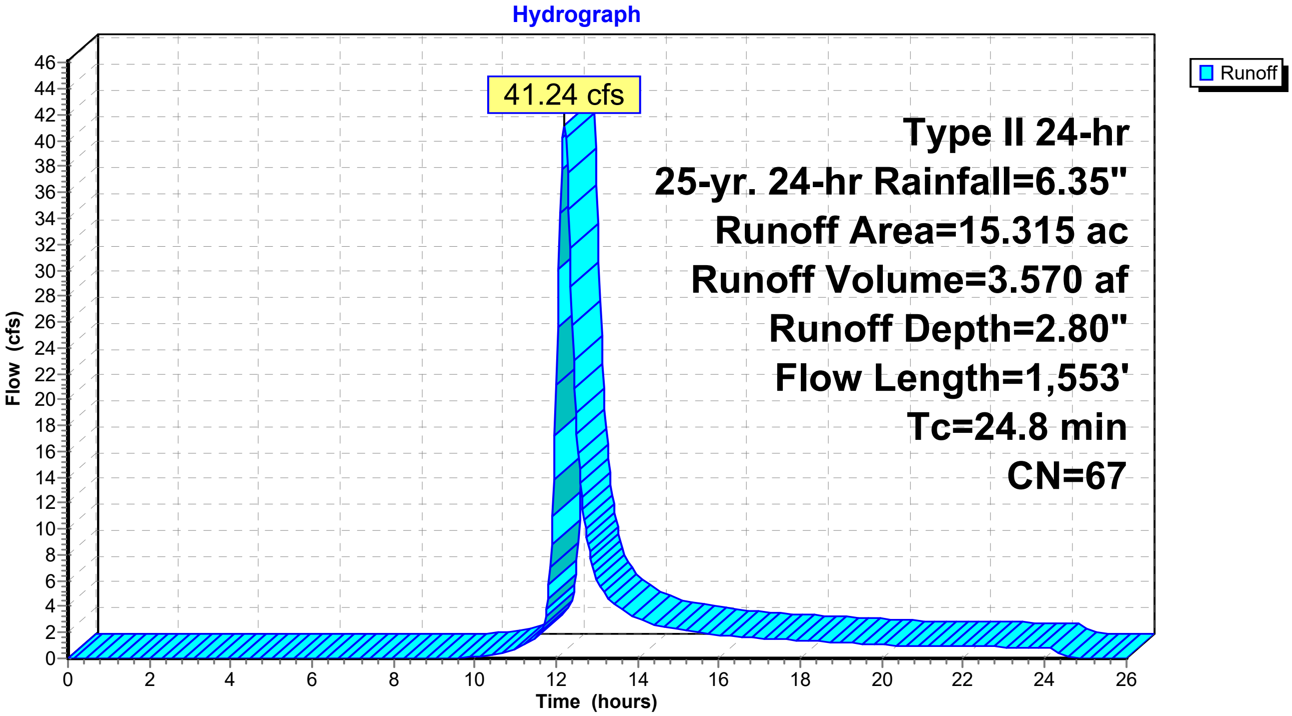
Runoff = 41.24 cfs @ 12.19 hrs, Volume= 3.570 af, Depth= 2.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	11.314	60	6Na Woods
*	4.001	86	6N bare soil below CCR
	15.315	67	Weighted Average
	15.315		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0500	0.12		**Sheet Flow, 6Na Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
6.8	735	0.1290	1.80		**Shallow Concentrated Flow, 6Na Woods** Woodland Kv= 5.0 fps
4.5	718	0.0720	2.68		**Shallow Concentrated Flow, 6N bare soil** Nearly Bare & Untilled Kv= 10.0 fps
24.8	1,553	Total			

Subcatchment 46S: 6N



Summary for Subcatchment 47S: 13S

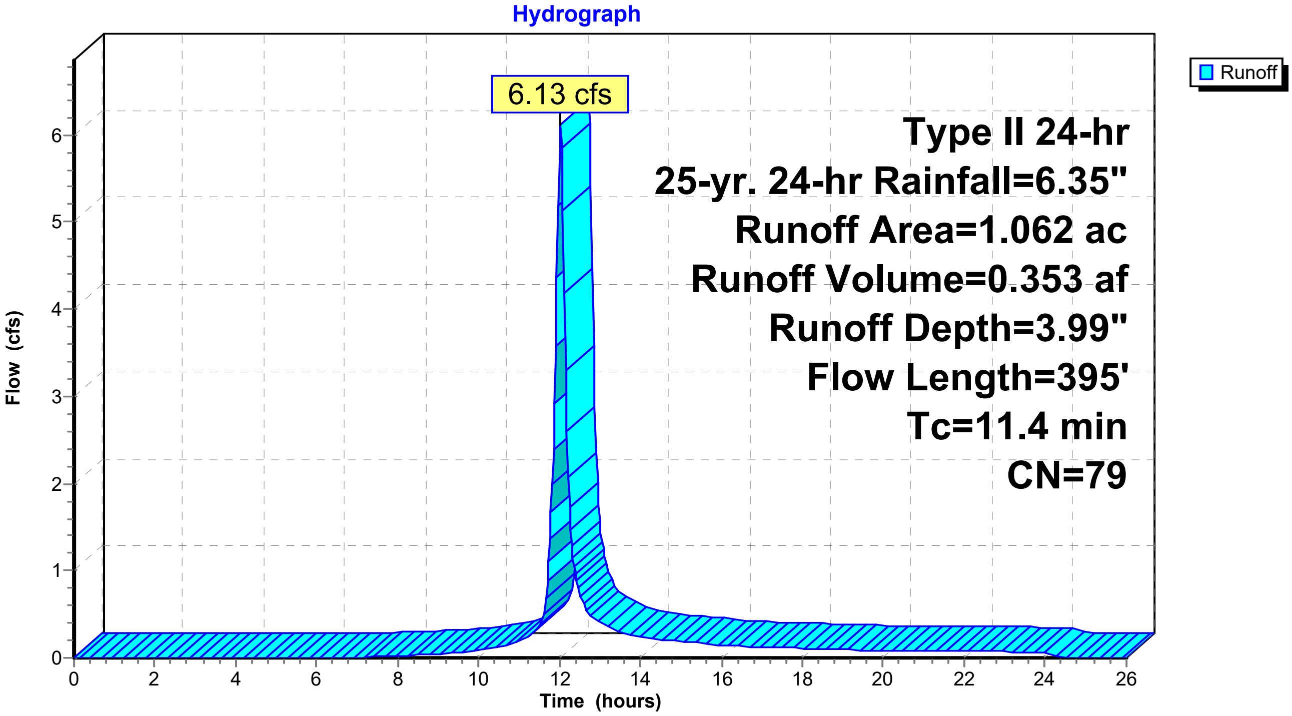
Runoff = 6.13 cfs @ 12.03 hrs, Volume= 0.353 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.297	60	13Sa Woods
*	0.765	86	New DA - 13S bare soil below CCR
	1.062	79	Weighted Average
	1.062		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.1200	0.18		**Sheet Flow, Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
1.9	295	0.0680	2.61		**Shallow Concentrated Flow, 13S bare soil below CCR** Nearly Bare & Untilled Kv= 10.0 fps
11.4	395	Total			

Subcatchment 47S: 13S



Summary for Subcatchment 48S: 1314S

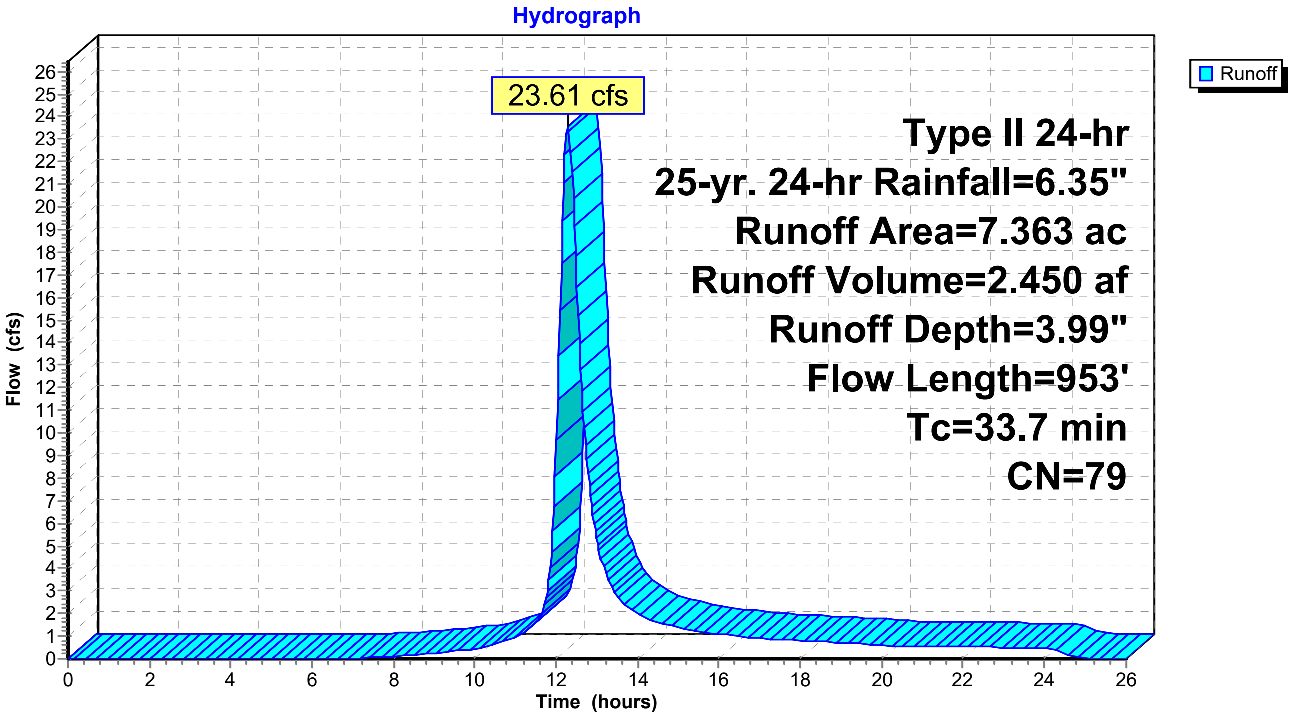
Runoff = 23.61 cfs @ 12.28 hrs, Volume= 2.450 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	2.019	60	1314Sa and 1314Sb Woods
*	5.344	86	1314S New DA - bare soil below CCR
	7.363	79	Weighted Average
	7.363		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	100	0.0900	0.16		**Sheet Flow, Woods 1314Sa** Woods: Light underbrush n= 0.400 P2= 3.91"
0.5	38	0.0780	1.40		**Shallow Concentrated Flow, Woods 1314Sa** Woodland Kv= 5.0 fps
4.4	568	0.0460	2.14		**Shallow Concentrated Flow, 1314S** Nearly Bare & Untilled Kv= 10.0 fps
16.5	100	0.0300	0.10		**Sheet Flow, 1314Sb Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
1.7	147	0.0820	1.43		**Shallow Concentrated Flow, 1314Sb Woods** Woodland Kv= 5.0 fps
33.7	953	Total			

Subcatchment 48S: 1314S



Summary for Subcatchment 49S: 11S

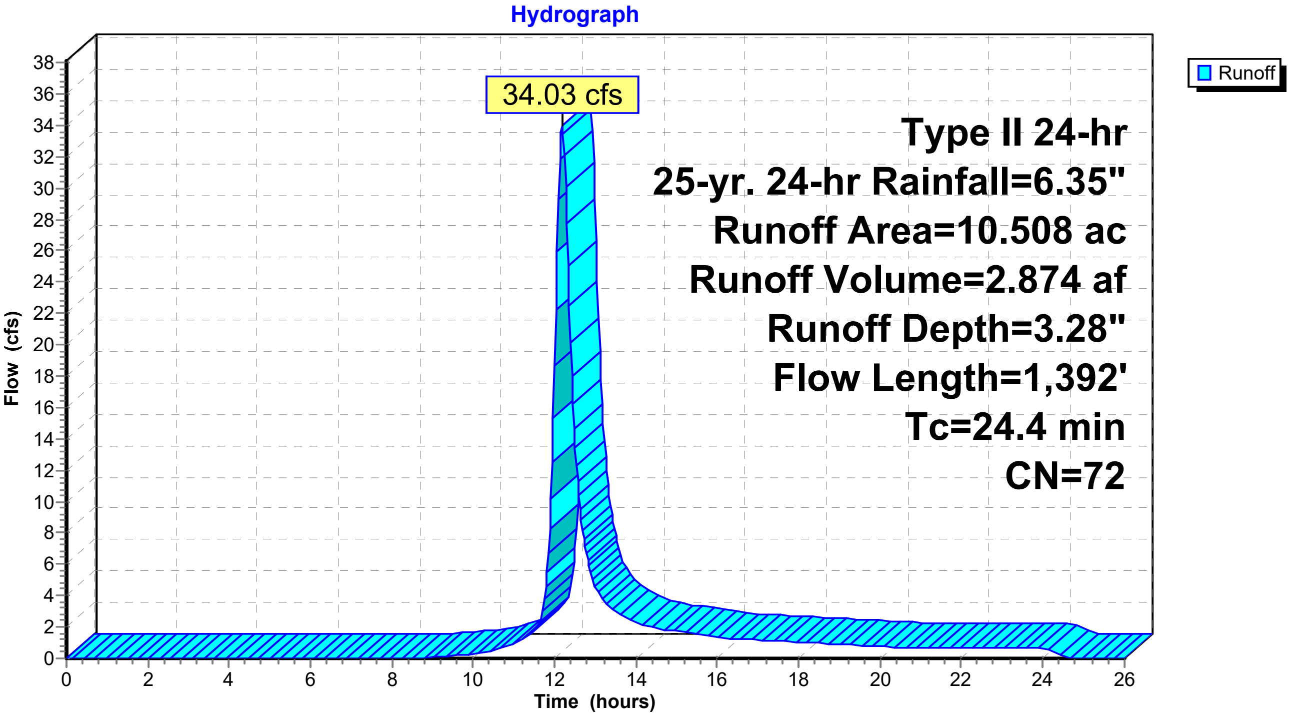
Runoff = 34.03 cfs @ 12.18 hrs, Volume= 2.874 af, Depth= 3.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	5.646	60	11Sa
*	4.862	86	11S New DA - bare soil below CCR
	10.508	72	Weighted Average
	10.508		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0500	0.12		**Sheet Flow, 11Sa Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
3.8	364	0.1020	1.60		**Shallow Concentrated Flow, 11Sa Woods** Woodland Kv= 5.0 fps
7.1	928	0.0470	2.17		**Shallow Concentrated Flow, 11S bare soil below CCR** Nearly Bare & Untilled Kv= 10.0 fps
24.4	1,392	Total			

Subcatchment 49S: 11S



Summary for Subcatchment 50S: 10S

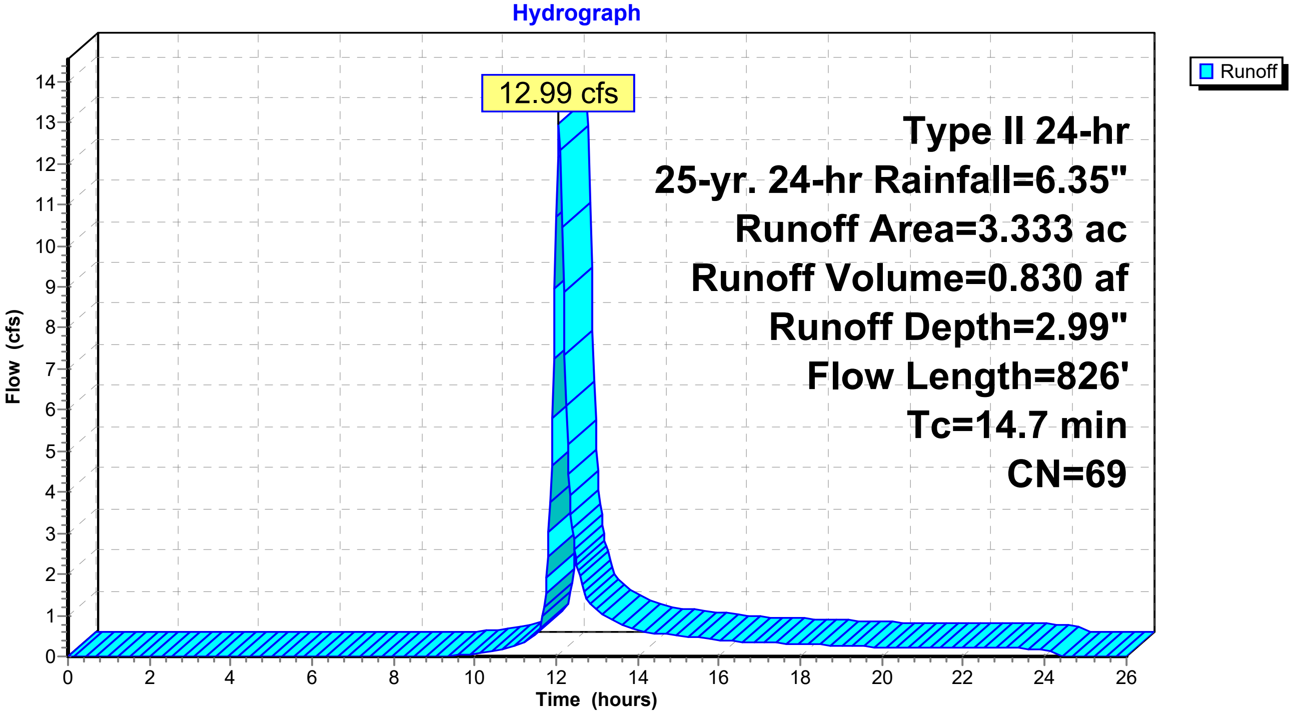
Runoff = 12.99 cfs @ 12.07 hrs, Volume= 0.830 af, Depth= 2.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	2.151	60	10Sa Woods
*	1.182	86	10Sa New DA - bare soil below CCR
	3.333	69	Weighted Average
	3.333		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.1200	0.18		**Sheet Flow, 10Sa Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
2.1	223	0.1200	1.73		**Shallow Concentrated Flow, 10Sa Woods** Woodland Kv= 5.0 fps
3.1	503	0.0750	2.74		**Shallow Concentrated Flow, 12S Bare soil Below CCR** Nearly Bare & Untilled Kv= 10.0 fps
14.7	826	Total			

Subcatchment 50S: 10S



Summary for Subcatchment 51S: 9S

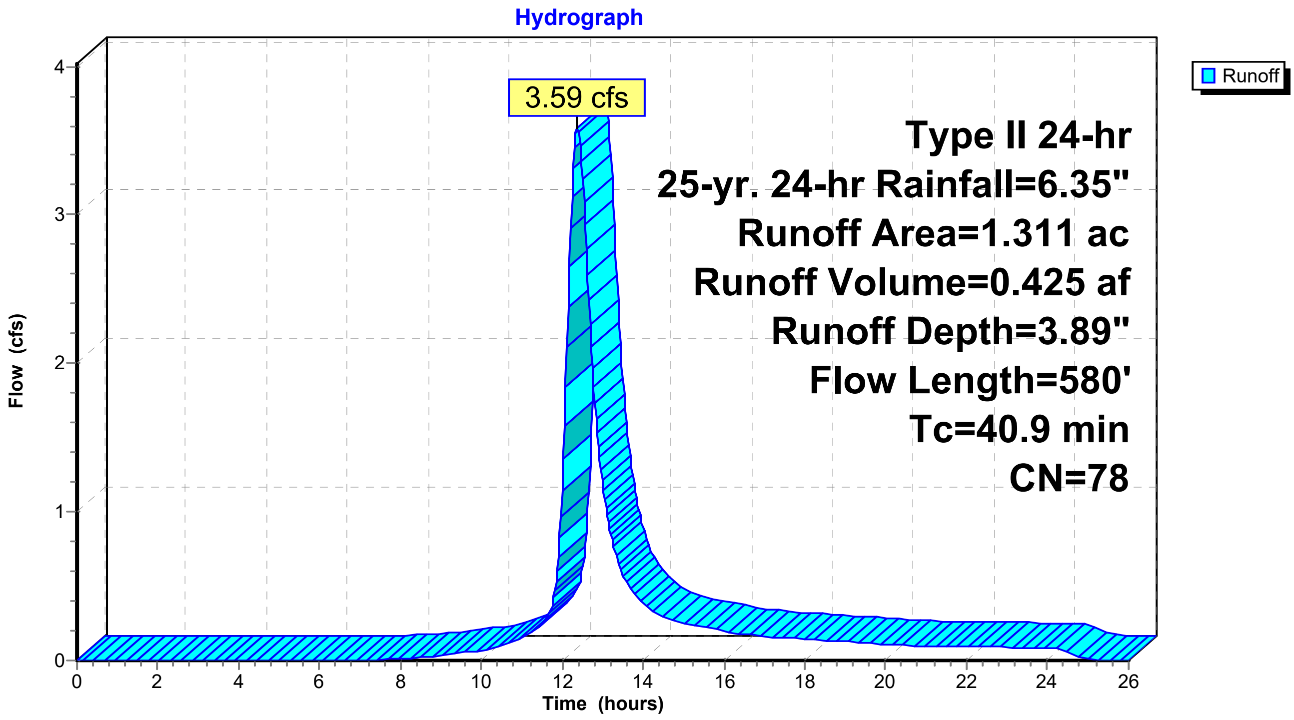
Runoff = 3.59 cfs @ 12.38 hrs, Volume= 0.425 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.384	60	9Sm and 9Sa Woods
*	0.927	86	9S - bare soil below CCR
	1.311	78	Weighted Average
	1.311		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	380	0.0920	3.03		**Shallow Concentrated Flow, bare soil below CCR 9S** Nearly Bare & Untilled Kv= 10.0 fps
19.4	100	0.0200	0.09		**Sheet Flow, 9Sm Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
19.4	100	0.0200	0.09		**Sheet Flow, 9Sa Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
40.9	580	Total			

Subcatchment 51S: 9S



Summary for Subcatchment 53S: 12S

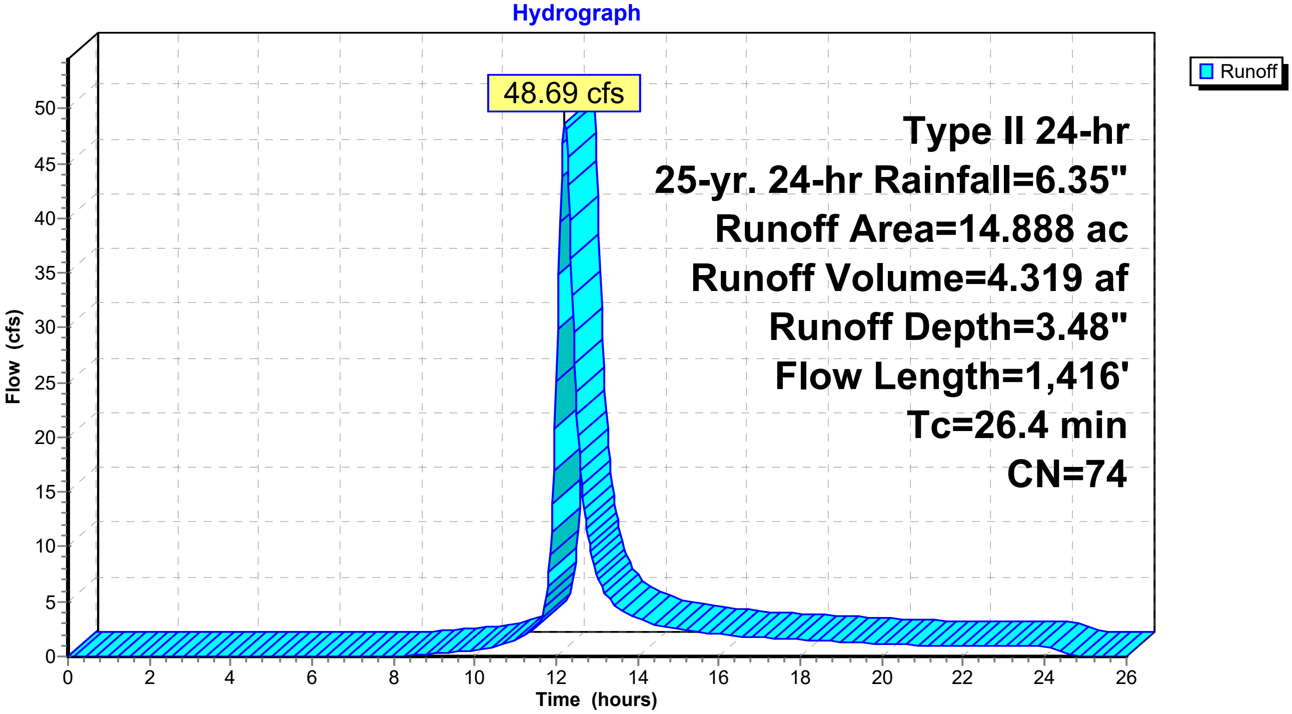
Runoff = 48.69 cfs @ 12.20 hrs, Volume= 4.319 af, Depth= 3.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	6.975	60	12Sa
*	7.913	86	12S New DA -below CCR bare soil
	14.888	74	Weighted Average
	14.888		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	100	0.0400	0.11		**Sheet Flow, 12Sa** Woods: Light underbrush n= 0.400 P2= 3.91"
4.5	378	0.0790	1.41		**Shallow Concentrated Flow, 12Sa** Woodland Kv= 5.0 fps
7.2	938	0.0470	2.17		**Shallow Concentrated Flow, 12S Bare soil** Nearly Bare & Untilled Kv= 10.0 fps
26.4	1,416	Total			

Subcatchment 53S: 12S



Summary for Subcatchment 60S: 7S

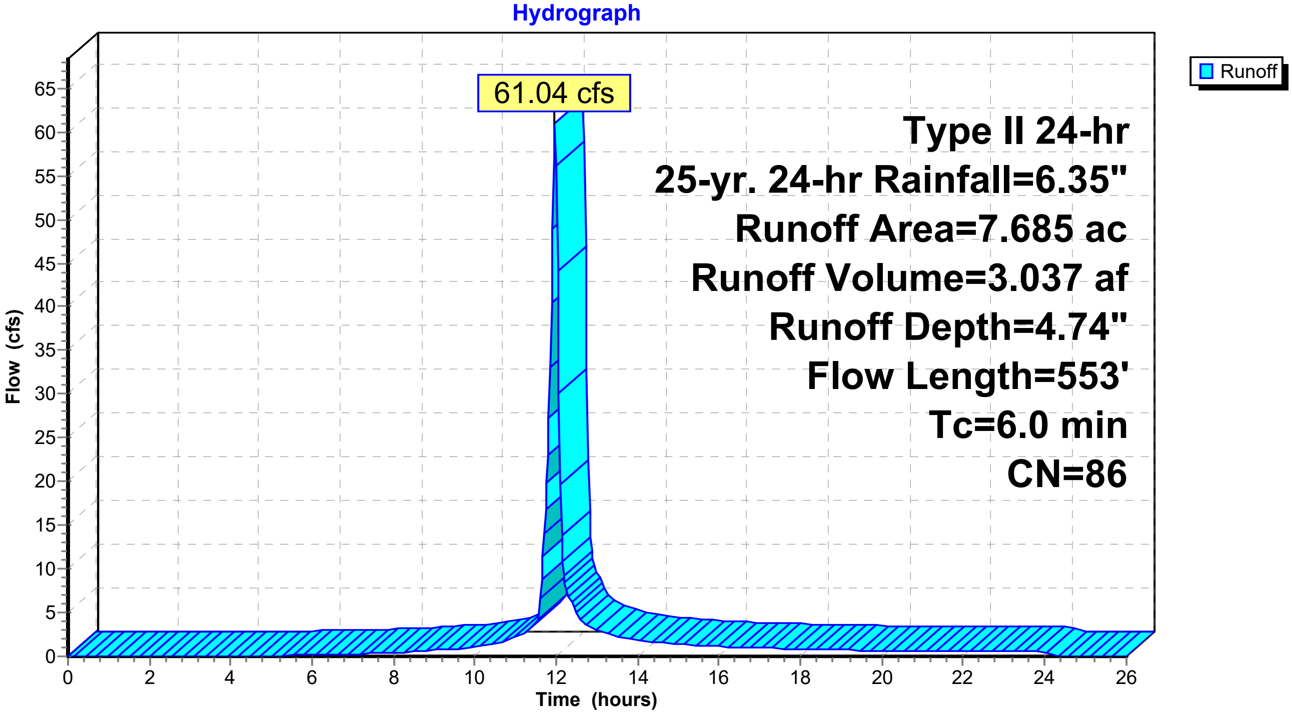
Runoff = 61.04 cfs @ 11.97 hrs, Volume= 3.037 af, Depth= 4.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	7.685	86	7S bare soil below CCR
	7.685		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	453	0.1020	3.19		**Shallow Concentrated Flow, 7S bare soil** Nearly Bare & Untilled Kv= 10.0 fps
0.3	100	0.3600	4.83		**Sheet Flow, 7S bare soil** Smooth surfaces n= 0.011 P2= 3.91"
2.7	553	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 60S: 7S



Summary for Subcatchment 63S: 8S

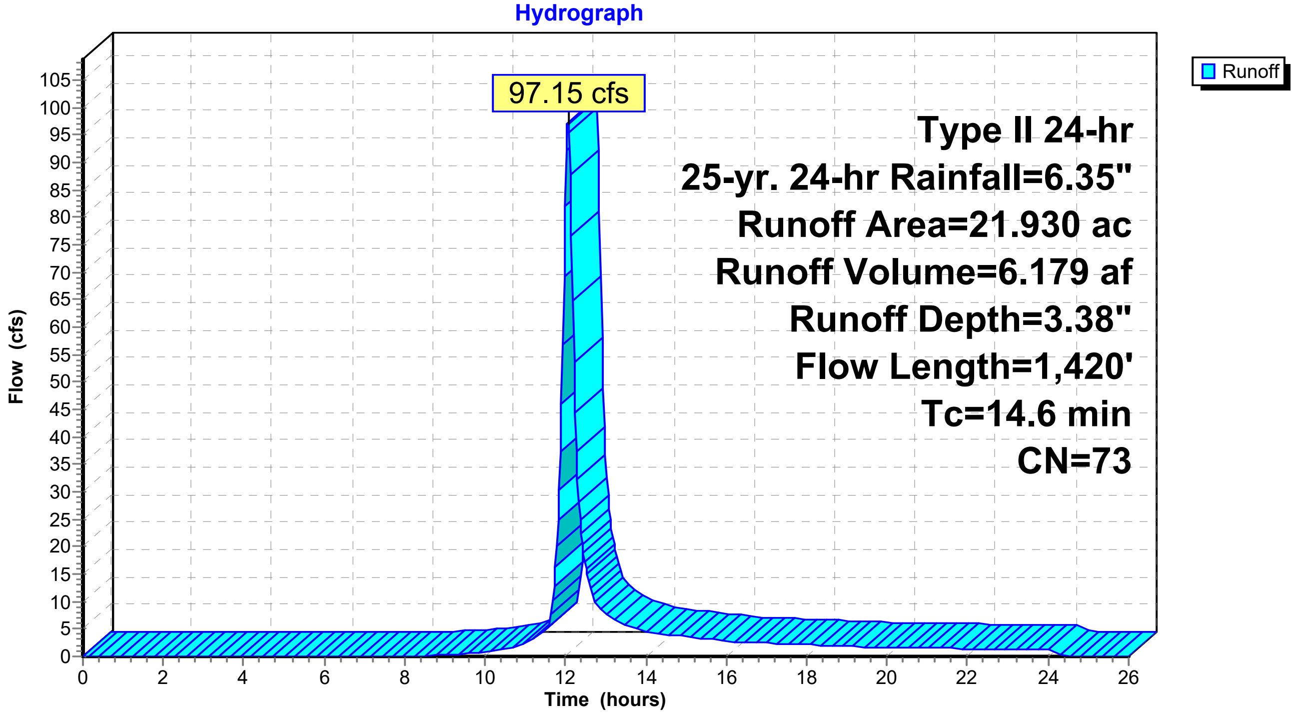
Runoff = 97.15 cfs @ 12.07 hrs, Volume= 6.179 af, Depth= 3.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	11.393	61	8Sa Grassed slope
*	10.537	86	8S bare soil below CCR
	21.930	73	Weighted Average
	21.930		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	100	0.2000	0.47		**Sheet Flow, 8Sa grassed slope** Grass: Short n= 0.150 P2= 3.91"
3.7	429	0.0770	1.94		**Shallow Concentrated Flow, 8Sa grassed slope** Short Grass Pasture Kv= 7.0 fps
7.4	891	0.0400	2.00		**Shallow Concentrated Flow, 8S Bare soil below CCR** Nearly Bare & Untilled Kv= 10.0 fps
14.6	1,420	Total			

Subcatchment 63S: 8S



Summary for Subcatchment 66S: 910S

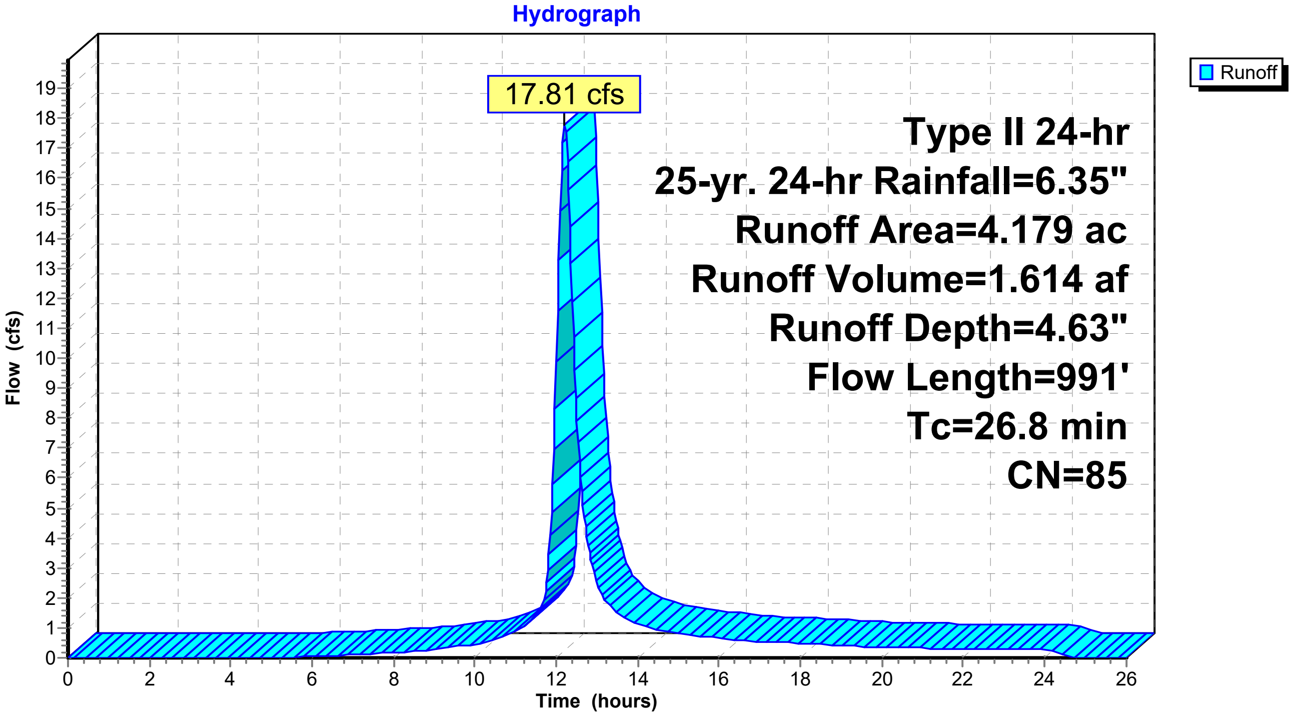
Runoff = 17.81 cfs @ 12.19 hrs, Volume= 1.614 af, Depth= 4.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Type II 24-hr 25-yr. 24-hr Rainfall=6.35"

	Area (ac)	CN	Description
*	0.236	60	910Sa Woods
*	3.943	86	910S- bare soil
	4.179	85	Weighted Average
	4.179		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.4	100	0.0200	0.09		**Sheet Flow, 910Sa Woods** Woods: Light underbrush n= 0.400 P2= 3.91"
7.4	891	0.0400	2.00		**Shallow Concentrated Flow, 9S bare soil** Nearly Bare & Untilled Kv= 10.0 fps
26.8	991	Total			

Subcatchment 66S: 910S



Summary for Reach 2R: PC 200

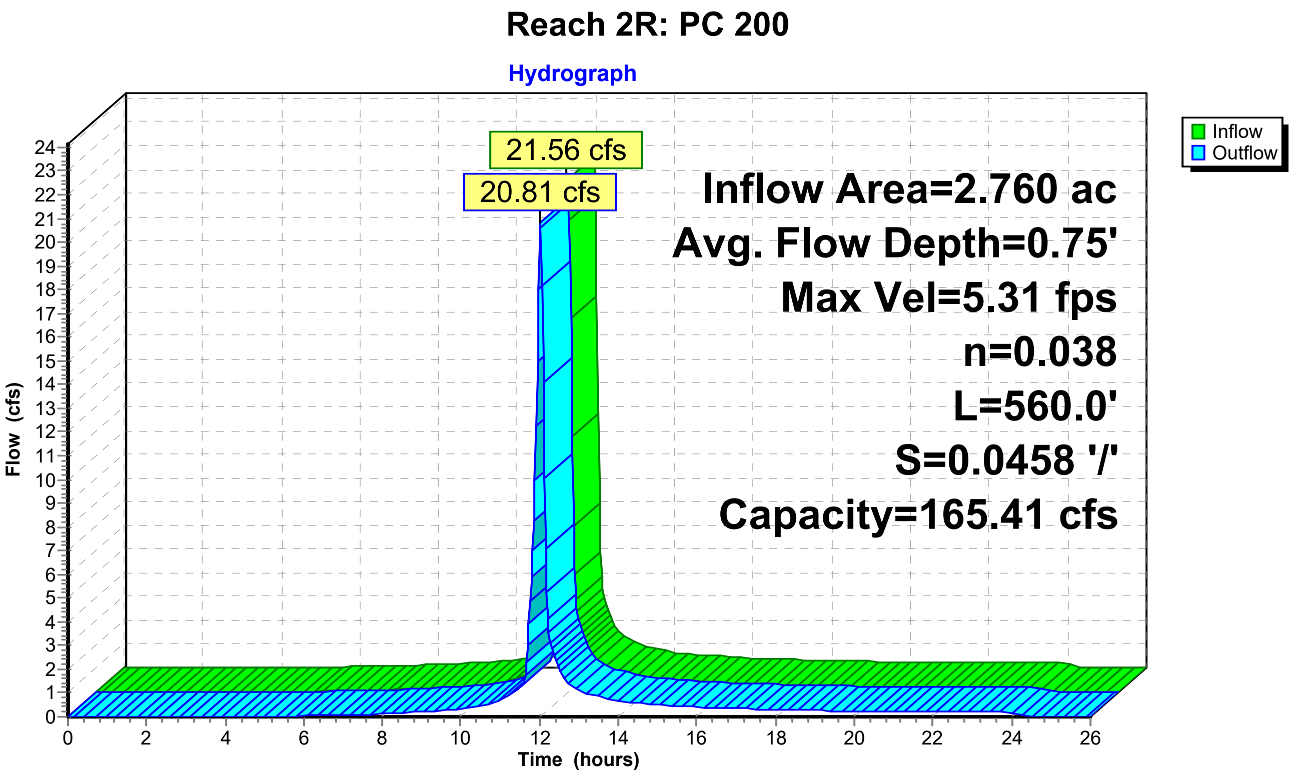
Inflow Area = 2.760 ac, 0.00% Impervious, Inflow Depth = 4.63" for 25-yr. 24-hr event
Inflow = 21.56 cfs @ 11.97 hrs, Volume= 1.066 af
Outflow = 20.81 cfs @ 12.02 hrs, Volume= 1.066 af, Atten= 3%, Lag= 3.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 5.31 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.35 fps, Avg. Travel Time= 6.9 min

Peak Storage= 2,194 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.75'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 165.41 cfs

3.00' x 2.00' deep channel, n= 0.038
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 560.0' Slope= 0.0458 '/'
Inlet Invert= 828.91', Outlet Invert= 803.25'

‡



Summary for Reach 6R: PC 203

Inflow Area = 0.740 ac, 0.00% Impervious, Inflow Depth = 4.20" for 25-yr. 24-hr event
Inflow = 5.36 cfs @ 11.97 hrs, Volume= 0.259 af
Outflow = 5.03 cfs @ 12.03 hrs, Volume= 0.259 af, Atten= 6%, Lag= 3.7 min

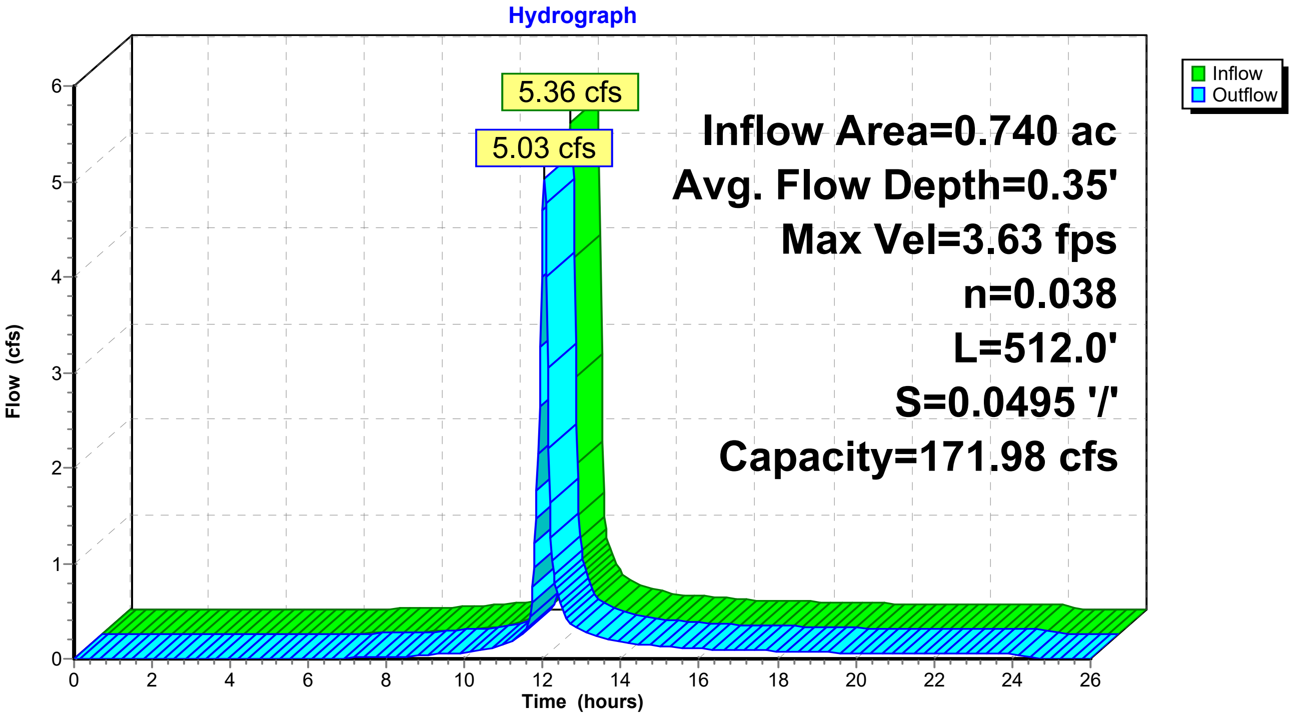
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 3.63 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.91 fps, Avg. Travel Time= 9.4 min

Peak Storage= 718 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 171.98 cfs

3.00' x 2.00' deep channel, n= 0.038
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 512.0' Slope= 0.0495 '/'
Inlet Invert= 828.70', Outlet Invert= 803.34'

‡

Reach 6R: PC 203



Summary for Reach 8R: PC 204

[62] Hint: Exceeded Reach 18R OUTLET depth by 0.01' @ 24.48 hrs

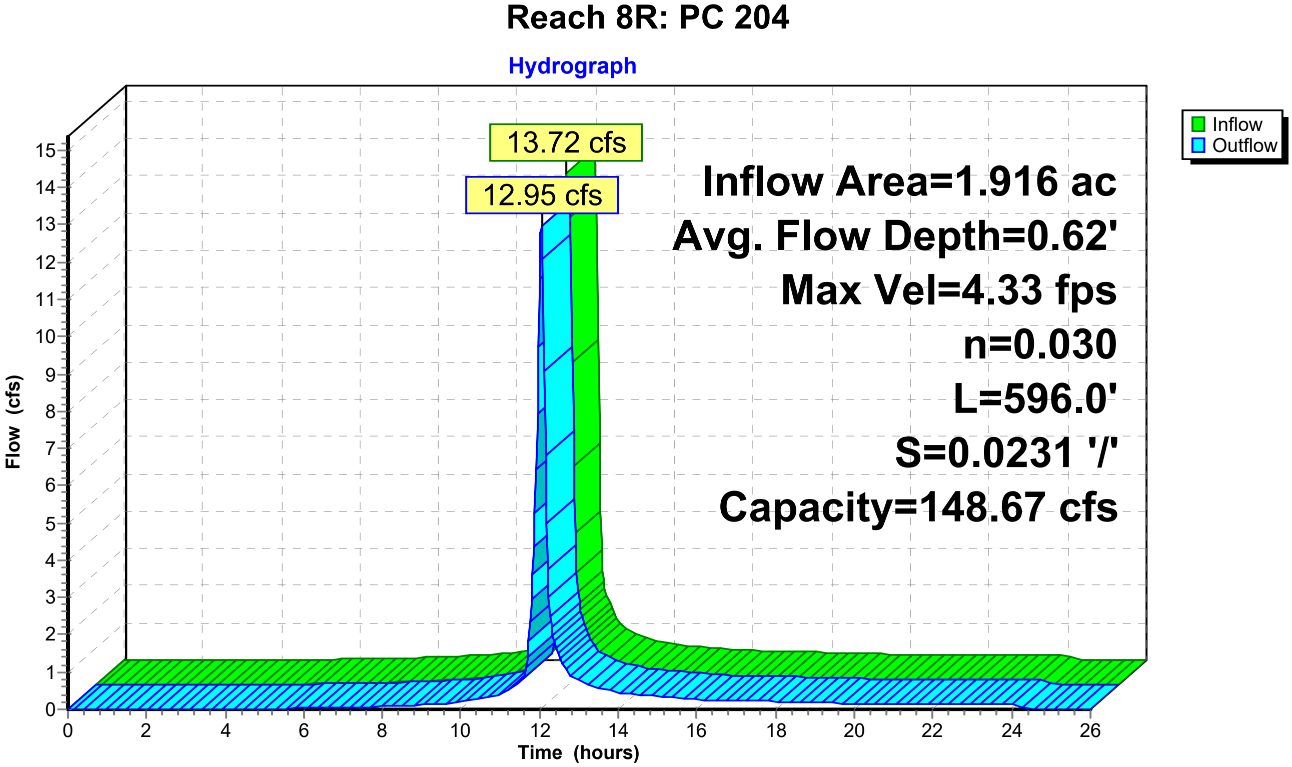
Inflow Area =	1.916 ac,	0.00% Impervious, Inflow Depth =	4.35"	for 25-yr. 24-hr event
Inflow =	13.72 cfs @	11.98 hrs, Volume=	0.695 af	
Outflow =	12.95 cfs @	12.04 hrs, Volume=	0.695 af,	Atten= 6%, Lag= 3.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 4.33 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 9.2 min

Peak Storage= 1,805 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.62'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 148.67 cfs

3.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 596.0' Slope= 0.0231 '/'
Inlet Invert= 823.75', Outlet Invert= 810.00'

‡



Summary for Reach 9R: PC 205

Inflow Area = 0.565 ac, 0.00% Impervious, Inflow Depth = 4.53" for 25-yr. 24-hr event
Inflow = 4.34 cfs @ 11.97 hrs, Volume= 0.213 af
Outflow = 4.18 cfs @ 12.01 hrs, Volume= 0.213 af, Atten= 3%, Lag= 2.3 min

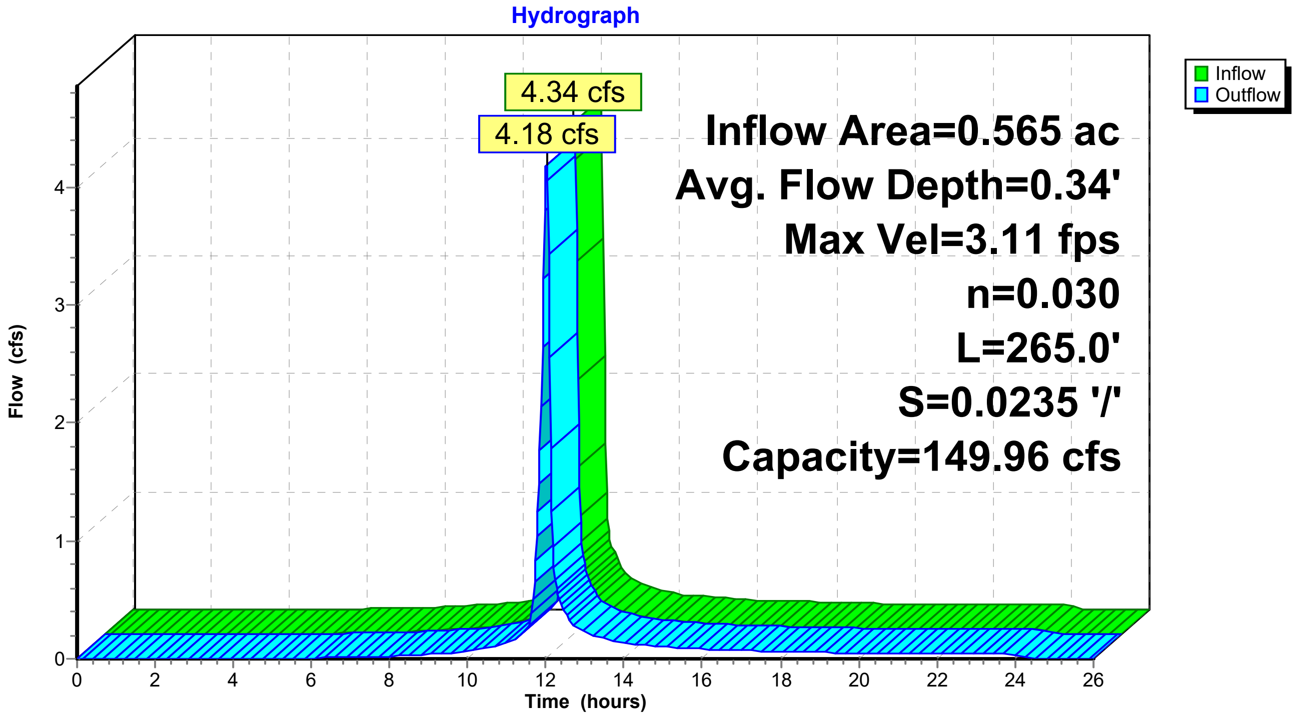
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 3.11 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.77 fps, Avg. Travel Time= 5.7 min

Peak Storage= 360 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 149.96 cfs

3.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 265.0' Slope= 0.0235 '/'
Inlet Invert= 829.09', Outlet Invert= 822.87'

‡

Reach 9R: PC 205



Summary for Reach 10R: Pipe 200

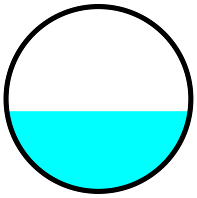
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach 11R OUTLET depth by 0.89' @ 12.03 hrs
[62] Hint: Exceeded Reach 15R OUTLET depth by 0.59' @ 12.03 hrs

```
Inflow Area =         4.122 ac,    0.00% Impervious,  Inflow Depth =   3.99"    for  25-yr. 24-hr event
Inflow       =       26.27 cfs @   12.02 hrs,  Volume=             1.370 af
Outflow      =       26.18 cfs @   12.02 hrs,  Volume=             1.370 af,  Atten= 0%,  Lag= 0.2 min
```

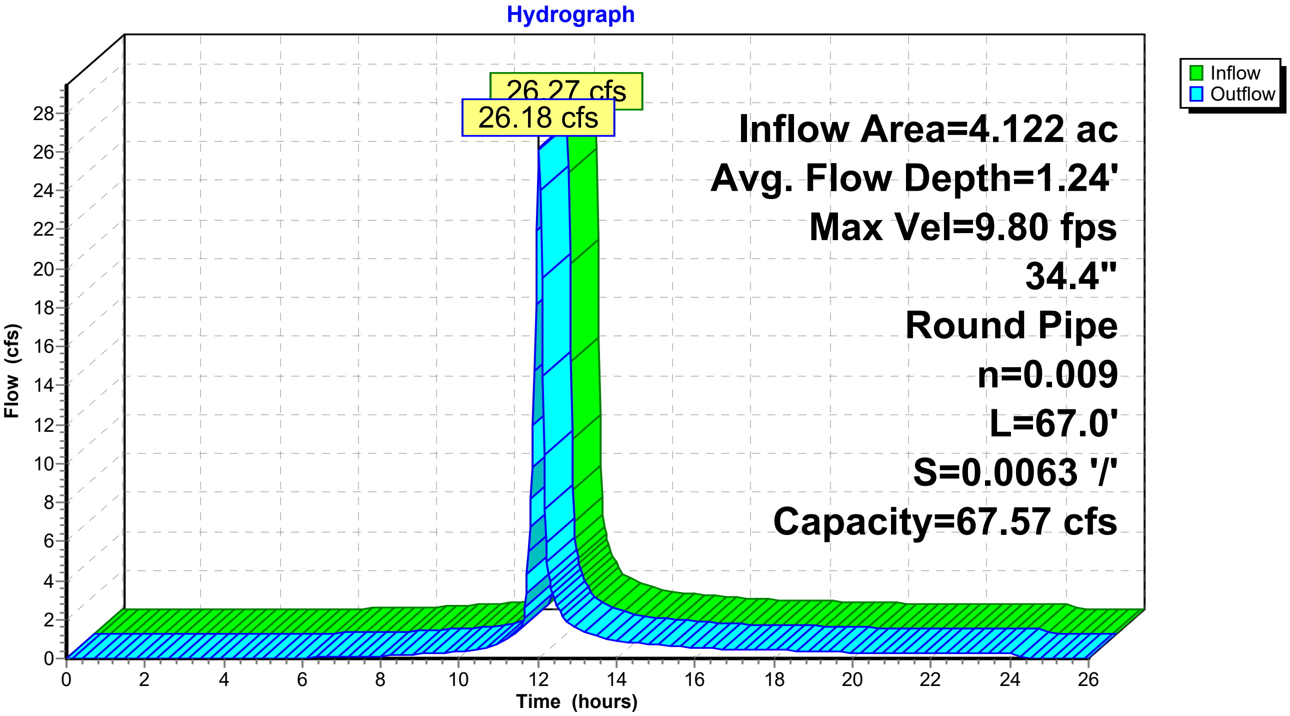
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 9.80 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.76 fps, Avg. Travel Time= 0.4 min

Peak Storage= 179 cf @ 12.02 hrs
Average Depth at Peak Storage= 1.24'
Bank-Full Depth= 2.87' Flow Area= 6.5 sf, Capacity= 67.57 cfs

34.4" Round Pipe
n= 0.009
Length= 67.0' Slope= 0.0063 '/'
Inlet Invert= 795.25', Outlet Invert= 794.83'



Reach 10R: Pipe 200



Summary for Reach 11R: PC 201

[61] Hint: Exceeded Reach 20R outlet invert by 0.35' @ 12.03 hrs

Inflow Area = 0.976 ac, 0.00% Impervious, Inflow Depth = 2.24" for 25-yr. 24-hr event
Inflow = 3.68 cfs @ 12.03 hrs, Volume= 0.182 af
Outflow = 3.61 cfs @ 12.05 hrs, Volume= 0.182 af, Atten= 2%, Lag= 0.9 min

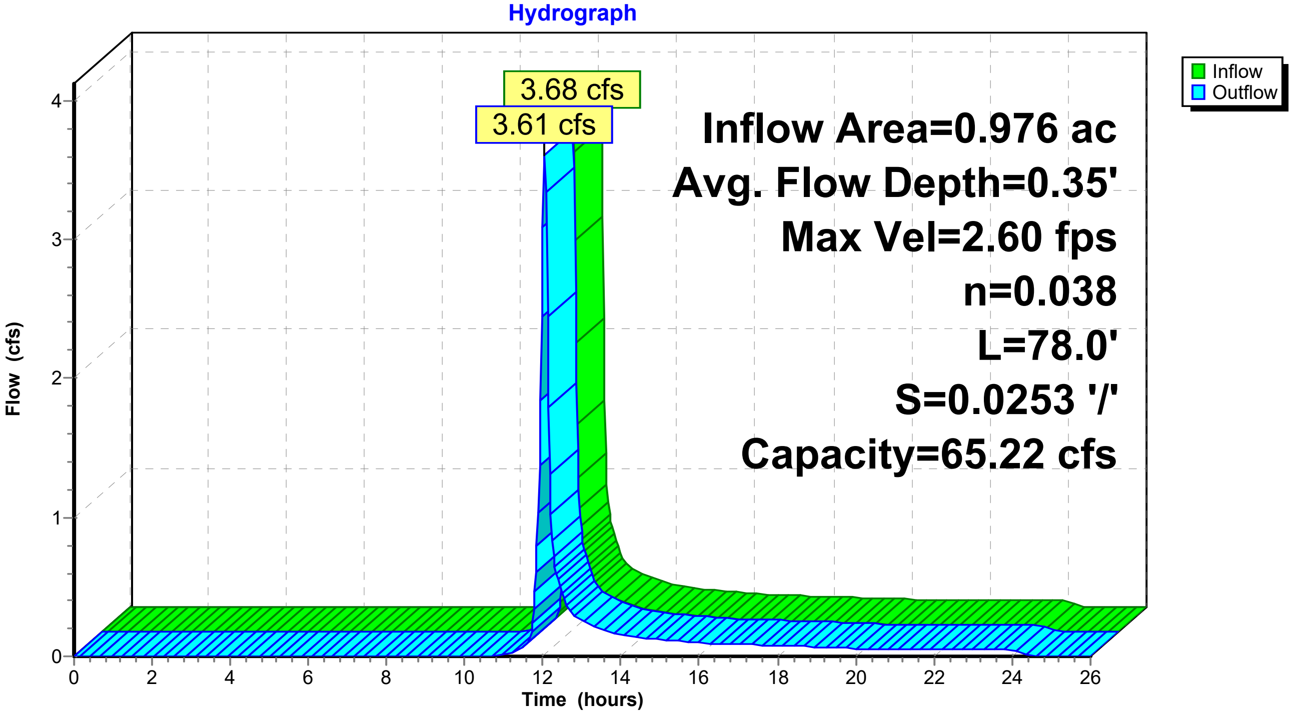
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 2.60 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 0.71 fps, Avg. Travel Time= 1.8 min

Peak Storage= 110 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.50' Flow Area= 11.3 sf, Capacity= 65.22 cfs

3.00' x 1.50' deep channel, n= 0.038
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 78.0' Slope= 0.0253 '/'
Inlet Invert= 797.22', Outlet Invert= 795.25'

‡

Reach 11R: PC 201



Summary for Reach 13R: PC 206

[62] Hint: Exceeded Reach 6R OUTLET depth by 0.03' @ 12.12 hrs

Inflow Area =	0.887 ac,	0.00% Impervious,	Inflow Depth =	4.03"	for 25-yr. 24-hr event	
Inflow =	5.66 cfs @	12.02 hrs,	Volume=	0.298 af		
Outflow =	5.61 cfs @	12.03 hrs,	Volume=	0.298 af,	Atten= 1%,	Lag= 0.4 min

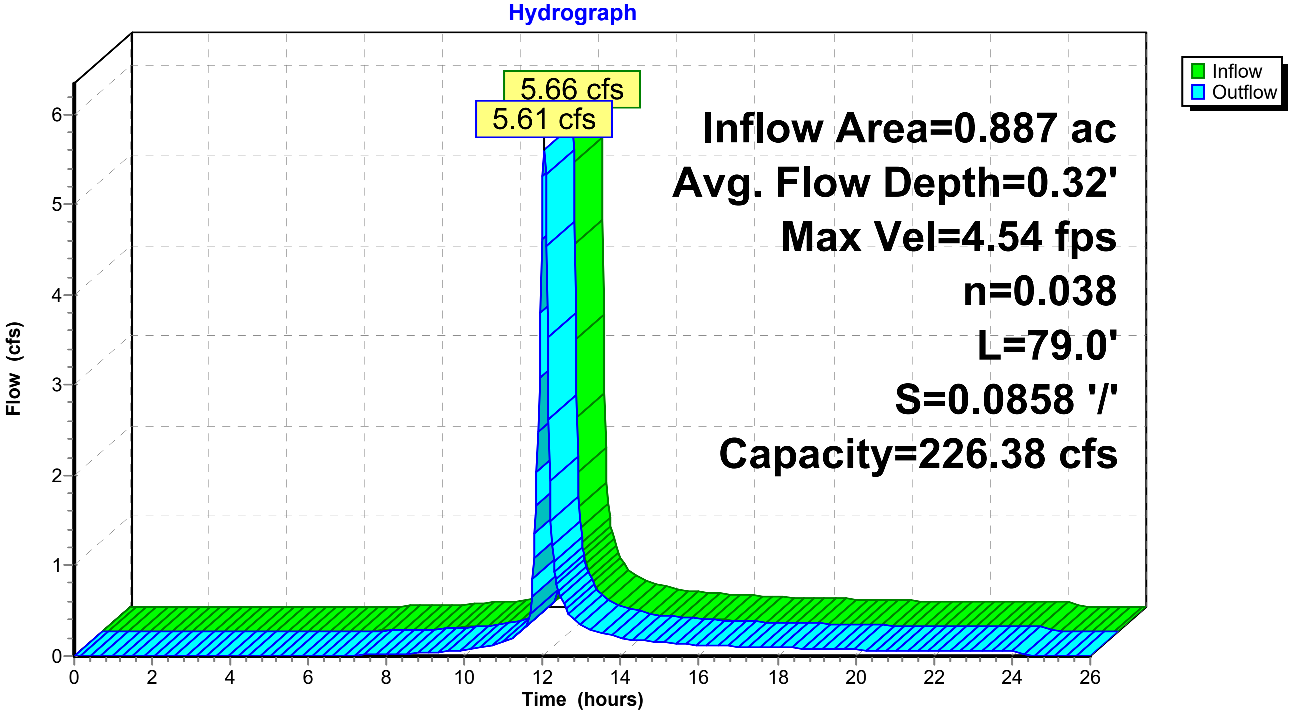
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 4.54 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.15 fps, Avg. Travel Time= 1.1 min

Peak Storage= 98 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 226.38 cfs

3.00' x 2.00' deep channel, n= 0.038
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 79.0' Slope= 0.0858 '/'
Inlet Invert= 803.34', Outlet Invert= 796.56'

‡

Reach 13R: PC 206



Summary for Reach 15R: PC 202

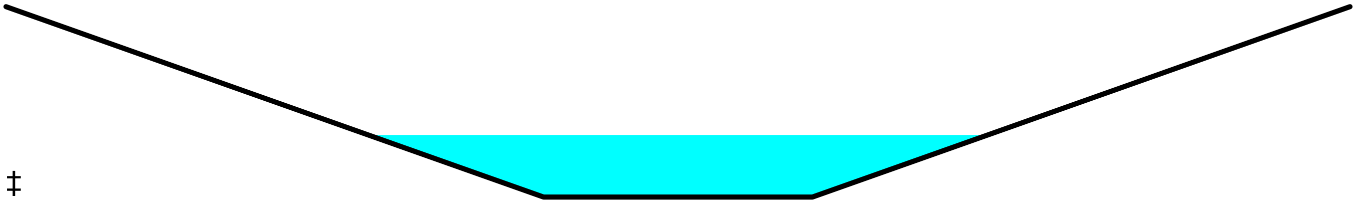
[62] Hint: Exceeded Reach 2R OUTLET depth by 0.02' @ 12.12 hrs

```
Inflow Area =       3.146 ac,   0.00% Impervious,  Inflow Depth =   4.53"    for  25-yr. 24-hr event
Inflow      =      22.92 cfs @   12.01 hrs,  Volume=          1.188 af
Outflow     =      22.83 cfs @   12.02 hrs,  Volume=          1.188 af,  Atten= 0%,  Lag= 0.3 min
```

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 7.06 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.79 fps, Avg. Travel Time= 0.8 min

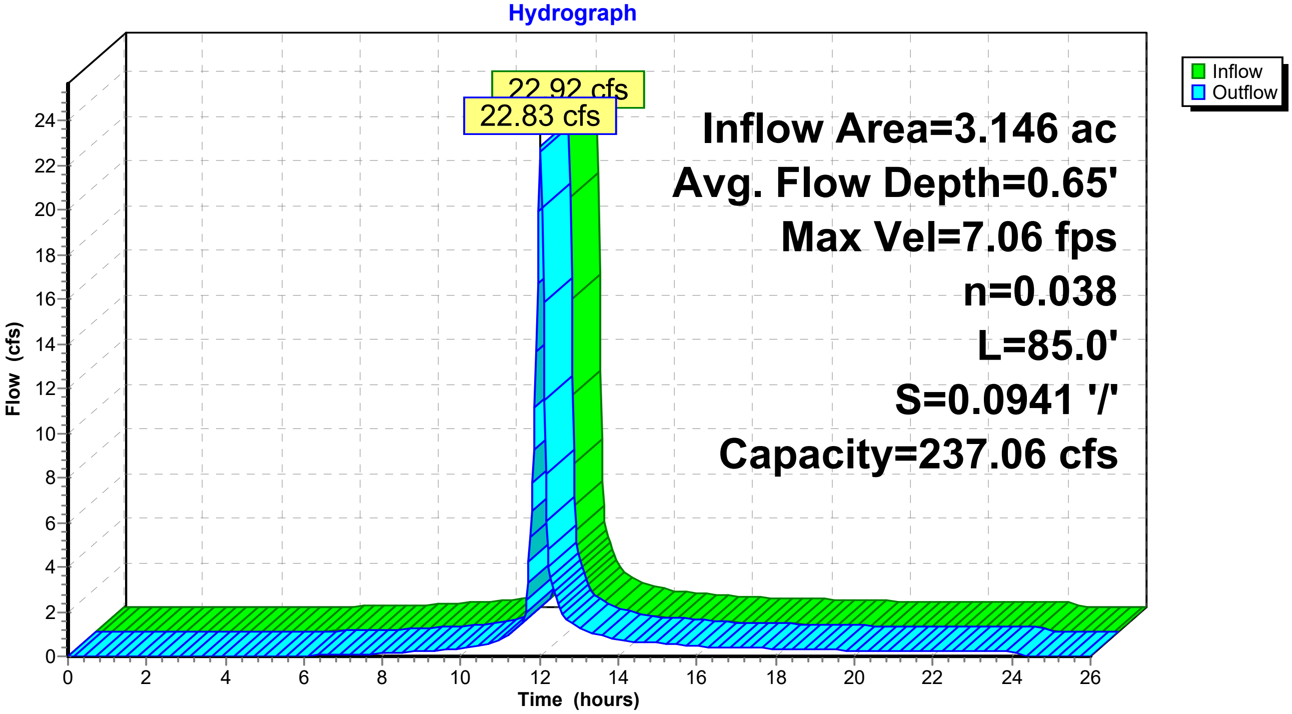
Peak Storage= 275 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.65'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 237.06 cfs

3.00' x 2.00' deep channel, n= 0.038
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 85.0' Slope= 0.0941 '/'
Inlet Invert= 803.25', Outlet Invert= 795.25'



‡

Reach 15R: PC 202



Summary for Reach 16R: PC 208(A/B)

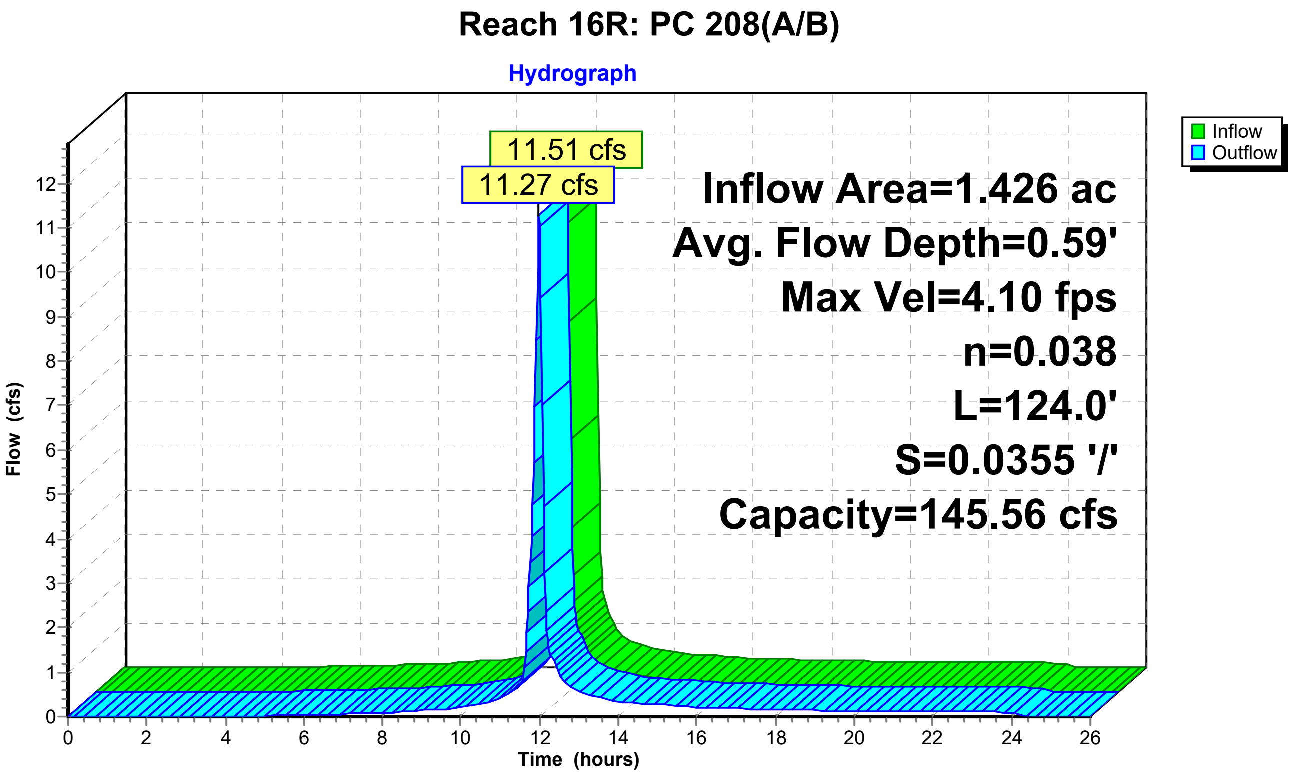
Inflow Area = 1.426 ac, 0.00% Impervious, Inflow Depth = 4.85" for 25-yr. 24-hr event
Inflow = 11.51 cfs @ 11.97 hrs, Volume= 0.577 af
Outflow = 11.27 cfs @ 11.98 hrs, Volume= 0.577 af, Atten= 2%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 4.10 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.03 fps, Avg. Travel Time= 2.0 min

Peak Storage= 346 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 145.56 cfs

3.00' x 2.00' deep channel, n= 0.038
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 124.0' Slope= 0.0355 '/'
Inlet Invert= 829.02', Outlet Invert= 824.62'

‡



Summary for Reach 17R: PC 210

[62] Hint: Exceeded Reach 8R OUTLET depth by 0.55' @ 11.97 hrs
[61] Hint: Exceeded Reach 58R outlet invert by 1.17' @ 12.00 hrs

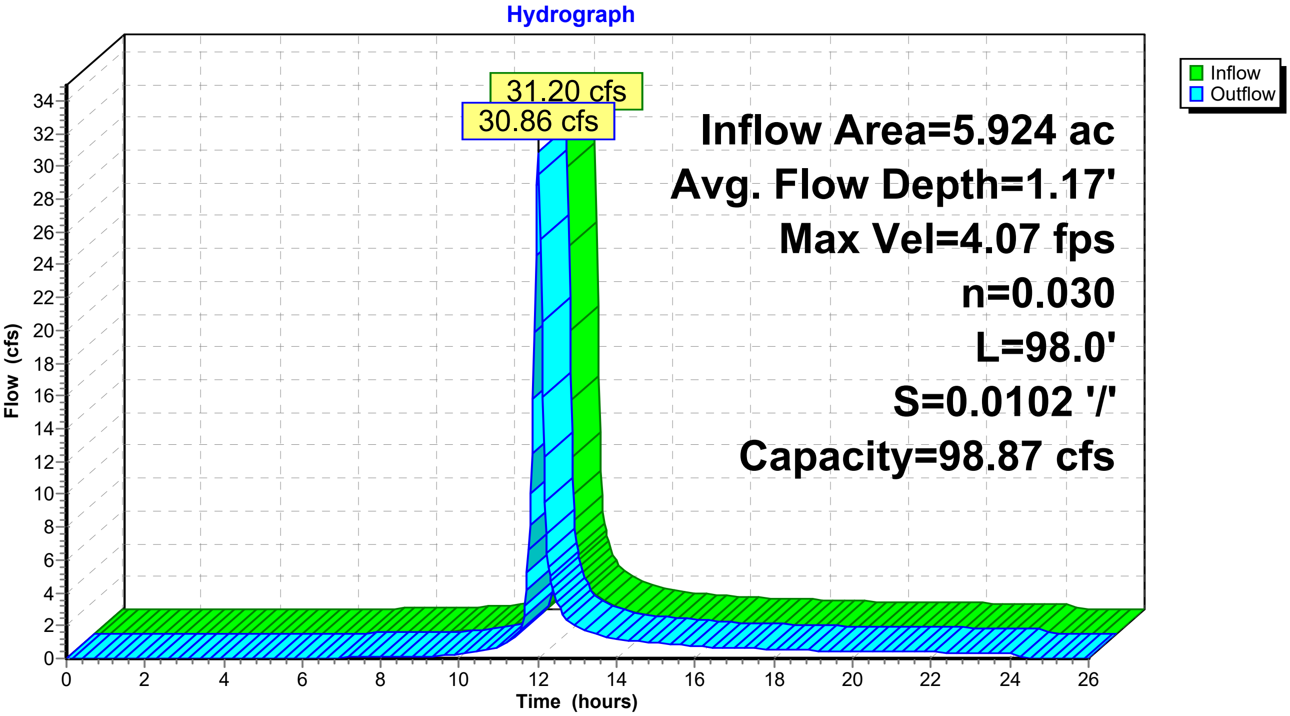
```
Inflow Area =         5.924 ac,    0.00% Impervious,  Inflow Depth =   3.36"    for  25-yr. 24-hr event
Inflow       =       31.20 cfs @   11.99 hrs,  Volume=             1.661 af
Outflow      =       30.86 cfs @   12.00 hrs,  Volume=             1.661 af,  Atten= 1%,  Lag= 0.7 min
```

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 4.07 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 1.5 min

Peak Storage= 750 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.17'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 98.87 cfs

3.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 98.0' Slope= 0.0102 '/'
Inlet Invert= 810.00', Outlet Invert= 809.00'

Reach 17R: PC 210



Summary for Reach 18R: Pipe 201

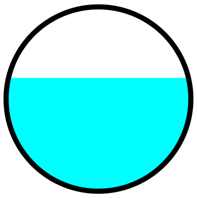
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach 16R OUTLET depth by 0.32' @ 12.00 hrs

```
Inflow Area =          1.426 ac,    0.00% Impervious,  Inflow Depth =   4.85"    for  25-yr. 24-hr event
Inflow      =        11.27 cfs @   11.98 hrs,  Volume=              0.577 af
Outflow     =        11.26 cfs @   11.99 hrs,  Volume=              0.577 af,  Atten= 0%,  Lag= 0.2 min
```

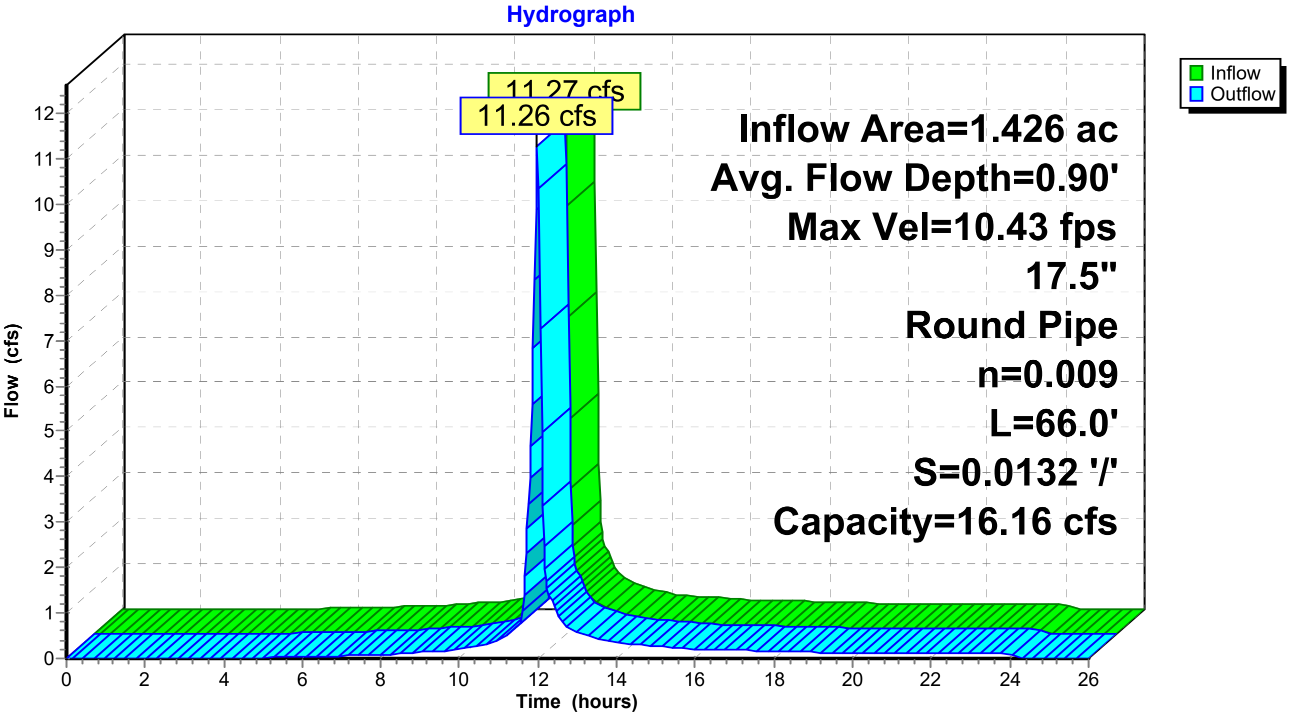
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 10.43 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.14 fps, Avg. Travel Time= 0.4 min

Peak Storage= 71 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.90'
Bank-Full Depth= 1.46' Flow Area= 1.7 sf, Capacity= 16.16 cfs

17.5" Round Pipe
n= 0.009
Length= 66.0' Slope= 0.0132 '/'
Inlet Invert= 824.62', Outlet Invert= 823.75'



Reach 18R: Pipe 201



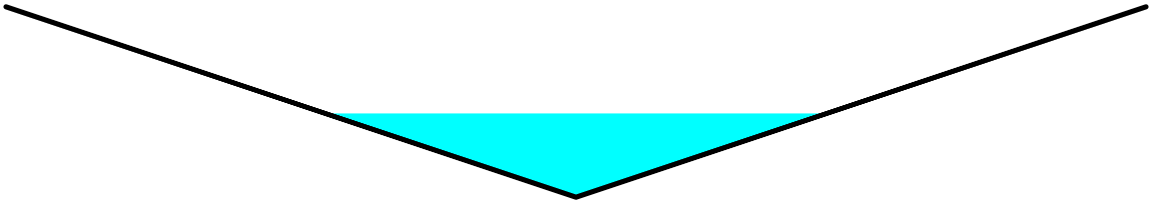
Summary for Reach 20R: PC 209

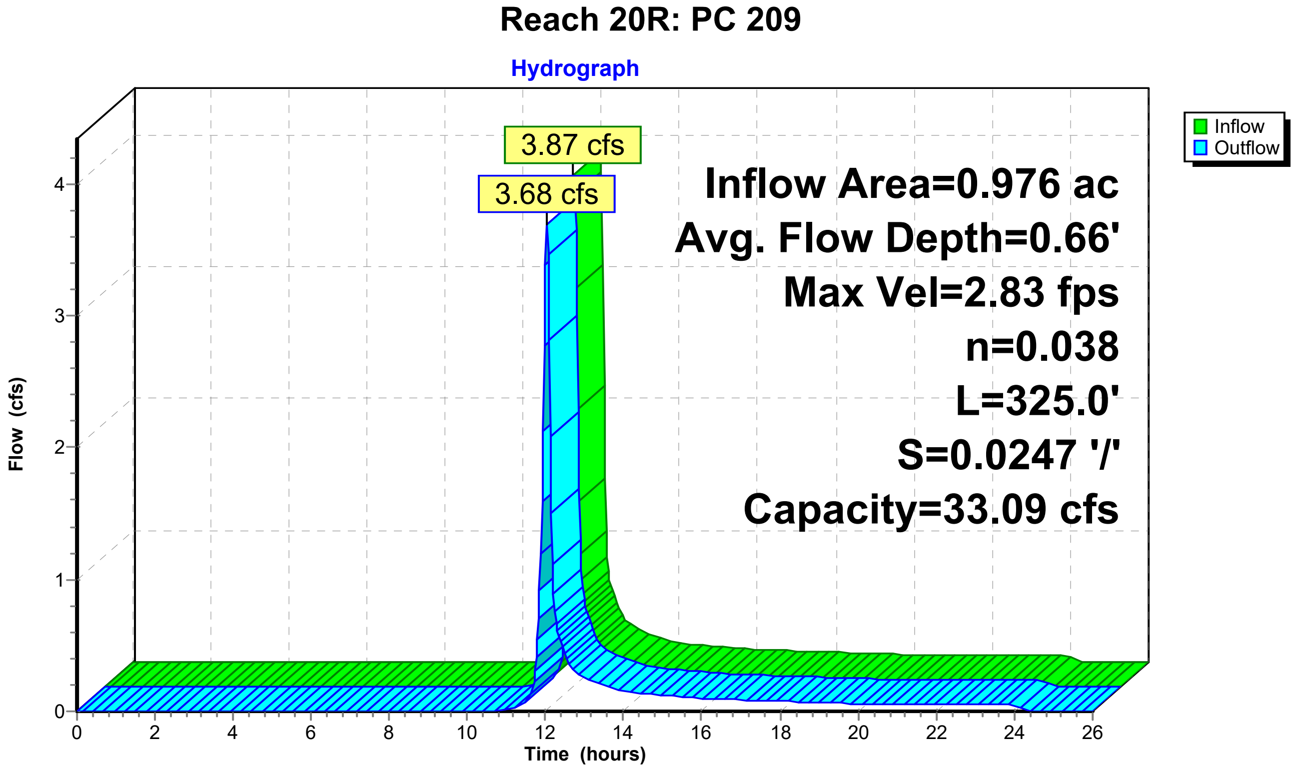
Inflow Area =	0.976 ac,	0.00% Impervious,	Inflow Depth = 2.24"	for 25-yr. 24-hr event	
Inflow =	3.87 cfs @	11.98 hrs,	Volume=	0.182 af	
Outflow =	3.68 cfs @	12.03 hrs,	Volume=	0.182 af,	Atten= 5%, Lag= 3.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 2.83 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.05 fps, Avg. Travel Time= 5.2 min

Peak Storage= 424 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 33.09 cfs

0.00' x 1.50' deep channel, n= 0.038
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 325.0' Slope= 0.0247 '/'
Inlet Invert= 805.26', Outlet Invert= 797.22'





Summary for Reach 21R: PIPE 203

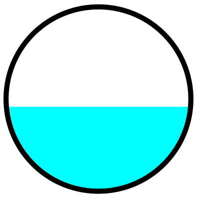
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach 17R OUTLET depth by 0.21' @ 12.03 hrs

```
Inflow Area =          5.924 ac,    0.00% Impervious,  Inflow Depth =   3.36"    for  25-yr. 24-hr event
Inflow       =        30.86 cfs @   12.00 hrs,  Volume=             1.661 af
Outflow      =        30.78 cfs @   12.01 hrs,  Volume=             1.661 af,  Atten= 0%,  Lag= 0.1 min
```

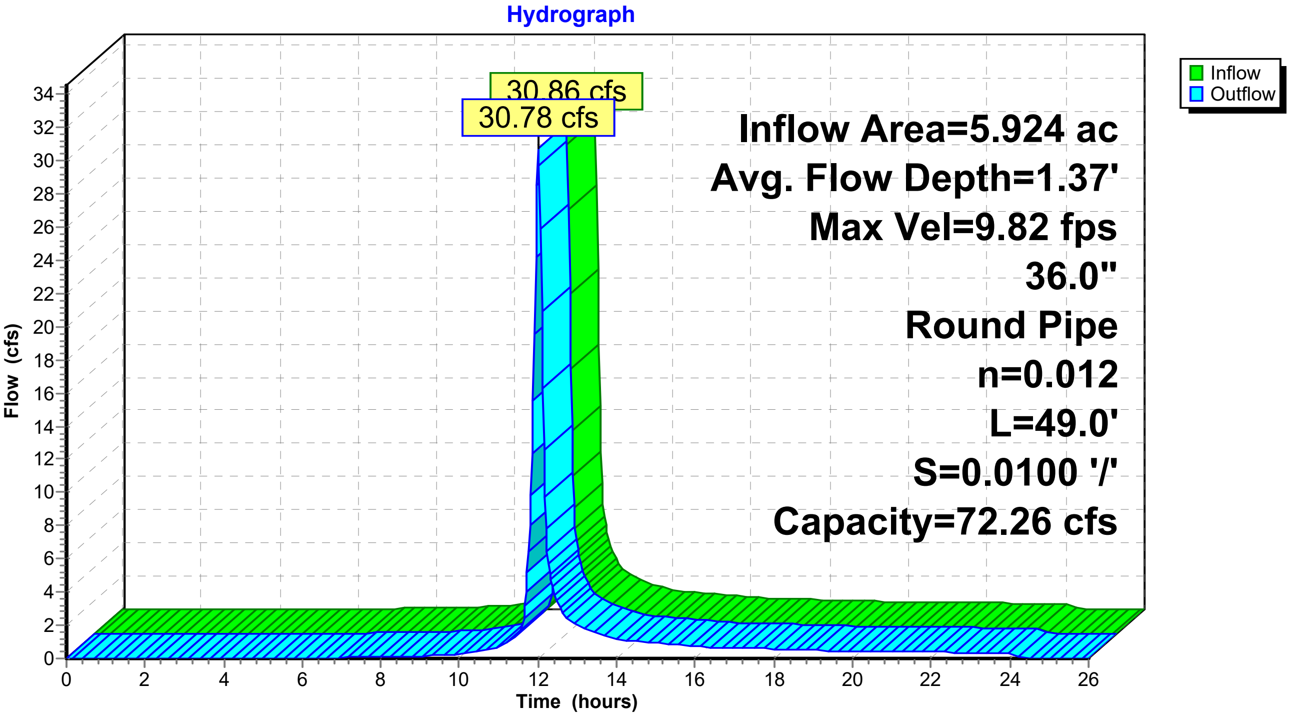
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 9.82 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.70 fps, Avg. Travel Time= 0.3 min

Peak Storage= 154 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.37'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 72.26 cfs

36.0" Round Pipe
n= 0.012
Length= 49.0' Slope= 0.0100 '/'
Inlet Invert= 809.01', Outlet Invert= 808.52'



Reach 21R: PIPE 203



Summary for Reach 22R: PC 211

[61] Hint: Exceeded Reach 21R outlet invert by 1.16' @ 12.00 hrs

```
Inflow Area =        5.924 ac,   0.00% Impervious,  Inflow Depth =   3.36"    for  25-yr. 24-hr event
Inflow      =       30.78 cfs @   12.01 hrs,  Volume=            1.661 af
Outflow     =       30.52 cfs @   12.01 hrs,  Volume=            1.661 af,  Atten= 1%,  Lag= 0.5 min
```

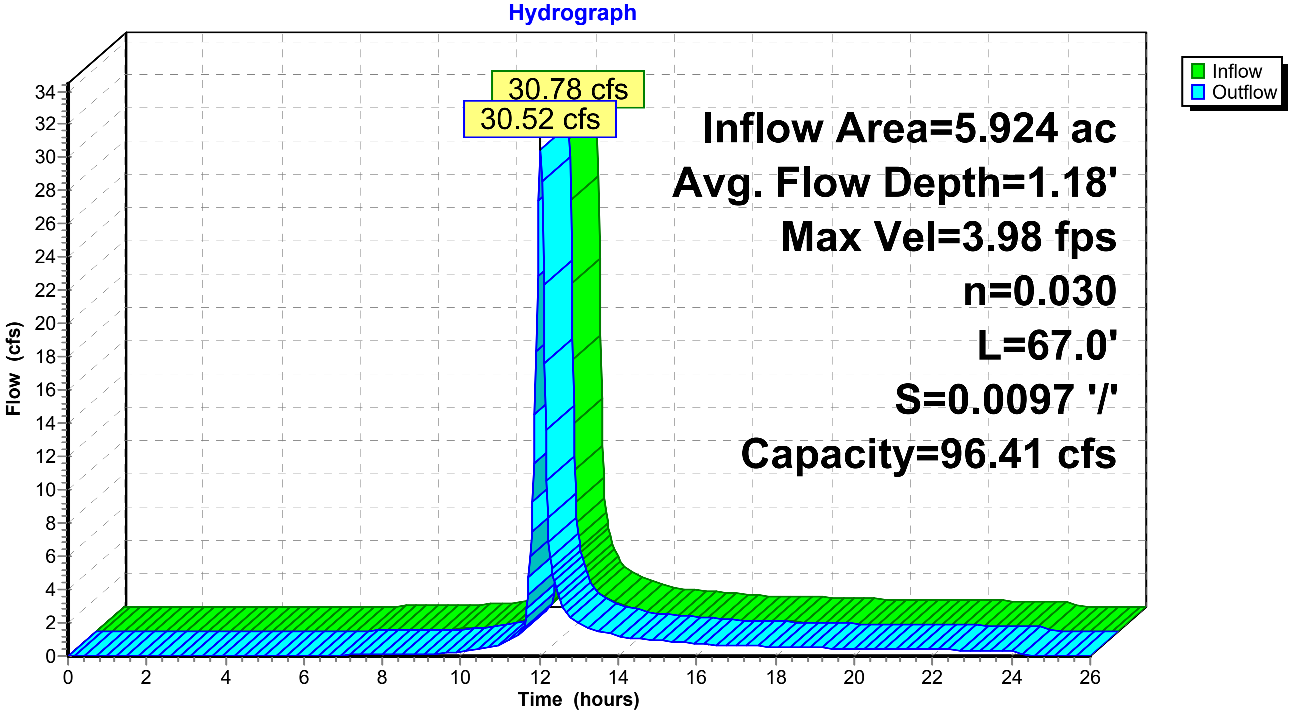
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 3.98 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.05 fps, Avg. Travel Time= 1.1 min

Peak Storage= 517 cf @ 12.01 hrs
Average Depth at Peak Storage= 1.18'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 96.41 cfs

3.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 67.0' Slope= 0.0097 '/'
Inlet Invert= 808.50', Outlet Invert= 807.85'

‡

Reach 22R: PC 211



Summary for Reach 32R: PIPE 202

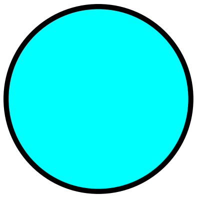
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 122% of Manning's capacity
[76] Warning: Detained 0.018 af (Pond w/culvert advised)

```
Inflow Area =         2.267 ac,    0.00% Impervious,  Inflow Depth =   5.19"    for  25-yr. 24-hr event
Inflow       =       17.85 cfs @   12.03 hrs,  Volume=            0.980 af
Outflow      =       14.66 cfs @   12.03 hrs,  Volume=            0.980 af,  Atten= 18%,  Lag= 0.0 min
```

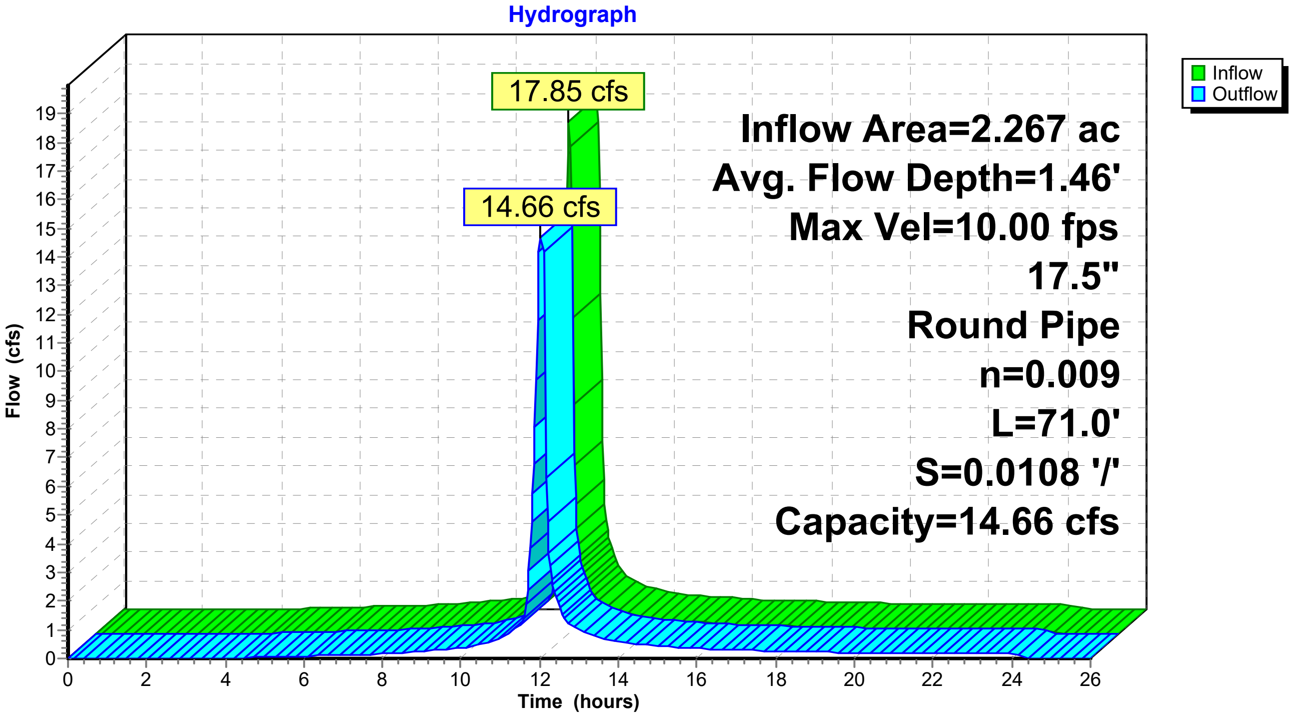
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 10.00 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.24 fps, Avg. Travel Time= 0.4 min

Peak Storage= 119 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.46'
Bank-Full Depth= 1.46' Flow Area= 1.7 sf, Capacity= 14.66 cfs

17.5" Round Pipe
n= 0.009
Length= 71.0' Slope= 0.0108 '/'
Inlet Invert= 798.77', Outlet Invert= 798.00'



Reach 32R: PIPE 202



Summary for Reach 33R: PC 207

outlet invert based on drop inlet elev

Inflow Area =	2.267 ac,	0.00% Impervious,	Inflow Depth = 5.19"	for 25-yr. 24-hr event
Inflow =	19.10 cfs @	11.97 hrs,	Volume=	0.980 af
Outflow =	17.85 cfs @	12.03 hrs,	Volume=	0.980 af, Atten= 7%, Lag= 3.9 min

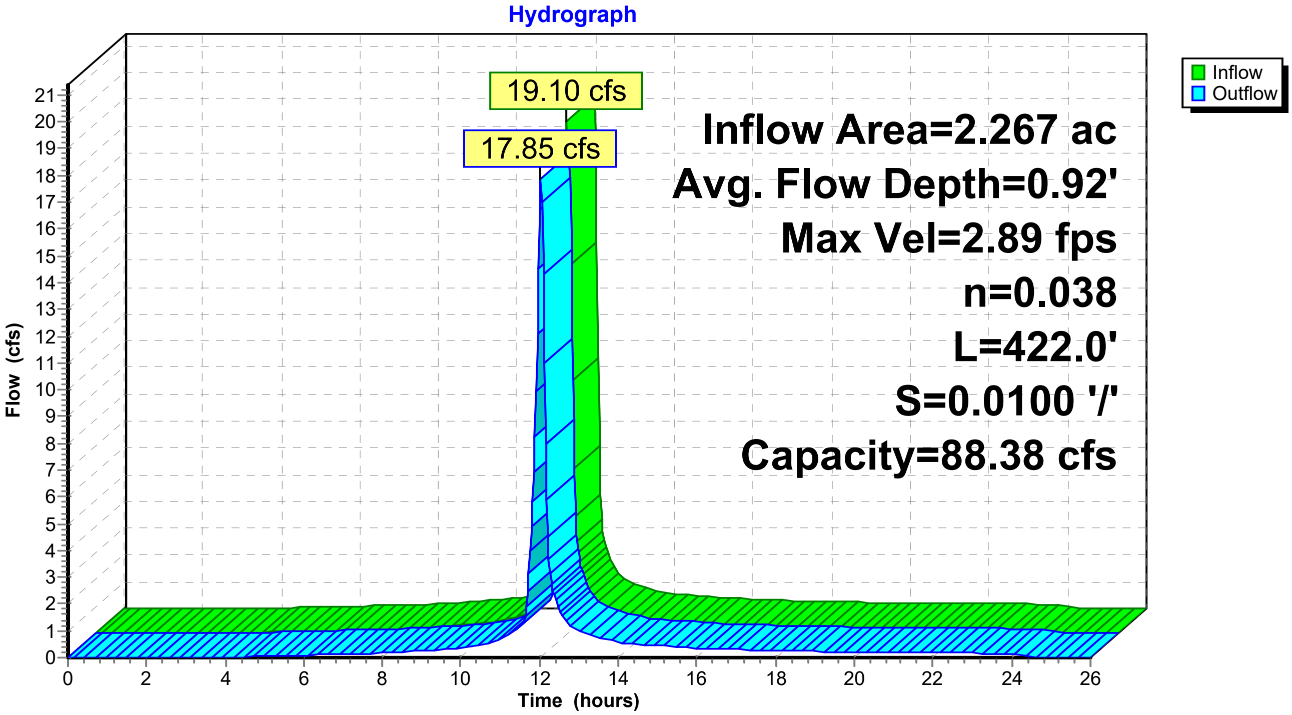
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 2.89 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 9.8 min

Peak Storage= 2,642 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.92'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 88.38 cfs

4.00' x 2.00' deep channel, n= 0.038
Side Slope Z-value= 3.0 '/' Top Width= 16.00'
Length= 422.0' Slope= 0.0100 '/'
Inlet Invert= 806.97', Outlet Invert= 802.75'

‡

Reach 33R: PC 207



Summary for Reach 45R: CH-14

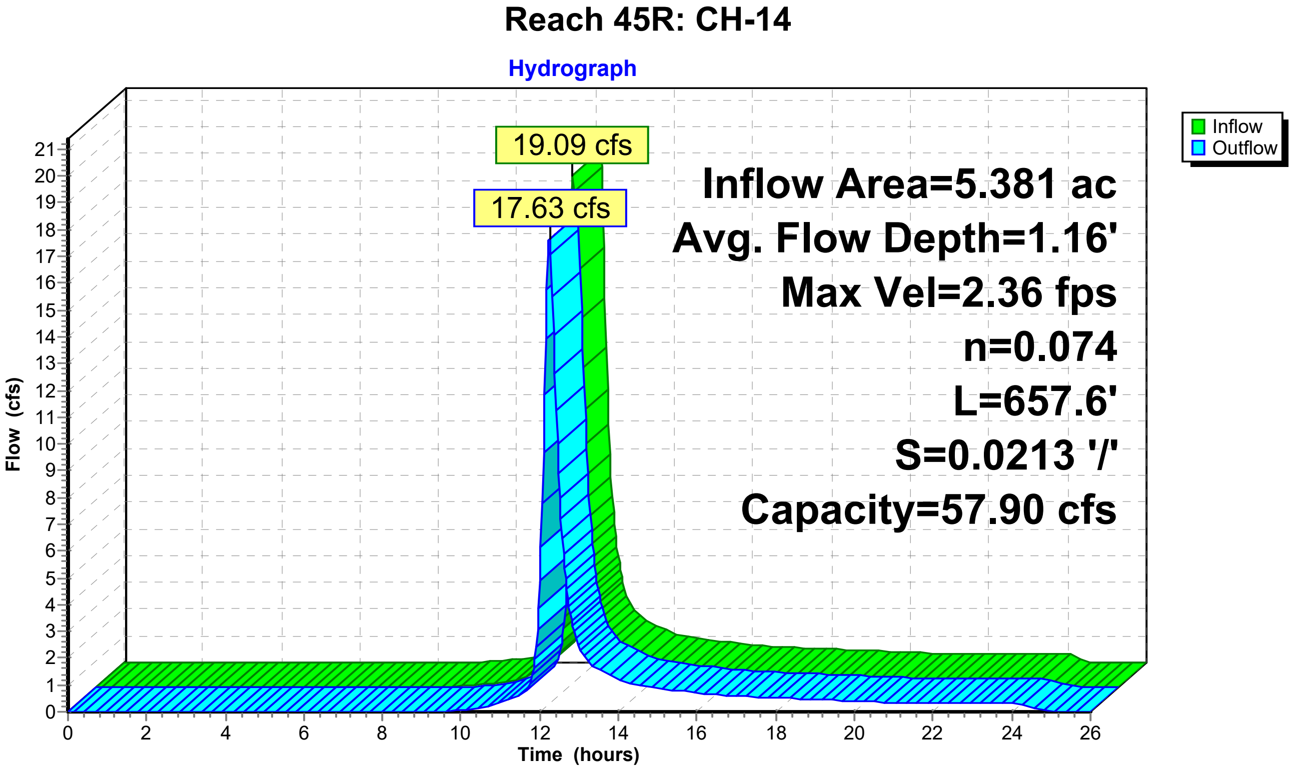
Inflow Area = 5.381 ac, 0.00% Impervious, Inflow Depth = 3.09" for 25-yr. 24-hr event
Inflow = 19.09 cfs @ 12.12 hrs, Volume= 1.384 af
Outflow = 17.63 cfs @ 12.25 hrs, Volume= 1.383 af, Atten= 8%, Lag= 8.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 2.36 fps, Min. Travel Time= 4.6 min
Avg. Velocity = 0.80 fps, Avg. Travel Time= 13.6 min

Peak Storage= 4,922 cf @ 12.17 hrs
Average Depth at Peak Storage= 1.16'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 57.90 cfs

3.00' x 2.00' deep channel, n= 0.074
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 657.6' Slope= 0.0213 '/'
Inlet Invert= 780.00', Outlet Invert= 766.00'

‡



Summary for Reach 46R: CH-13

[63] Warning: Exceeded Reach 32R INLET depth by 1.23' @ 0.00 hrs

Inflow Area = 3.329 ac, 0.00% Impervious, Inflow Depth = 4.81" for 25-yr. 24-hr event
Inflow = 20.78 cfs @ 12.03 hrs, Volume= 1.333 af
Outflow = 20.68 cfs @ 12.06 hrs, Volume= 1.333 af, Atten= 1%, Lag= 1.5 min

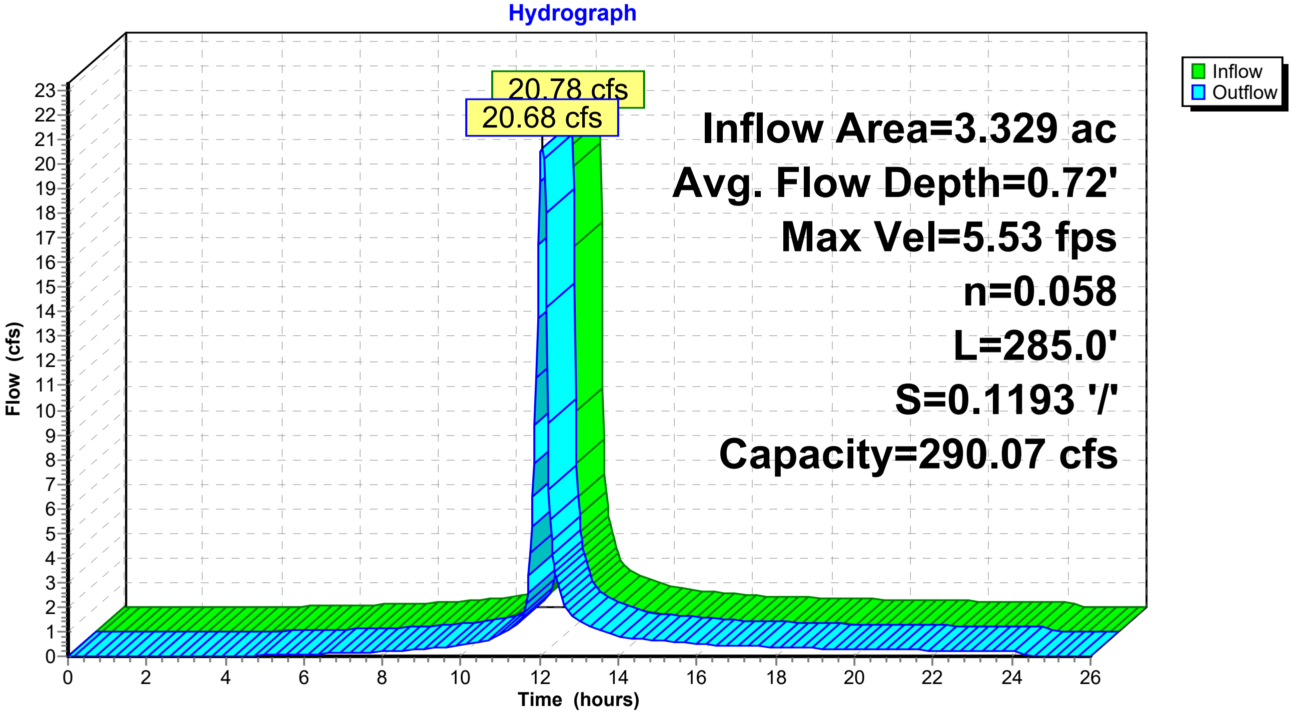
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 5.53 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 3.2 min

Peak Storage= 1,069 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 2.50' Flow Area= 26.3 sf, Capacity= 290.07 cfs

3.00' x 2.50' deep channel, n= 0.058
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 285.0' Slope= 0.1193 '/'
Inlet Invert= 800.00', Outlet Invert= 766.00'

‡

Reach 46R: CH-13



Summary for Reach 47R: CH-13_14

[62] Hint: Exceeded Reach 45R OUTLET depth by 0.43' @ 12.42 hrs
[62] Hint: Exceeded Reach 46R OUTLET depth by 1.05' @ 12.30 hrs

```
Inflow Area =       16.073 ac,    0.00% Impervious,  Inflow Depth >   3.86"    for  25-yr. 24-hr event
Inflow      =       51.53 cfs @   12.16 hrs,  Volume=            5.167 af
Outflow     =       50.66 cfs @   12.22 hrs,  Volume=            5.167 af,  Atten= 2%,  Lag= 3.5 min
```

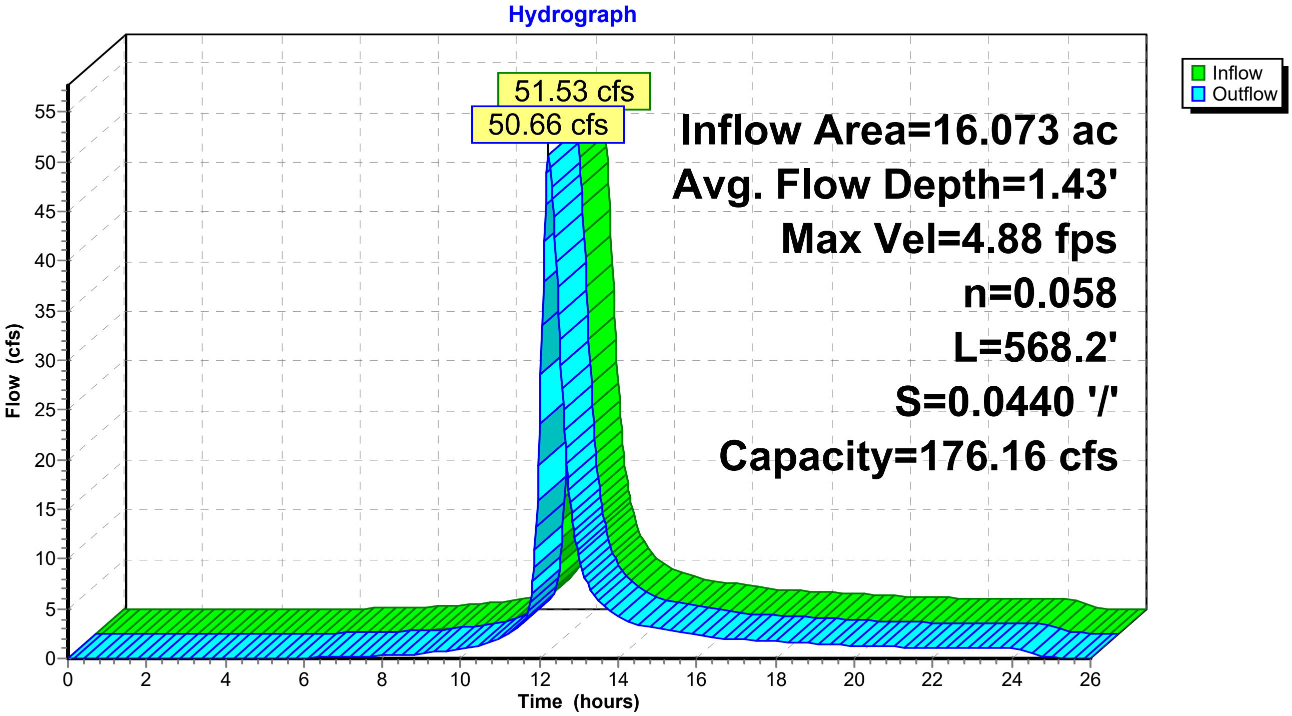
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 4.88 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.61 fps, Avg. Travel Time= 5.9 min

Peak Storage= 5,911 cf @ 12.19 hrs
Average Depth at Peak Storage= 1.43'
Bank-Full Depth= 2.50' Flow Area= 26.3 sf, Capacity= 176.16 cfs

3.00' x 2.50' deep channel, n= 0.058
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 568.2' Slope= 0.0440 '/'
Inlet Invert= 766.00', Outlet Invert= 741.00'

‡

Reach 47R: CH-13_14



Summary for Reach 48R: CH-12

Inflow Area = 14.888 ac, 0.00% Impervious, Inflow Depth = 3.48" for 25-yr. 24-hr event
Inflow = 48.69 cfs @ 12.20 hrs, Volume= 4.319 af
Outflow = 47.66 cfs @ 12.29 hrs, Volume= 4.319 af, Atten= 2%, Lag= 5.1 min

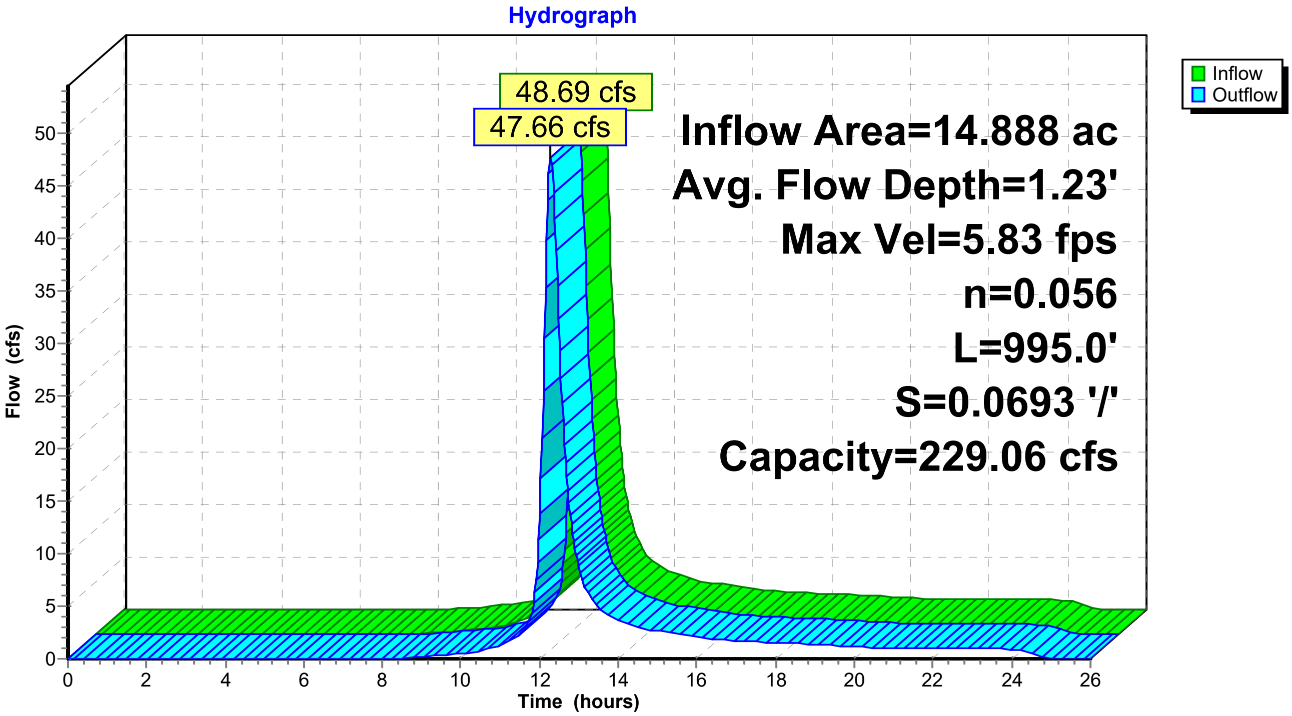
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 5.83 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 2.05 fps, Avg. Travel Time= 8.1 min

Peak Storage= 8,161 cf @ 12.24 hrs
Average Depth at Peak Storage= 1.23'
Bank-Full Depth= 2.50' Flow Area= 26.3 sf, Capacity= 229.06 cfs

3.00' x 2.50' deep channel, n= 0.056
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 995.0' Slope= 0.0693 '/'
Inlet Invert= 800.00', Outlet Invert= 731.00'

‡

Reach 48R: CH-12



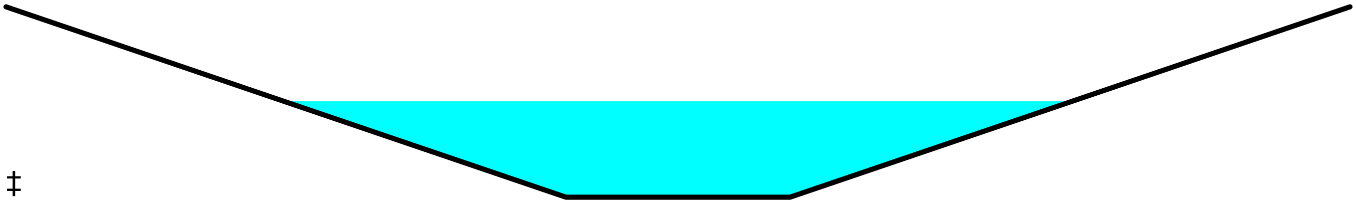
Summary for Reach 49R: CH-11

Inflow Area =	16.432 ac,	0.00% Impervious, Inflow Depth = 3.31"	for 25-yr. 24-hr event	
Inflow =	52.97 cfs @	12.05 hrs, Volume=	4.535 af	
Outflow =	51.16 cfs @	12.15 hrs, Volume=	4.534 af,	Atten= 3%, Lag= 5.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 6.02 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.87 fps, Avg. Travel Time= 9.3 min

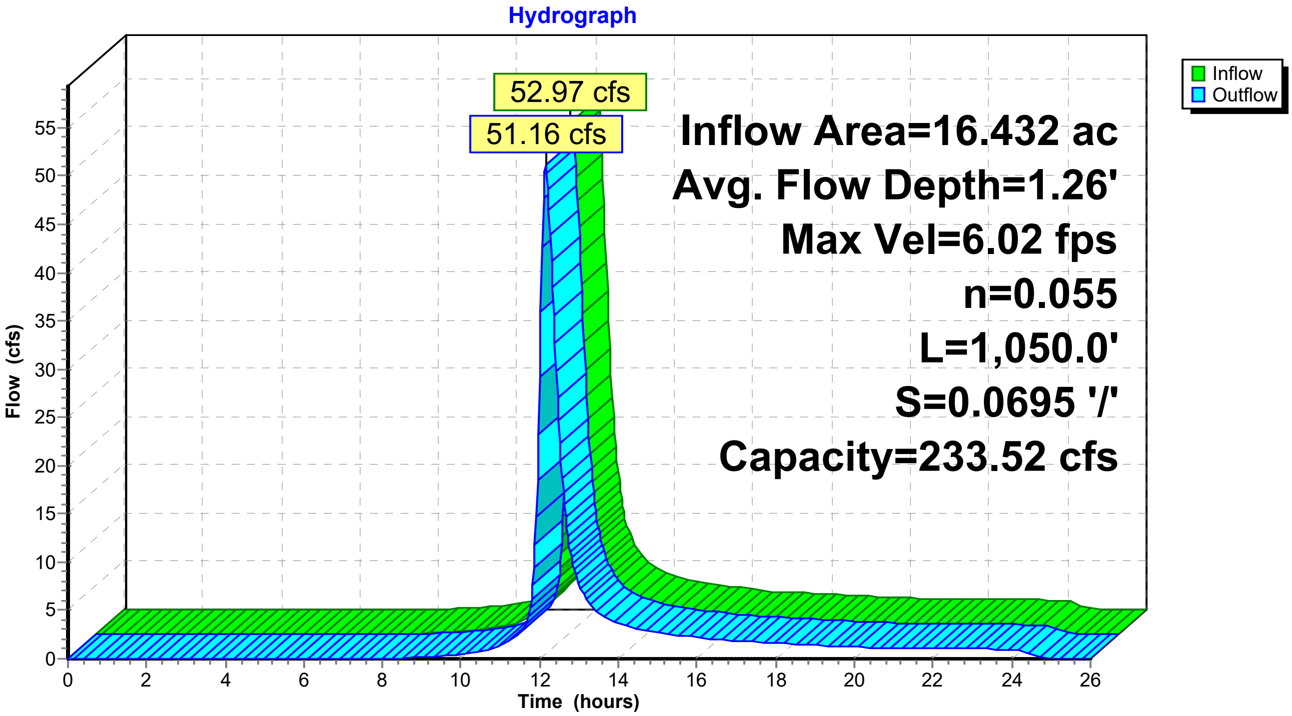
Peak Storage= 8,953 cf @ 12.10 hrs
Average Depth at Peak Storage= 1.26'
Bank-Full Depth= 2.50' Flow Area= 26.3 sf, Capacity= 233.52 cfs

3.00' x 2.50' deep channel, n= 0.055
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 1,050.0' Slope= 0.0695 '/'
Inlet Invert= 800.00', Outlet Invert= 727.00'



‡

Reach 49R: CH-11



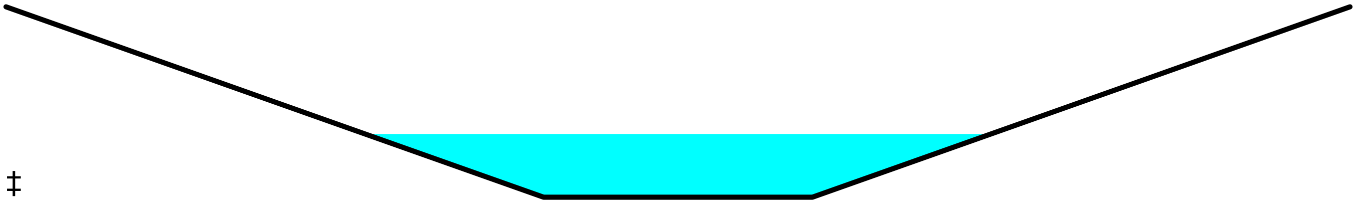
Summary for Reach 50R: CH-10

Inflow Area = 3.333 ac, 0.00% Impervious, Inflow Depth = 2.99" for 25-yr. 24-hr event
Inflow = 12.99 cfs @ 12.07 hrs, Volume= 0.830 af
Outflow = 12.33 cfs @ 12.16 hrs, Volume= 0.830 af, Atten= 5%, Lag= 5.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 3.74 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 1.14 fps, Avg. Travel Time= 9.8 min

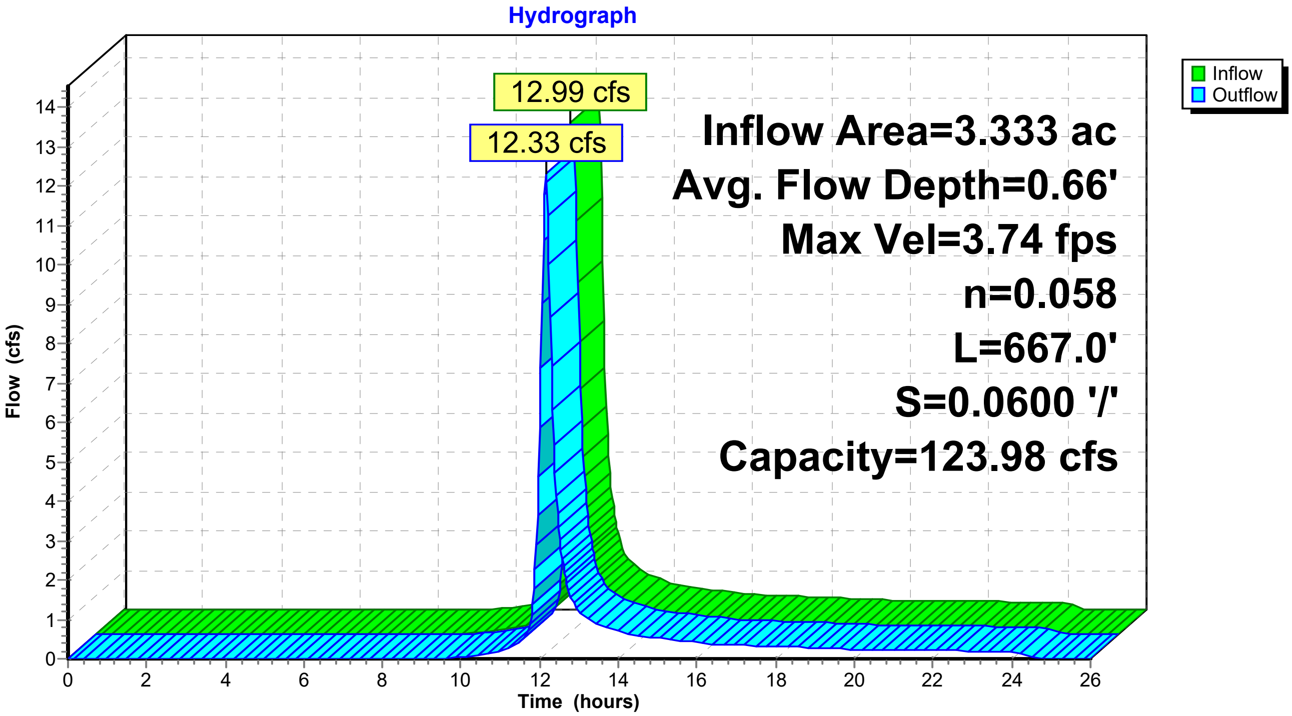
Peak Storage= 2,212 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 123.98 cfs

3.00' x 2.00' deep channel, n= 0.058
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 667.0' Slope= 0.0600 '/'
Inlet Invert= 800.00', Outlet Invert= 760.00'



‡

Reach 50R: CH-10



Summary for Reach 51R: CH-09

[63] Warning: Exceeded Reach 10R INLET depth by 4.82' @ 12.51 hrs
[62] Hint: Exceeded Reach 13R OUTLET depth by 4.14' @ 12.06 hrs

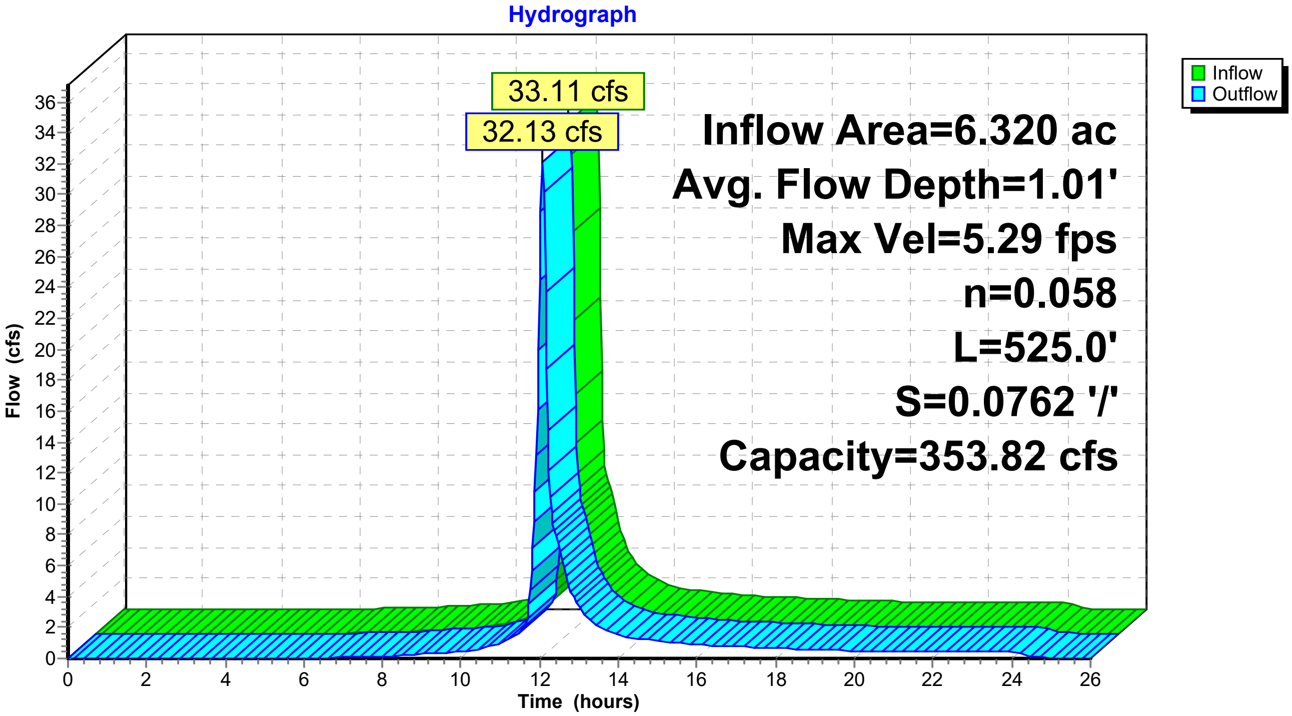
```
Inflow Area =         6.320 ac,    0.00% Impervious,  Inflow Depth =   3.97"    for  25-yr. 24-hr event
Inflow       =        33.11 cfs @   12.03 hrs,  Volume=              2.093 af
Outflow      =        32.13 cfs @   12.07 hrs,  Volume=              2.093 af,  Atten= 3%,  Lag= 2.8 min
```

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 5.29 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 5.7 min

Peak Storage= 3,198 cf @ 12.05 hrs
Average Depth at Peak Storage= 1.01'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 353.82 cfs

3.00' x 3.00' deep channel, n= 0.058
Side Slope Z-value= 3.0 '/' Top Width= 21.00'
Length= 525.0' Slope= 0.0762 '/'
Inlet Invert= 800.00', Outlet Invert= 760.00'

Reach 51R: CH-09



Summary for Reach 52R: CH-5

Inflow Area = 54.425 ac, 0.00% Impervious, Inflow Depth = 3.28" for 25-yr. 24-hr event
Inflow = 122.58 cfs @ 12.39 hrs, Volume= 14.884 af
Outflow = 117.88 cfs @ 12.58 hrs, Volume= 14.874 af, Atten= 4%, Lag= 11.1 min

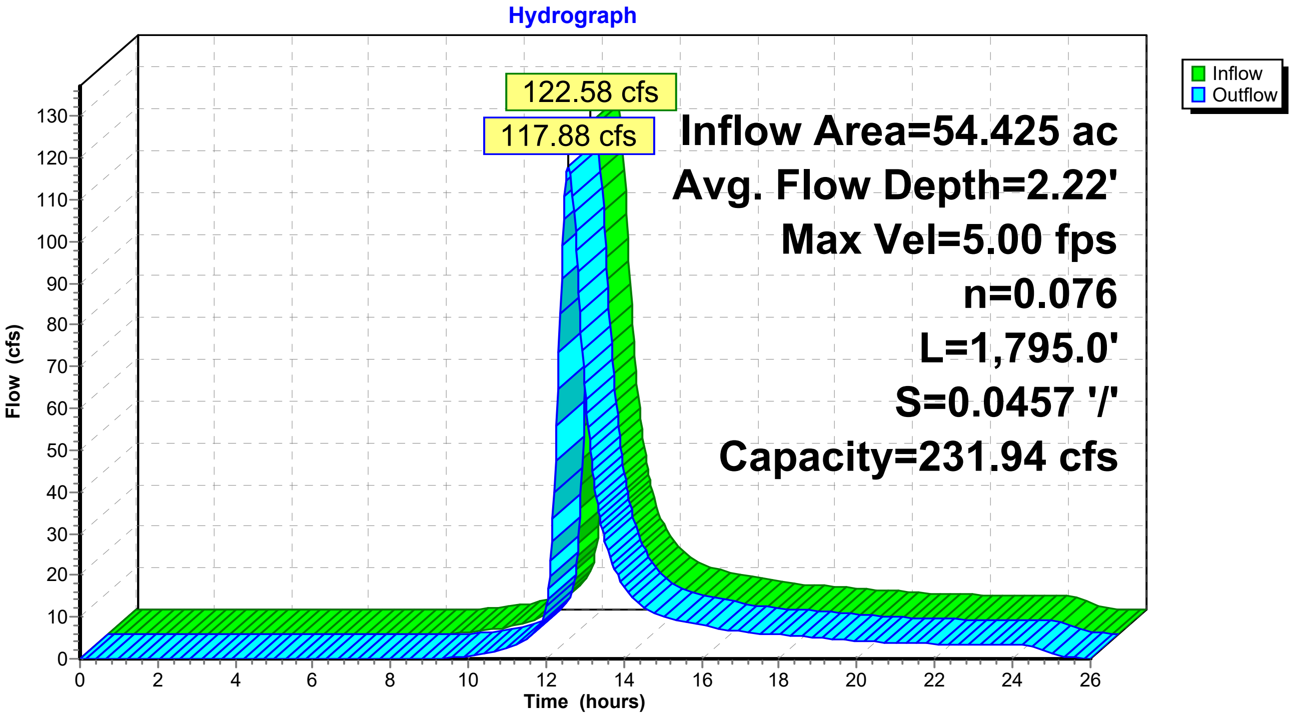
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 5.00 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 2.06 fps, Avg. Travel Time= 14.5 min

Peak Storage= 42,342 cf @ 12.48 hrs
Average Depth at Peak Storage= 2.22'
Bank-Full Depth= 3.00' Flow Area= 39.0 sf, Capacity= 231.94 cfs

4.00' x 3.00' deep channel, n= 0.076
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 1,795.0' Slope= 0.0457 '/'
Inlet Invert= 800.00', Outlet Invert= 718.00'

‡

Reach 52R: CH-5



Summary for Reach 53R: CH-4

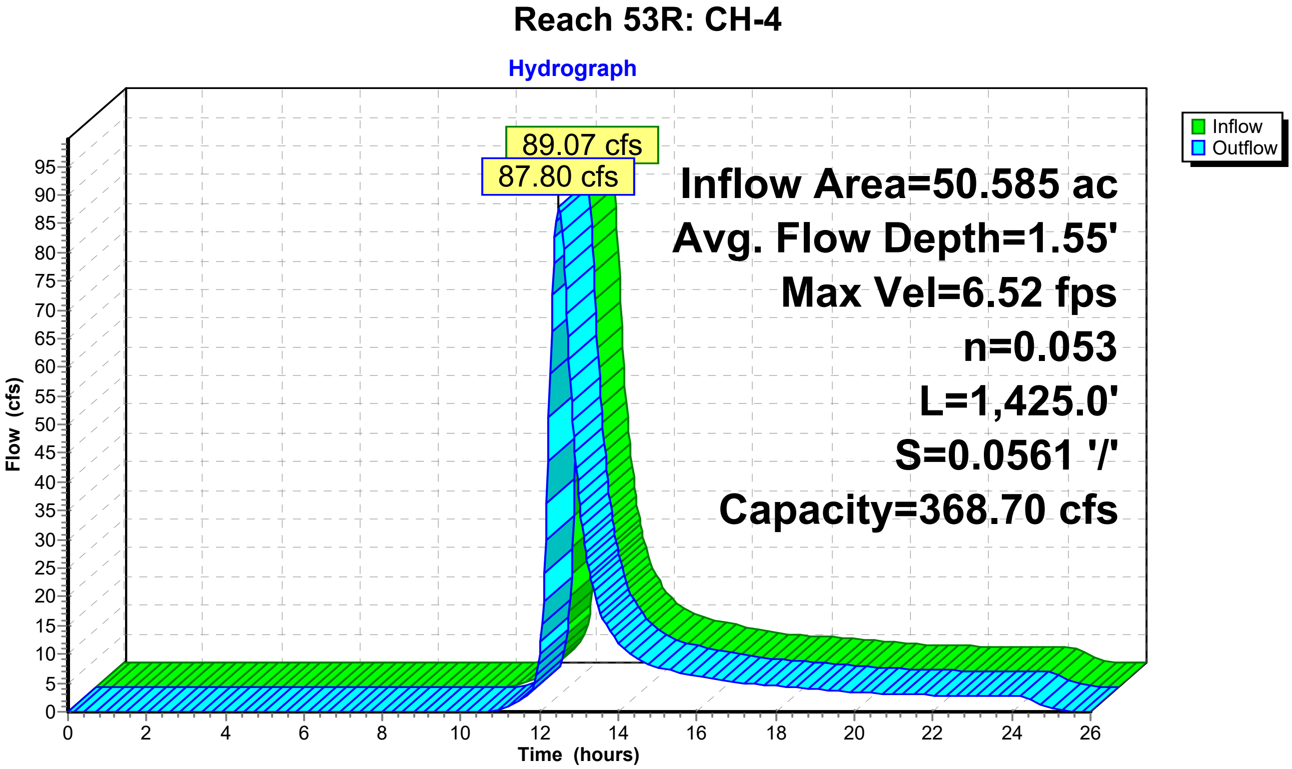
Inflow Area = 50.585 ac, 0.00% Impervious, Inflow Depth = 2.52" for 25-yr. 24-hr event
Inflow = 89.07 cfs @ 12.37 hrs, Volume= 10.607 af
Outflow = 87.80 cfs @ 12.48 hrs, Volume= 10.604 af, Atten= 1%, Lag= 6.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 6.52 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 2.70 fps, Avg. Travel Time= 8.8 min

Peak Storage= 19,179 cf @ 12.42 hrs
Average Depth at Peak Storage= 1.55'
Bank-Full Depth= 3.00' Flow Area= 39.0 sf, Capacity= 368.70 cfs

4.00' x 3.00' deep channel, n= 0.053
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 1,425.0' Slope= 0.0561 '/'
Inlet Invert= 800.00', Outlet Invert= 720.00'

‡



Summary for Reach 54R: CH-3

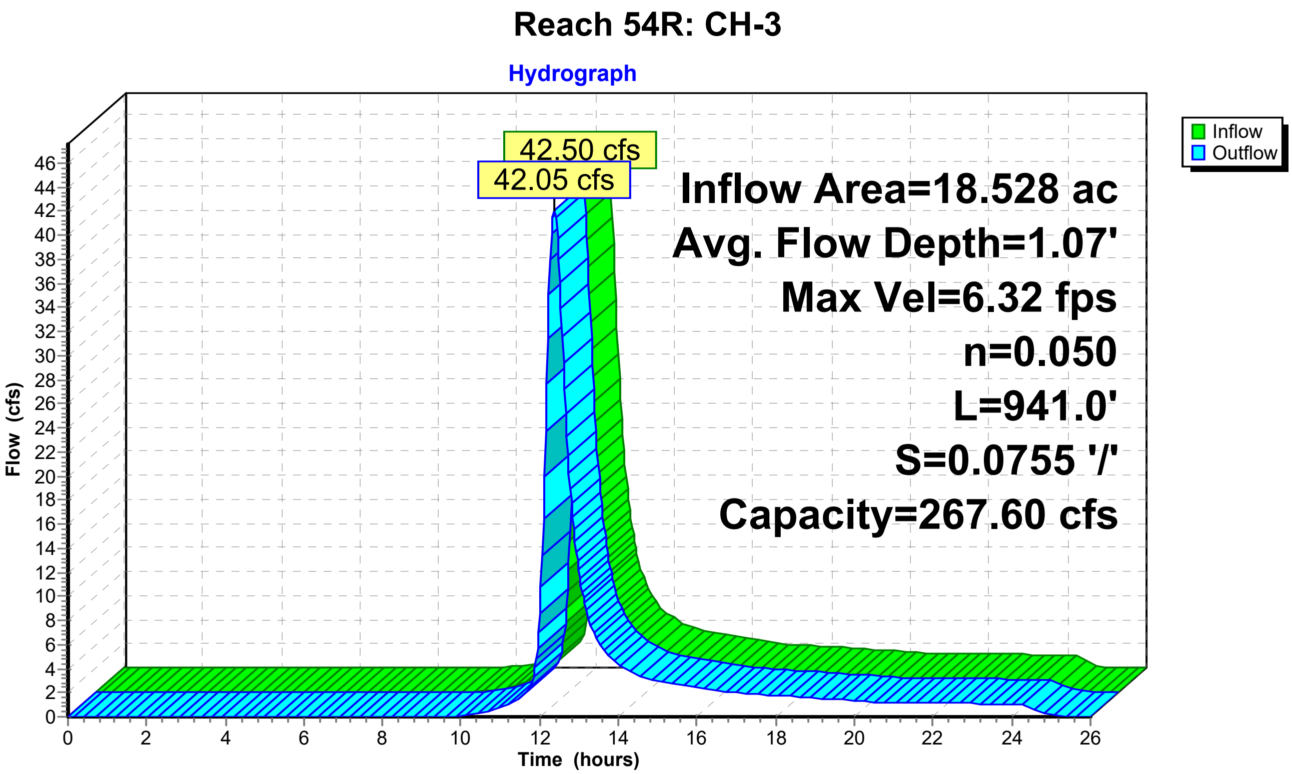
Inflow Area = 18.528 ac, 0.00% Impervious, Inflow Depth = 2.89" for 25-yr. 24-hr event
Inflow = 42.50 cfs @ 12.30 hrs, Volume= 4.466 af
Outflow = 42.05 cfs @ 12.37 hrs, Volume= 4.466 af, Atten= 1%, Lag= 4.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 6.32 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 2.41 fps, Avg. Travel Time= 6.5 min

Peak Storage= 6,272 cf @ 12.33 hrs
Average Depth at Peak Storage= 1.07'
Bank-Full Depth= 2.50' Flow Area= 26.3 sf, Capacity= 267.60 cfs

3.00' x 2.50' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 941.0' Slope= 0.0755 '/'
Inlet Invert= 800.00', Outlet Invert= 729.00'

‡



Summary for Reach 55R: CH-2

Inflow Area = 84.338 ac, 0.00% Impervious, Inflow Depth > 2.33" for 25-yr. 24-hr event
Inflow = 111.34 cfs @ 12.55 hrs, Volume= 16.398 af
Outflow = 111.10 cfs @ 12.60 hrs, Volume= 16.395 af, Atten= 0%, Lag= 3.0 min

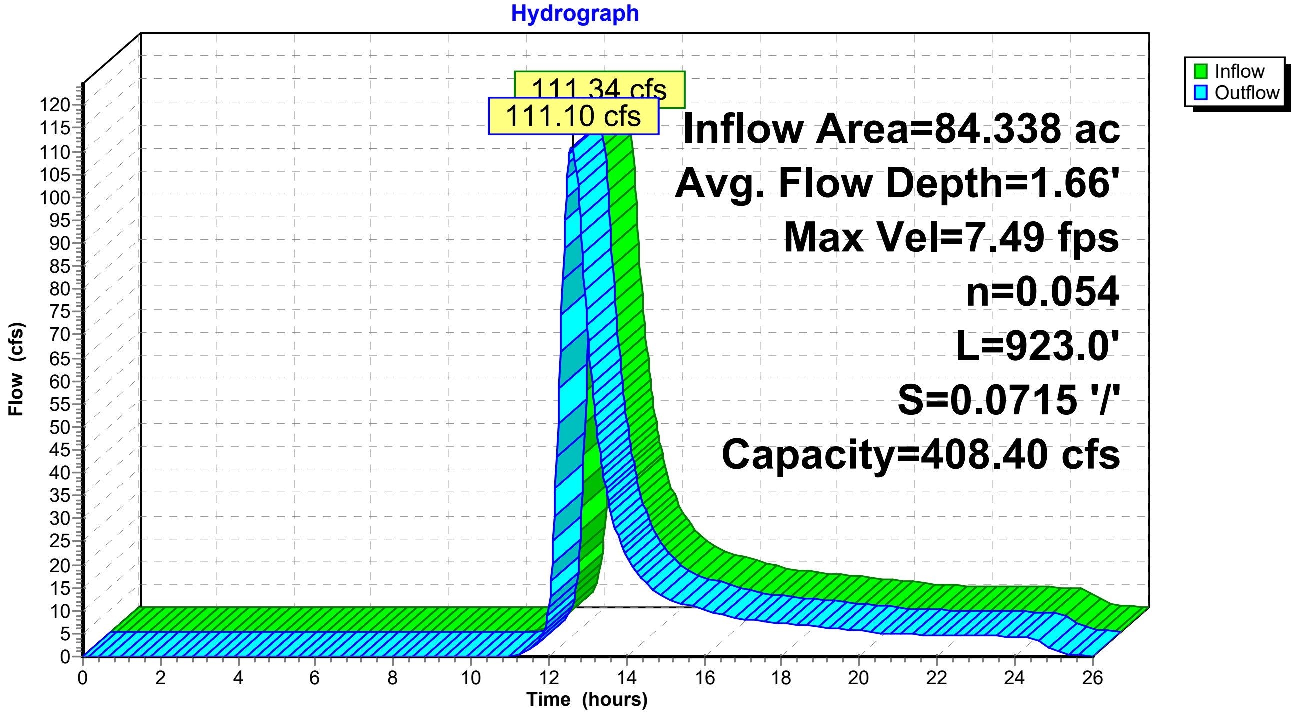
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 7.49 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 3.40 fps, Avg. Travel Time= 4.5 min

Peak Storage= 13,705 cf @ 12.57 hrs
Average Depth at Peak Storage= 1.66'
Bank-Full Depth= 3.00' Flow Area= 39.0 sf, Capacity= 408.40 cfs

4.00' x 3.00' deep channel, n= 0.054
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 923.0' Slope= 0.0715 '/'
Inlet Invert= 800.00', Outlet Invert= 734.00'

‡

Reach 55R: CH-2



Summary for Reach 56R: CH-1

Inflow Area = 37.955 ac, 0.00% Impervious, Inflow Depth = 3.99" for 25-yr. 24-hr event
Inflow = 103.48 cfs @ 12.39 hrs, Volume= 12.632 af
Outflow = 103.35 cfs @ 12.42 hrs, Volume= 12.632 af, Atten= 0%, Lag= 1.6 min

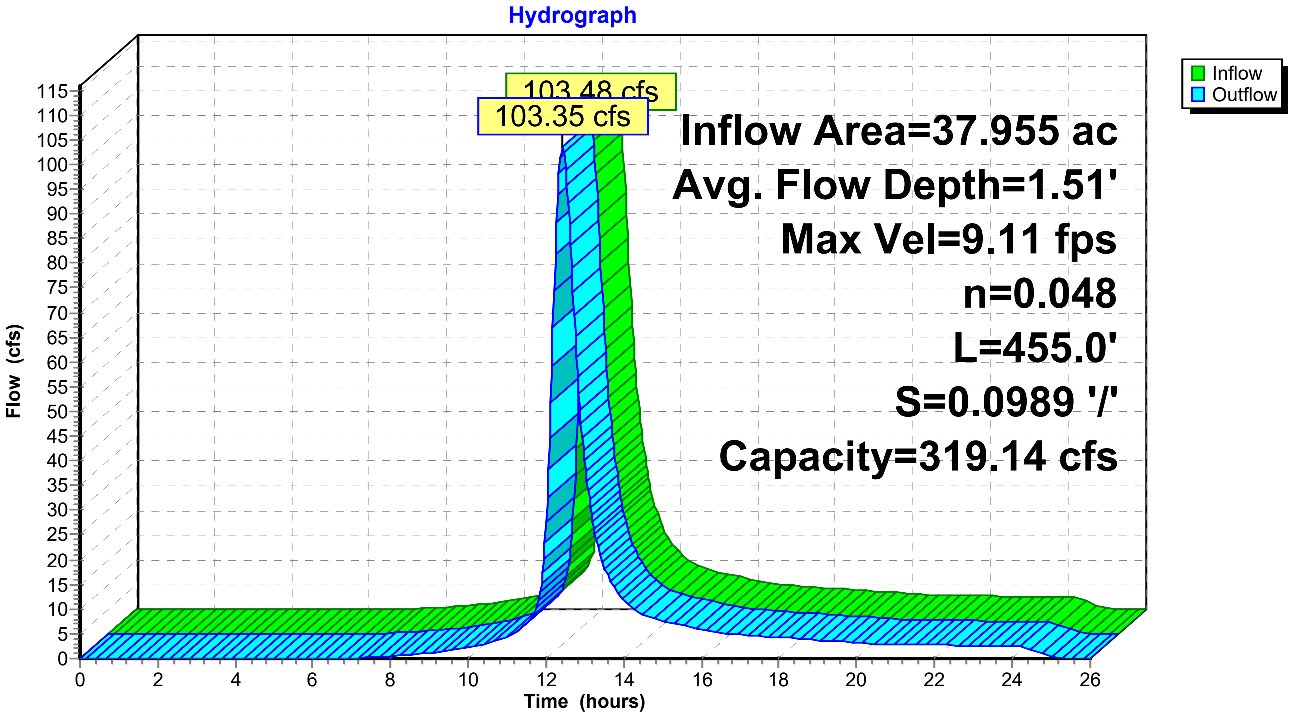
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 9.11 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 3.51 fps, Avg. Travel Time= 2.2 min

Peak Storage= 5,169 cf @ 12.40 hrs
Average Depth at Peak Storage= 1.51'
Bank-Full Depth= 2.50' Flow Area= 26.3 sf, Capacity= 319.14 cfs

3.00' x 2.50' deep channel, n= 0.048
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 455.0' Slope= 0.0989 '/'
Inlet Invert= 800.00', Outlet Invert= 755.00'

‡

Reach 56R: CH-1



Summary for Reach 58R: PC 212

[43] Hint: Has no inflow (Outflow=Zero)

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

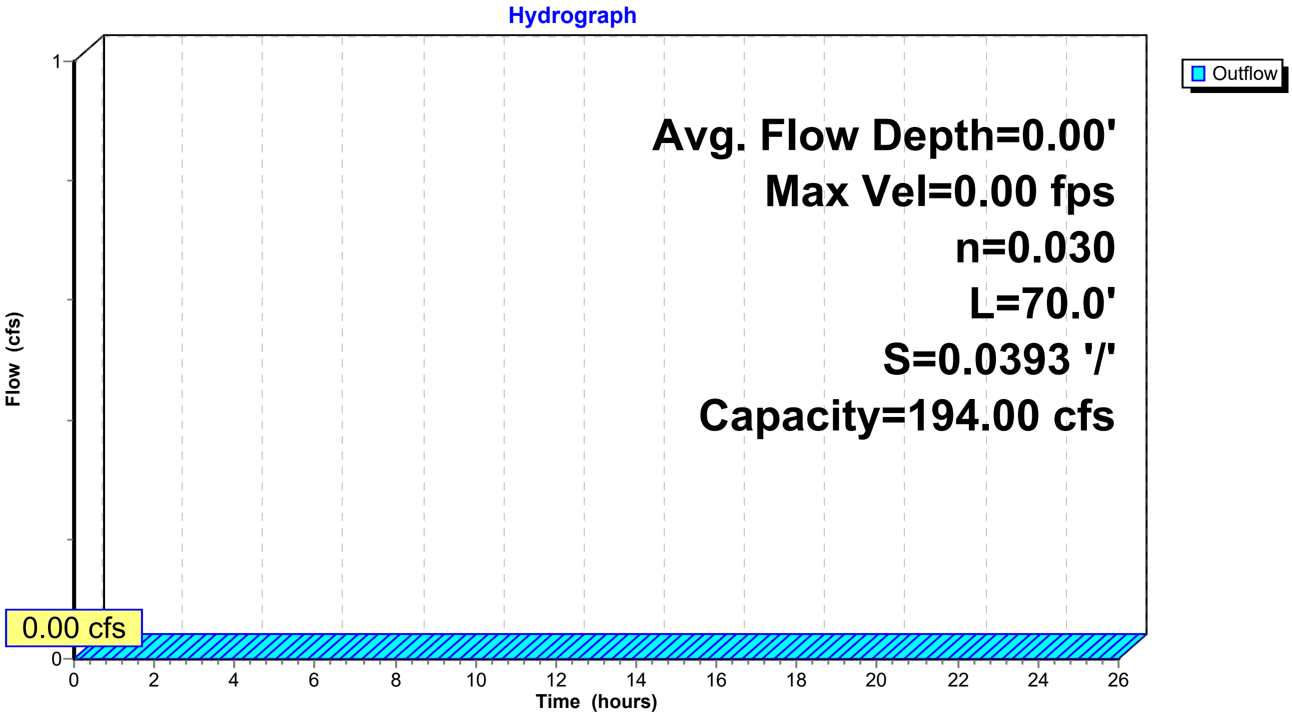
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 194.00 cfs

3.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 70.0' Slope= 0.0393 '/'
Inlet Invert= 812.75', Outlet Invert= 810.00'

‡

Reach 58R: PC 212



Summary for Reach 59R: CH-6

Inflow Area =	15.315 ac,	0.00% Impervious, Inflow Depth = 2.80"	for 25-yr. 24-hr event	
Inflow =	41.24 cfs @	12.19 hrs, Volume=	3.570 af	
Outflow =	40.69 cfs @	12.25 hrs, Volume=	3.570 af,	Atten= 1%, Lag= 3.7 min

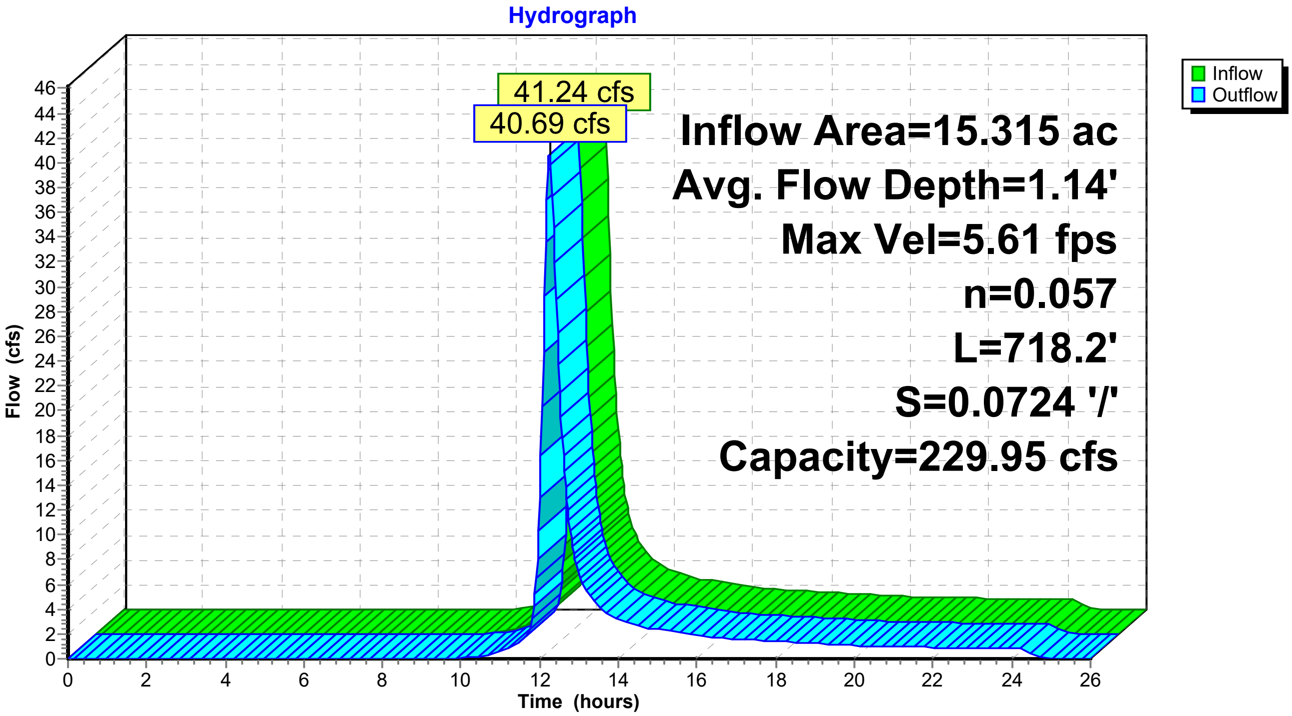
Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 5.61 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 2.02 fps, Avg. Travel Time= 5.9 min

Peak Storage= 5,224 cf @ 12.22 hrs
Average Depth at Peak Storage= 1.14'
Bank-Full Depth= 2.50' Flow Area= 26.3 sf, Capacity= 229.95 cfs

3.00' x 2.50' deep channel, n= 0.057
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 718.2' Slope= 0.0724 '/'
Inlet Invert= 798.00', Outlet Invert= 746.00'

‡

Reach 59R: CH-6



Summary for Reach 61R: CH-7

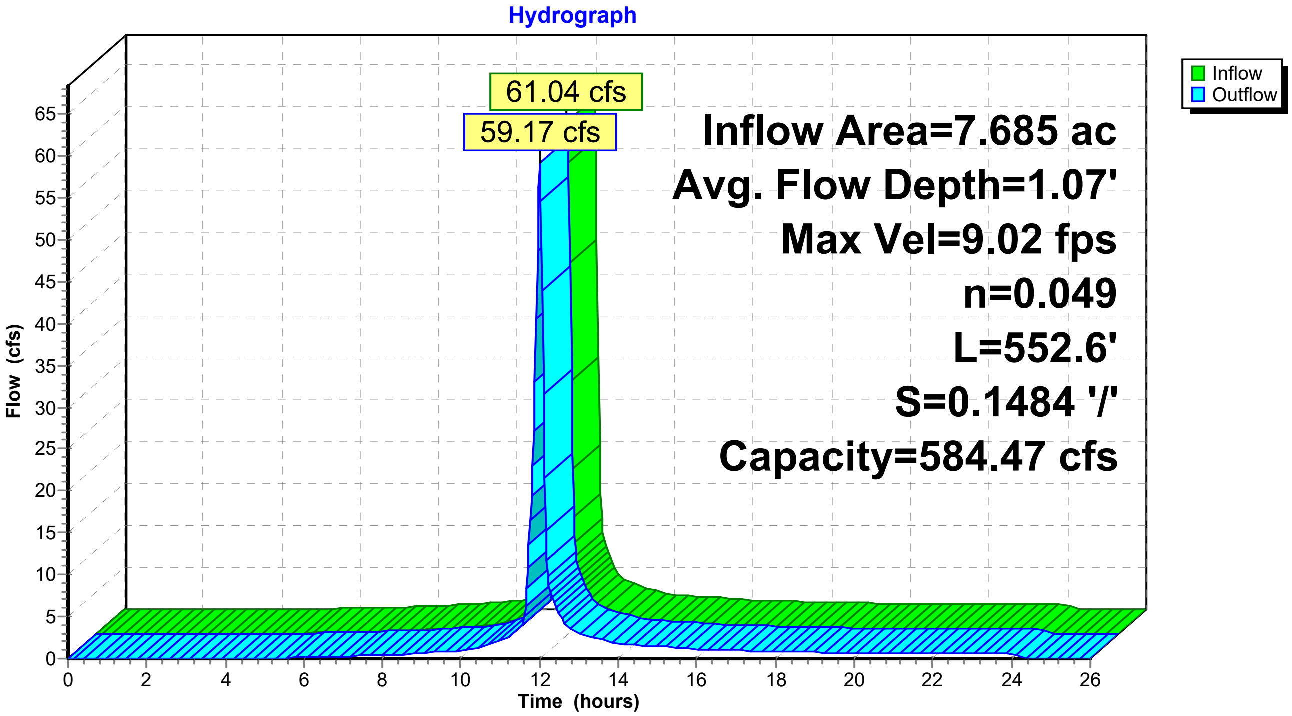
Inflow Area = 7.685 ac, 0.00% Impervious, Inflow Depth = 4.74" for 25-yr. 24-hr event
Inflow = 61.04 cfs @ 11.97 hrs, Volume= 3.037 af
Outflow = 59.17 cfs @ 12.00 hrs, Volume= 3.037 af, Atten= 3%, Lag= 1.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 9.02 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 2.47 fps, Avg. Travel Time= 3.7 min

Peak Storage= 3,671 cf @ 11.98 hrs
Average Depth at Peak Storage= 1.07'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 584.47 cfs

3.00' x 3.00' deep channel, n= 0.049
Side Slope Z-value= 3.0 '/' Top Width= 21.00'
Length= 552.6' Slope= 0.1484 '/'
Inlet Invert= 810.00', Outlet Invert= 728.00'

Reach 61R: CH-7



Summary for Reach 64R: CH-8

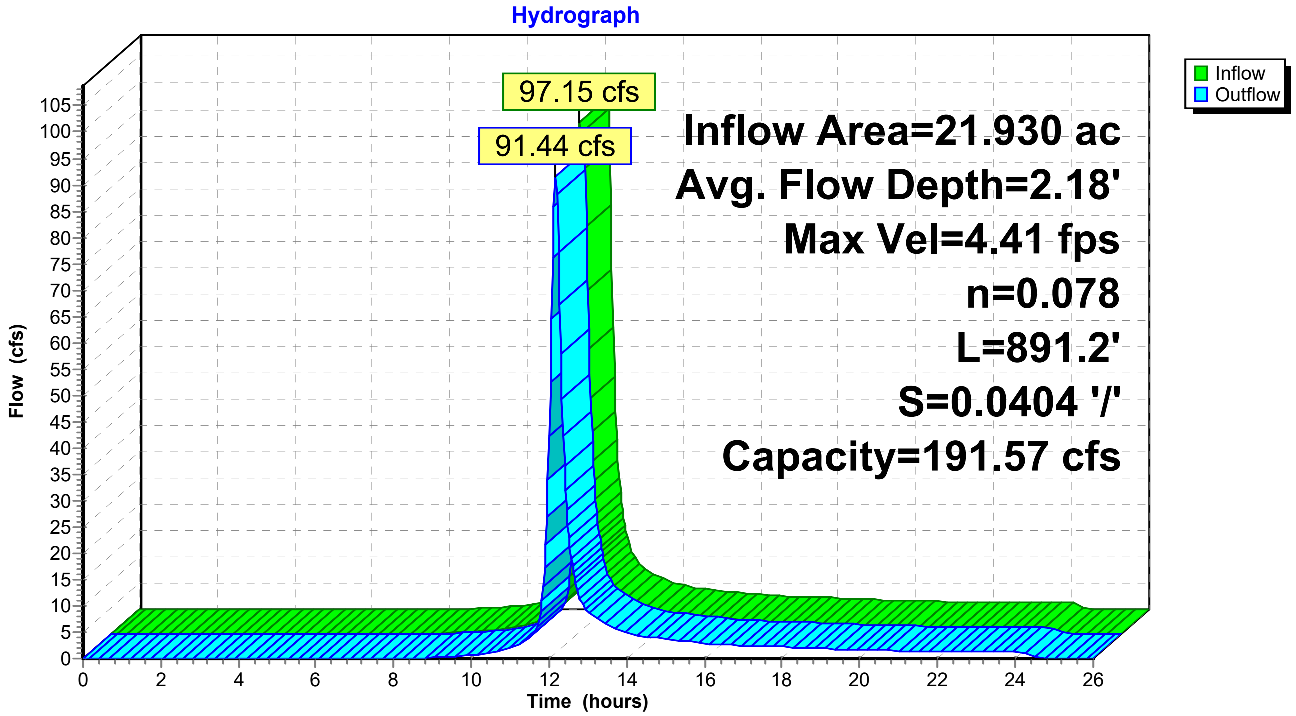
Inflow Area = 21.930 ac, 0.00% Impervious, Inflow Depth = 3.38" for 25-yr. 24-hr event
Inflow = 97.15 cfs @ 12.07 hrs, Volume= 6.179 af
Outflow = 91.44 cfs @ 12.16 hrs, Volume= 6.179 af, Atten= 6%, Lag= 5.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 4.41 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 1.50 fps, Avg. Travel Time= 9.9 min

Peak Storage= 18,508 cf @ 12.11 hrs
Average Depth at Peak Storage= 2.18'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 191.57 cfs

3.00' x 3.00' deep channel, n= 0.078
Side Slope Z-value= 3.0 '/' Top Width= 21.00'
Length= 891.2' Slope= 0.0404 '/'
Inlet Invert= 780.00', Outlet Invert= 744.00'

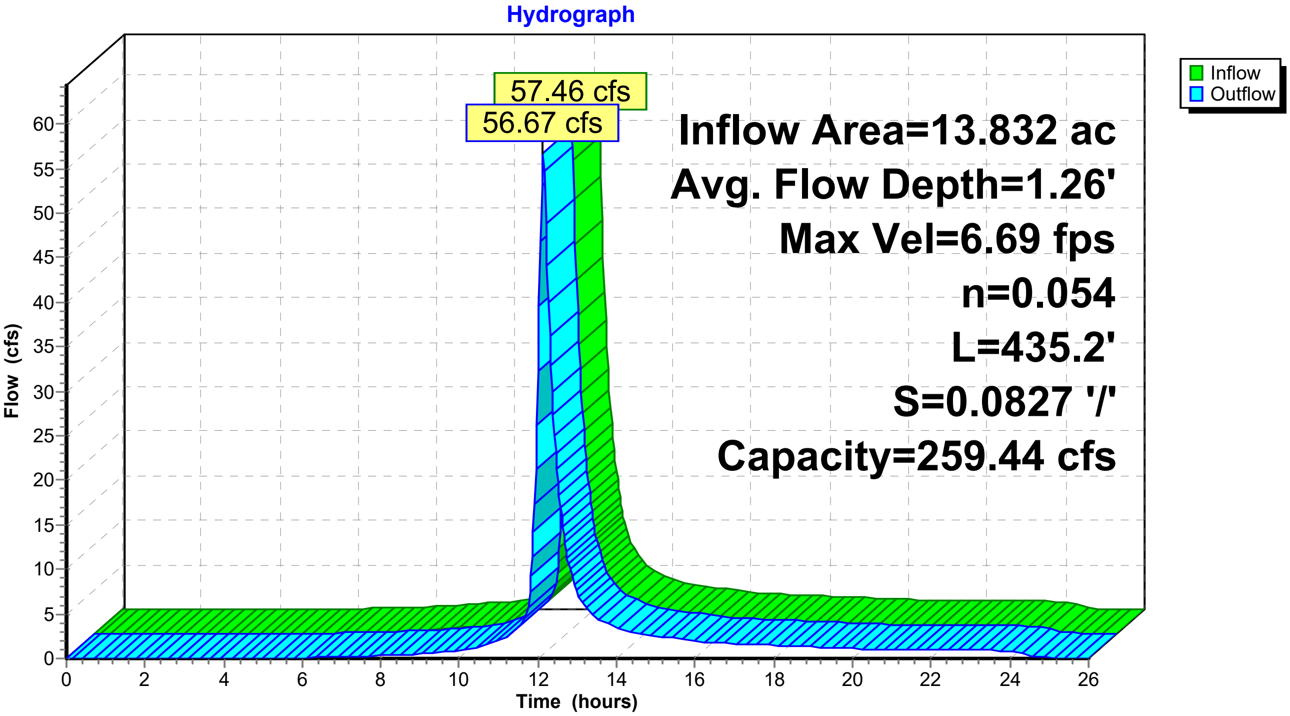
Reach 64R: CH-8



Summary for Reach 65R: CH-09_10

```
[62] Hint: Exceeded Reach 50R OUTLET depth by 0.60' @ 12.12 hrs
[62] Hint: Exceeded Reach 51R OUTLET depth by 0.52' @ 12.21 hrs

Inflow Area =     13.832 ac,   0.00% Impervious,  Inflow Depth =   3.94"   for  25-yr. 24-hr event
Inflow      =     57.46 cfs @   12.10 hrs,  Volume=          4.537 af
Outflow     =     56.67 cfs @   12.13 hrs,  Volume=          4.537 af,  Atten= 1%,  Lag= 2.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs
Max. Velocity= 6.69 fps,  Min. Travel Time= 1.1 min
Avg. Velocity = 2.11 fps,  Avg. Travel Time= 3.4 min

Peak Storage= 3,709 cf @ 12.12 hrs
Average Depth at Peak Storage= 1.26'
Bank-Full Depth= 2.50'  Flow Area= 26.3 sf,  Capacity= 259.44 cfs

3.00'  x  2.50'  deep channel,  n= 0.054
Side Slope Z-value= 3.0 '/'   Top Width= 18.00'
Length= 435.2'   Slope= 0.0827 '/'
Inlet Invert= 760.00',  Outlet Invert= 724.00'
```

Reach 65R: CH-09_10



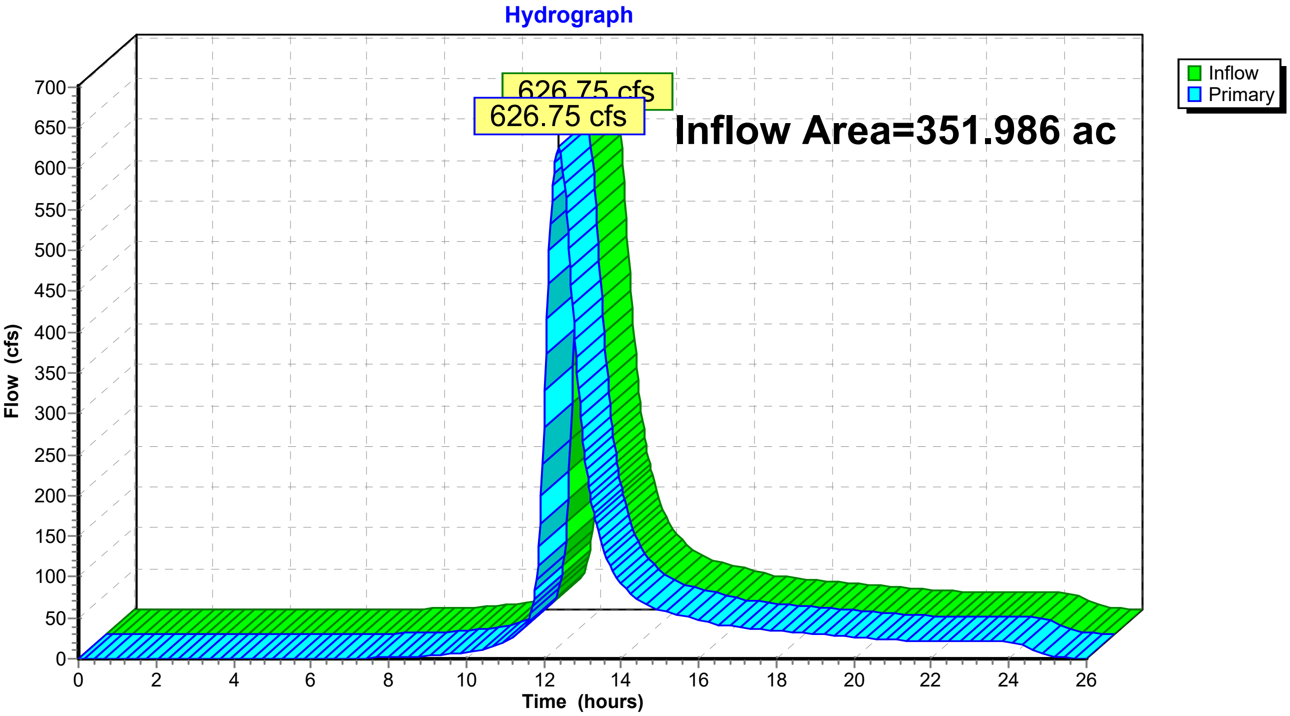
Summary for Pond 12P: Pond

[40] Hint: Not Described (Outflow=Inflow)

```
Inflow Area =      351.986 ac,    0.00% Impervious,  Inflow Depth >   3.08"    for  25-yr. 24-hr event
Inflow      =     626.75 cfs @   12.39 hrs,  Volume=          90.313 af
Primary     =     626.75 cfs @   12.39 hrs,  Volume=          90.313 af,  Atten= 0%,  Lag= 0.0 min
```

Routing by Stor-Ind method, Time Span= 0.00-26.01 hrs, dt= 0.03 hrs

Pond 12P: Pond



ATTACHMENT 5

EXAMPLE HEC15 CALCULATIONS

Example Calculations for Temporary Drainage Channel CH-04

Hydrologic analysis results provided the following parameters for CH-04.

Table 1: CH-04 Hydrologic Results

Variable	Value	Units
Ditch Length	727	ft
Area	36.9	acres
Channel Slope	6.9%	ft/ft
Q_{25} (25yr, 24hr Peak Flow)	175	cfs

Step 1. Assume first iteration channel dimensions and riprap size.

Table 2: Design Variables Iteration 1

	Variable	Value	Units
Side Slope	m	3	H:1V
Flow Depth	d	2.38	ft
Bottom Width	B	4	ft
Safety Factor	SF	1.2	SF
Assumed D_{50}	D_{50}	0.75	ft

Step 2. Calculate dimensional variables based on trapezoidal channel.

Area, A

$$A = B * d + m * d^2 \qquad \text{Eq. 7}$$

$$A = 4 * 2.38 + 3 * 2.38^2$$

$$A = 26.51 ft^2$$

Perimeter, P

$$P = B + 2\sqrt{(m * d)^2 + d^2} \qquad \text{Eq. 8}$$

$$P = 4 + 2\sqrt{(3 * 2.38)^2 + 2.38^2}$$

$$P = 19.05 ft$$

Hydraulic Radius, R

$$R = A/P \qquad \text{Eq. 9}$$

$$R = 26.51/19.05$$

$$R = 1.39 ft$$

Top Width, T

$$T = B + 2 * m * d \qquad \text{Eq. 10}$$

$$T = 4 + 2 * 3 * 2.38$$

$$T = 18.28ft$$

Average Depth, da

$$d_a = A/T \qquad \text{Eq. 11}$$

$$d_a = 26.51/18.28$$

$$d_a = 1.45ft$$

Step 3. Calculate Manning's n

Equation 6.1 is appropriate for the range of conditions where 1.5 ≤ d_a/D_{50} ≤ 185.

$$n = \frac{0.262 * {d_a}^{1/2}}{2.25 + 5.23 * \log\left(\frac{d_a}{D_{50}}\right)} \qquad \text{Eq. D1 (HEC15 Eq. 6.1)}$$

Where n = Manning's roughness coefficient
d_a = Average flow depth in the channel, feet
D_{50} = Median riprap/gravel size, feet

If d_a/D_{50} is less than 1.5 use equation 6.2.

$$n = \frac{1.49 * {d_a}^{1/2}}{\sqrt{g}f(Fr) * f(REG) * f(CG)} \qquad \text{Eq. D2 (HEC15 Eq. 6.2)}$$

Where g = gravitational constant
Fr = Froude number
REG = roughness element geometry
CG = channel geometry
T = channel top width, feet

$$d_a/D_{50} = 1.45/0.75 \qquad \text{Eq. 11}$$

$$d_a/D_{50} = 1.93$$

Since d_a/D_{50} is more than 1.6 use Equation 6.1.

$$n = \frac{0.262 * {d_a}^{1/2}}{2.25 + 5.23 * \log\left(\frac{d_a}{D_{50}}\right)} \qquad \text{Eq. D6 (HEC15 Eq. 6.6)}$$

$$n = 0.074$$

Froude number (Fr)

Step 4. Calculate flow rate based on estimated geometry, Q_{est}

$$Q_{est} = \frac{1.49}{n} AR^{2/3} S^{1/2}$$ Eq. 12 (Manning's)

$$Q_{est} = \frac{1.49}{0.074} * 26.51 * 1.39^{2/3} * 0.069^{1/2}$$

$$Q_{est} = 173.63$$

Step 5. Compare Q_{est} to design Q. Q_{est} must be within 5%

$$\frac{Q_{est} - Q}{Q} \leq 5\%$$

$$\frac{173.63 - 175.5}{175.5} = 1.0\%$$

Since Q_{est} is less than 5% the design is sufficient. If Q_{est} was greater than 5% then decrease depth estimate and start over at Step 2. If Q_{est} was less than -5% then increase depth estimate and start over at Step 2. Repeat steps 2 through 5 until Q_{est} is within 5% of Q.

Step 6. Check minimum size of D_{50}. The D_{50} must be great than or equal to the result of Equation 7.

$$D_{50} \geq D_{min} = \frac{SF * D * S_O}{F_* * (SG - 1)}$$ Eq. 7 (HEC15 Eq. 6.8)

Shield's Parameter, F_*

Table 3- HEC15 Table 6.1 Shield's Parameter

Reynolds number	F*	SF
$\leq 4x10^4$	0.047	1
$4x10^4 < R_e < 2x10^5$	Linear Interpolation	F1N Design
$\geq 2x10^5$	0.15	1.5

Shear Velocity, V_*

$$V_* = \sqrt{g * d * S}$$ Eq. 9 (HEC15 Eq. 6.10)

$$V_* = \sqrt{32.2 * 2.38 * 0.069}$$

$$V_* = 2.30\ ft/s$$

Reynold's Number, R_e

$$R_e = \frac{V_* * D_{50}}{v}$$

$$v\ (Kinematic\ Viscosity) = 1.22x10^{-5}$$

Eq. 8 (HEC15 Eq. 6.9)

$$R_e = \frac{2.30 * 0.75}{1.22x10^{-5}}$$

$$R_e = 1.42x10^5$$

Shield's Parameter, F_*

$$F_* = 0.15 - (2x10^5 - R_e) * \frac{0.15 - 0.047}{2x10^5 - 4x10^4}$$

Linear Interpolation

$$F_* = 0.15 - (2x10^5 - 1.42x10^5) * \frac{0.15 - 0.047}{2x10^5 - 4x10^4}$$

$$F_* = 0.113$$

Minimum D_{50}, D_{min}

$$D_{50} \geq D_{min} = \frac{SF * D * S_o}{F_* * (SG - 1)}$$

Eq. 7 (HEC15 Eq. 6.8)

$$D_{min} = \frac{1.2 * 2.38 * 0.069}{0.113 * (2.65 - 1)}$$

$$D_{50} \geq D_{min}$$

$$0.75\ is\ not \geq 1.06$$

Since the assumed D_{50} is not greater than the minimum D_{50}, the actual D_{50} becomes the calculated D_{50}.

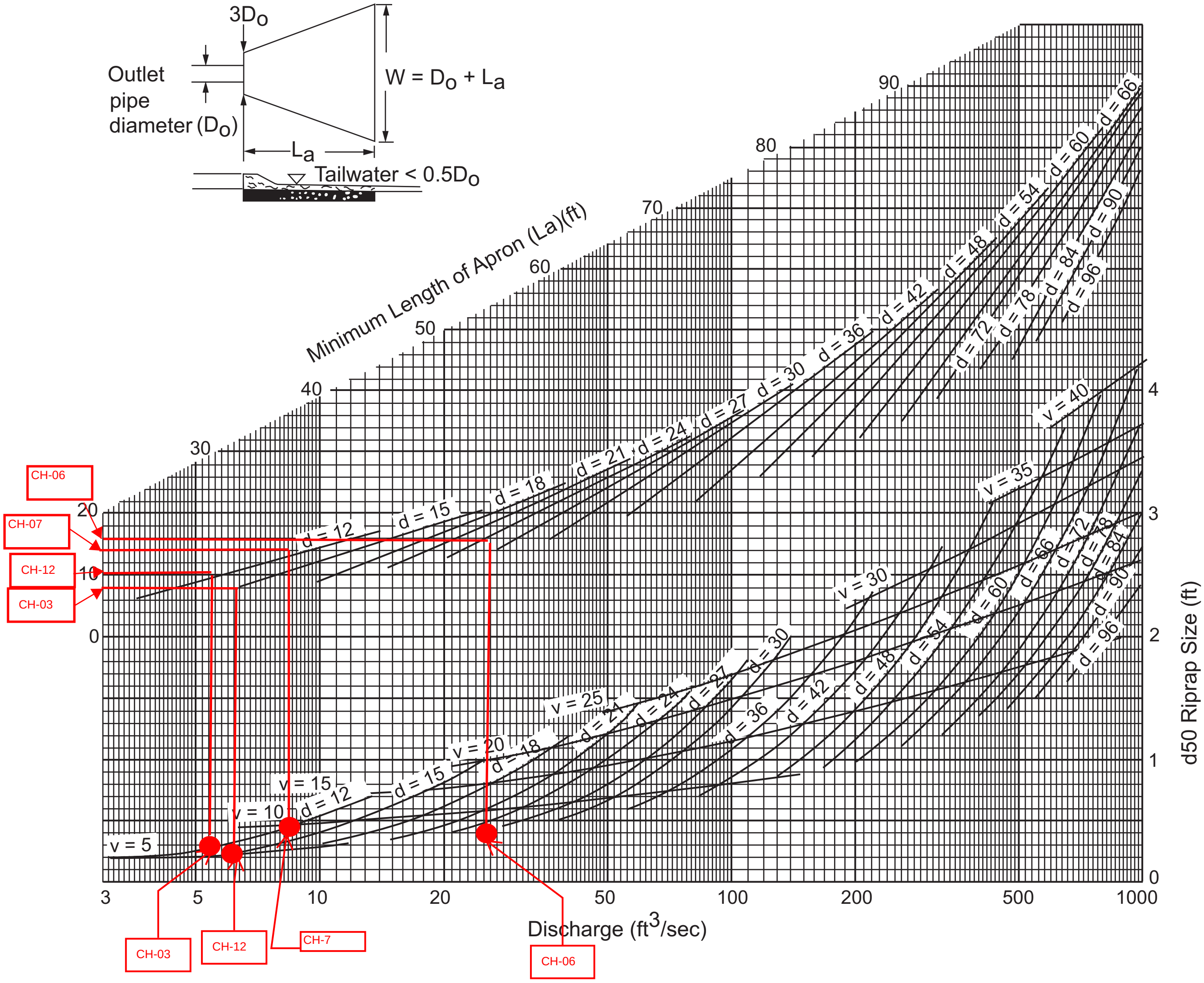
Results of Iteration

Table 4: Results Iteration Final

	Variable	**Value**	**Units**
Side Slope	m	3	H:1V
Flow Depth	d	2.39	ft
Bottom Width	B	4	ft
Safety Factor	SF	1.2	SF
Assumed D_{50}	$D_{50\ assumed}$	0.75	ft
Actual D_{50}	D_{50}	1.06	ft
Manning’s n	n	0.08	unitless
$\frac{Q_{est} - Q}{Q}$		0.0%	%

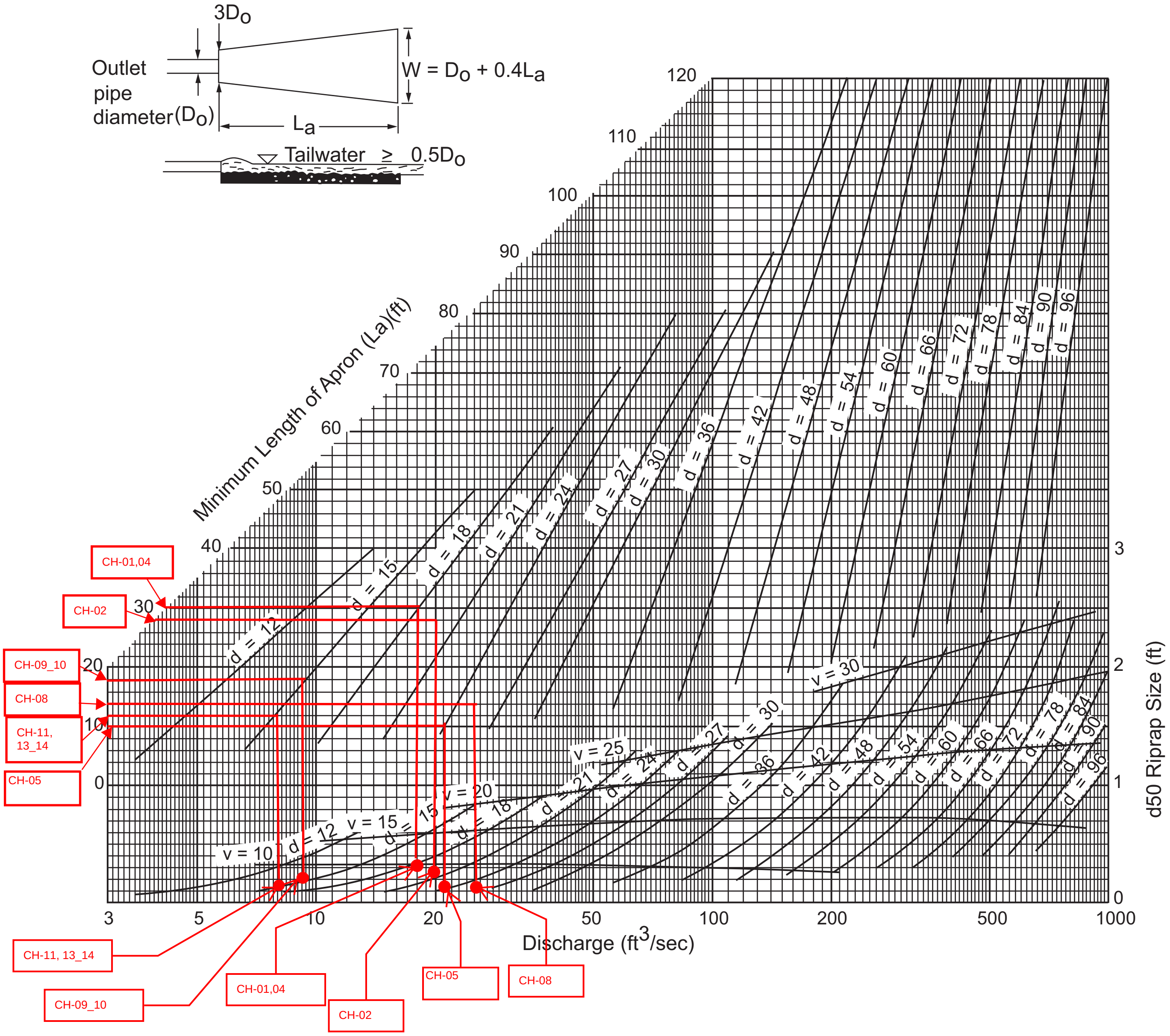
ATTACHMENT 6

RIPRAP APRON SIZING



Curves may not be extrapolated.

Figure 6-34.1 - Design of Outlet Protection From a Round Pipe Flowing Full, Minimum Tailwater Condition (Tw < 0.5 Diameter)



Curves may not be extrapolated.

Figure 6-34.2 - Design of Outlet Protection From a Round Pipe Flowing Full, Maximum Tailwater Condition (Tw > 0.5 Diameter)