Gibbons Creek Environmental Redevelopment Group, LLC

September 6, 2022

Eun Ju Lee, Ph.D., P.E.
Industrial & Hazardous Waste Permits Section
Waste Permits Division
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Re: Technical NOD2 New CCR Registration
Gibbons Creek Environmental Redevelopment Group, LLC – Anderson, Grimes County
New Coal Combustion Residuals (CCR) Registration No. CCR113
Industrial Solid Waste Registration No. 32271
EPA Identification No. TXD000751073
Tracking No. 27262344; RN100214550/CN6505860162

Dear Ms. Lee,

In response to your review comments dated August 12, 2022, the following includes the clarifications and/or revisions to complete the Permit Application for the Gibbons Creek Environmental Redevelopment Group (GCERG) facility.

15. Attachment L

Provide an updated periodic run-on and run-off control system plan with the required certification by a qualified P.E. Use the most current rainfall data from the National Oceanic and Atmospheric Administration. The plan provided is dated October 17, 2016 and the rule requires the plan to be revised every five years.

A revised run-on and run-off control system plan with required certification can be found in Response Item 15 Attachment.

16. Table IV.D (Att. M)

Include facility unit(s) and specify all landfill components and basic elements for inspections to match with the 2021 Site F Landfill annual inspection report (Att. M). Additionally, correct inspection intervals to “not exceeding seven days” from weekly.

The revised Table IV.D can be found in Attachment Respond Item 16.

17. Form TCEQ 20870, p. 38

Provide a dike certification form.

The Scrubber Sludge Pond and Ash Ponds A, B, and C have been clean closed and are not subject to CCR registration.

18. Table V.J

Complete inspection requirements for surface impoundment inspections.

The surface impoundments (Scrubber Sludge Pond and Ash Ponds A, B, and C) have been clean closed and are not subject to CCR registration.

19. Att. S

Provide cross section(s) showing the geologic units and fill materials overlying the uppermost aquifer.

A cross section showing the geologic units and fill materials overlying the uppermost aquifer can be found in Response Item 19 Attachment.

20. Table VI.C-1

Add and complete attached "Table VI.C-1 – Groundwater Detection Monitoring Parameters.", if applicable. This table was inadvertently omitted in the application form.

Table VI.C-1 can be found in Response Item 20 Attachment.

HDR Engineering, Inc.
17111 Preston Road
Suite 300
Dallas, TX 75248

Phone: (9724)9603-4400
Fax: (972) 960-4471
www.hdrinc.com

20. Table VI.D-2

Replace title of "Table VI.D.2 – Groundwater Detection Monitoring Parameters" with "Table VI.D-2-Groundwater Assessment Monitoring Parameters" and complete if applicable.

Table VI.D.2 can be found in Response Item 20 Attachment.

21. 2021 Groundwater (GW) Report

Provide historical data since the groundwater levels (ft amsl) are inconsistent with the aquifer report.

See Response Item 21 Attachment for historical groundwater levels from 2018 through 2021.

22. 2021 GW Report, Figures

Provide reports and figures signed and sealed by a P.E.

See response Item 22 Attachment for revised reports and figures.

23. Table 1.6 & V.A.

Reconcile AP and SSP dimensions and capacities with Form TCEQ-20870, Table V.A. Update Table I.6 accordingly.

See Response Item 23 Attachment for revised Table V.A. and Table I.6.

24. Att. V, Secs 2.1 & 2.2

Provide reference locations for TMPA drawings.

See Response Item 24 Attachment for referenced TMPA drawings.

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25. Att. V, Secs 3.2.1 and 3.2.2

Correct typographical error for SSD and correct rule citation

Please see Response Item 25 Attachment for revised Sections.

26. Att. V, Fig 2

Reconcile the geomembrane information in the final cover system with Section 2 of the 2021 Groundwater Report and Att. Y, Sheets 00C-11 & 00C-12.

Please see Response Item 26 Attachment for revised detail.

27. ATT. V

Include erosion control, settlement, and slope stability analyses information for landfill Site F for closure and post closure.

Please see Response Item 27 for ESC Plan for Stie F Landfill for closure and post closure.

28. Attachment VIII.34

Provide a statement that a Financial Assurance mechanism will be provided within 90 days if a registration is issued.

Please see Response Item 28 for statement that a Financial Assurance mechanism will be provided within 90 days if a registration is issued.

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6. (2) Property/Legal Description

Provide updated map(s) that depict the registration boundary throughout the application. Update all drawings accordingly if any changes affects the boundary after selling of portion(s) of the property.

Please see Response Item 6 (2) for a revised property map.

10. (2) Att. A

Provide updated adjacent landowner list and drawing, and pre-printed mailing labels after selling off portions of the property. Additionally, include mineral interest ownership information.

Please see Response Item 10 (2) for a revised adjacent landowner list and drawing. Pre-printed mailing labels will be sent separately to the TCEQ.

Mineral Interest Ownership Information:

Per 30 TAC 350.59(c)(3) "(B) The adjacent and potentially affected landowners' list shall be keyed to the land ownership maps and shall give each property owner's name and mailing address. The list shall comply with the requirements of §281.5 of this title ,and shall include all property owners within 1/4 mile of the facility, and all mineral interest ownership under the facility. Property and mineral interest owners' names and mailing addresses derived from the real property appraisal records as listed on the date that the application is filed will comply with this paragraph. Notice of an application is not defective if property owners or mineral interest owners did not receive notice because they were not listed in the real property appraisal records. The list shall also be provided in electronic form.

Mineral interest ownership under the CCR unit cannot be derived from real property appraisal records as suggested under 30 TAC 350.59(c)(3). Therefore, this information cannot be provided

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If you have any questions regarding this response, please give Dave Vogt a call at 972-960-4400 or Norman Divers at 704-472-3919. We look forward to continuing to work with you to complete the registration process.

Sincerely,

David C. Vogt, P.E.
HDR Engineering, Inc.

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RESPONSE ITEM 15

ATTACHMENT

2021 RUN-ON RUN-OFF CONTROL SYSTEM PLAN

Gibbons Creek Environmental Redevelopment Group, LLC

Run-on and Run-off Control System Plan

For Compliance with the Coal Combustion Residuals Rule (40 CFR Part 257.81)

Gibbons Creek Steam Electric Station

Anderson, Texas

August 26, 2022

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Table 2-1 Summary of Site F Landfill Soils
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LIST OF ACRONYMS

CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
cfs	cubic feet per second
CN	curve number
EPA	Environmental Protection Agency
HSG	hydrologic soil group
NOAA	National Oceanic and Atmospheric Administration
RCRA	Resource Conservation and Recovery Act
SCS	Soil Conservation Service
TR-55	Technical Release 55

1.0 INTRODUCTION

On April 17, 2015 the U.S. Environmental Protection Agency (EPA) published regulations under Subtitle D of the Resource Conservation and Recovery Act (RCRA) meant to control the safe disposal of coal combustion residuals (CCR) generated by coal fired electric utilities. The rule defines a set of requirements for the disposal and handling of CCR within CCR units (defined as either landfills or surface impoundments). The requirements include preparation of a Run-on and Run-off Control System Plan for all existing and new CCR landfills.

This Run-on and Run-off Control System Plan has been prepared for the Site F Landfill, a CCR landfill unit at the Gibbons Creek Steam Electric Station (GCSES). It has been prepared in accordance with the requirements of 40 CFR 257.81. The regulation requires an initial Run-on and Run-off Control System Plan be prepared no later than October 17, 2016 and updated every five years. The original Run-on and Run-off Control System was completed on October 19, 2016.

1.1 Facility Description

The GCSES is located at 12824 FM 244, Anderson, TX 77830. The Site F Landfill (Landfill) is located approximately 1.5 miles northeast of the site's administrative building. The GCSES is approximately 15 miles east of College Station, Texas.

The Site F Landfill (Landfill) is located at the Gibbons Creek Steam Electric Station (GCSES) and is approximately 96 acres in size. The Landfill was constructed in 1990 and expanded in 1995. The CCR material placed in the Landfill consists primarily of bottom ash, fly ash, fly ash mixed with dewatered scrubber sludge, and dewatered scrubber sludge. Approximately 30.1 acres of the landfill is still open and available to accept waste however, only approximately 18.3 acres is active without any temporary cover. The remainder of the Landfill has a cover system installed with a thick layer of vegetative cover.

The GCSES closed and stopped generating CCR material in 2018. The facility is currently being decommissioned. Upon completion of closure activities, the Landfill will contain approximately 8,078,000 cy of CCR material.

1.2 Regulatory Requirements

40 CFR 257.81 and 30 TAC §335.173(h) requires that an owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill design, construct, operate, and maintain:

1) a run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm;
2) a run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm; and
3) a run-off control system designed to handle run-off so that it does not cause a discharge of pollutants to waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) under Section 402 of the Clean Water Act.

2.0 RUN-ON / RUN-OFF CONTROLS FOR CCR LANDFILL

A hydrologic and hydraulic analysis was completed for the active portion of the CCR landfill unit in accordance with 40 CFR 257.81 and 30 TAC §335.173(h). Per §257.53 the active portion means "*that part of the CCR unit that has received or is receiving CCR or non-CCR waste and that has not completed closure in accordance with §257.102"*.

A surface water run-off model was prepared using the Soil Conservation Service (SCS) Technical Release 55 (TR-55) for computing curve numbers and times of concentration. The model is included as Appendix A. A detailed discussion of the information inputted into the model is provided below. This modeling system was used to determine whether existing run-on and run-off control systems meet the required criteria for controlling run-on and run-off from the 24-hour, 25-year storm event. The evaluation was completed using the best available information at the time and was based on an existing conditions survey May 21, 2021.

2.1 Description of the Active CCR Landfill and Drainage Area

Based on the survey data, the active area pf the CCR landfill is an approximate 18.34-acre area on the south side of the Landfill (see Figure 2). It is surrounded by a diversion berm (elevation 280 feet) and swale to direct non-CCR contact stormwater away from the active area. The active area is sloped to the lowest section where it ponds and eventually evaporates. The ponded area varies based on seasonal rainfall but is typically approximately 5.5 acres in size.

2.2 Description of Existing Run-on / Run-off Controls

2.2.1 Run-on Controls

The Landfill is bounded by a perimeter berm that varies in height from approximately 20-feet to 60-feet and relies on natural topography on the southern and eastern ends to prevent stormwater run-on to the landfill.

The area identified as Drainage Area 1 in Figure 2 flows east away from the active area and goes through an existing stormwater settling pond before discharge to the surrounding area.

The area identified as Drainage Area 2 is adjacent to the active area and is diverted away from the active area by a drainage swale and minimum 3-feet high diversion berm. Drainage Area 2 is approximately 28.4 acres in area.

The active area (Drainage Area 3) of the landfill is surrounded by a drainage swale and diversion berm, a minimum of 3-feet high, to prevent surface water run-on from contacting CCR material. The active area is approximately 30.1 acres in area.

2.2.2 Run-off Controls

The active area (Drainage Areas 3) is surrounded by the diversion berm. Stormwater landing within the active area is either absorbed by the uncovered CCR material or is directed to the lowest area where it ponds and eventually evaporates. There is no outfall at the active area. The overall area of the ponded water varies and averages approximately 5.5 acres in size.

2.3 Surface Water Run-off Model

A surface water run-off model was prepared using the Soil Conservation Service (SCS) Technical Release 55 (TR-55) for computing curve numbers and times of concentration. The model is included as Appendix A. A detailed discussion of the information inputted into the model is provided below.

2.3.1 Rainfall Data

Rainfall data was taken from the National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency Data Server. Rainfall data inputted into the model included the 25 year - 24 hour storm event of 8.99 inches. The precipitation information from the NOAA Precipitation Frequency Data Server is included as Appendix B.

2.3.2 Weighted Curve Number

The weighted curve number (CN) is determined according to a hydrologic soil group (HSG) and ground cover for a delineated drainage basin. The active area of the landfill was delineated into one drainage basin which drains to the low end (refer to Figure 2). To compute the weighted CN the Soil Conservation District Web Soil Survey map was consulted to identify the hydrologic soil groups for the native soils where ash was not present. A soil report for the native soils is included in Appendix C. According to the web soil map the native soils at the Site F Landfill consist primarily of the following:

Table 2-1: Summary of Site F Landfill Soils		
Soil Type	Slope	Hydrologic Soil Group
Burlewash, fine sand loam	1-5%	D
Bulrewash, fine sandy loam	5-12%	D
Elmina loamy fine sand	1-5%	A
Padina loamy fine sand	1-8%	A
Shirol loamy fine sand	1-5%	D
Singleton fine sandy laom	1-5%	D
Water		D

A summary of the breakdown used to calculate the weighted CN is provided in Table 2-2 and Table 2-3. The exposed CCR material was treated as "Fallow, Bare Soil" for the purposes of assigning the HSG.

Table 2-2: Summary of Drainage Area 2			
Cover Type	**HSG**	**Area**	**Curve Number**
Pasture, good condition	A	7.85	39
Pasture, good condition	D	7.11	80
Open Water	A	1.57	98
Weighted CN			**62**

Table 2-3: Summary of Drainage Area 3 (Active Area)			
Cover Type	**HSG**	**Area**	**Curve Number**
Fallow, Bare Soil	A	15.9	77
Pasture, good condition	D	8.7	80
Open Water	A	5.5	98
Weighted CN			**78**

2.3.3 Time of Concentration

The time of concentration is defined as the time required for runoff to travel from the most hydrologically distant point of a sub-catchment to the point of collection. It is determined by summing the travel time for consecutive flow segments along the sub-catchment's hydraulic path. The path for the time of concentration used to compute surface water runoff from the active landfill area is shown on Figure 2.

2.3.4 Active Area

The active area was modeled as a retention basin with no outlet.

2.4 Evaluation of Existing Run-on Controls

The active area of the landfill is enclosed with a berm that is 3-feet high and drainage swale. To comply with 40 Part 257.81 the existing contact pond must be of sufficient size to collect and control run-on resulting from the 24-hour, 25 year storm event. The model was run to evaluate whether the diversion berm was of sufficient size to prevent the design storm event from coming into contact with exposed CCR material at the active area.

Based on the model results the existing diversion berm is of sufficient size to prevent surface water run-on from contacting CCR material in the active area. Based on the model and calculations performed, the peak stormwater runoff will be approximately 104 cfs at the discharge point from the landfill. The depth of stormwater will be approximately 1.4 feet. The diversion berm has a height of approximately 3-feet therefore, the freeboard is greater than 1-foot.

2.5 Evaluation of Existing Run-Off Controls

To comply with 40 Part 257.81 the active area must be of sufficient size to collect and control run-off resulting from the 24-hour, 25-year storm event. The model was run to evaluate whether there was sufficient volume in the active area to contain the design storm event.

Based on the model results the existing containment within the active area is of sufficient size to prevent surface water run-off from leaving the active area. Based on the model and calculations performed, the peak stormwater runoff will be approximately 100 cfs to the low point of the active area and the volume of runoff is 17.1 acre-feet. The typical water surface depth is elevation 265-feet and the total storage volume at elevation 285-feet, 1-foot below top of containment berm, is approximately 40-acre feet which is over twice the expected runoff from the design storm event.

2.6 Improvements to Existing Run-on / Run-off Controls

Based on the available information and the model results the existing run-on and run-off controls in place for the active portion of the landfill unit meet the requirements of 40 CFR Part 257.81. There are no improvements proposed for the existing run-on and run-off control systems for the active portion of the CCR landfill.

3.0 ADMINISTRATIVE REQUIREMENTS

Per the requirements of 257.81(c) the initial run-on and run-off control system plan must be prepared by October 17, 2016. Following preparation of the initial plan the owner or operator shall amend the plan whenever changes occur that affect the current plan or at a minimum at a frequency of five years following preparation of the initial plan. Additional administrative requirements are discussed below.

3.1 Plan Amendments

Amendments to the run-on and run-off control system plan may be made at any time provided the revised plan is placed in the facility's operating record. The plan must be amended whenever there is a change in conditions that would substantially affect the written plan in effect. An example of when the plan should be amended includes the closure of an existing portion or cell of the CCR landfill resulting in a possible change in the size of the active portion of the CCR landfill.

At a minimum the owner and operator must prepare periodic run-on and run-off control system plans every five years starting from the date that the initial plan is completed. Plans shall be deemed complete when it has been placed in the facility's operating record.

3.2 Record Keeping Requirements

Record keeping requirements shall be in accordance with §257.105(g).

3.3 Notifications

Notifications are required in accordance with §257.106(g). Notifications require that the owner or operator notify the State Director and/or appropriate Tribal authority when the initial and periodic run-on and run-off control system plans are placed in the facility's operating record.

3.4 Internet Requirements

In accordance with §257.107(g) the initial and periodic run-on and run-off control system plans must be posted on the facility's web site. Only the most current plan shall be posted.

4.0 PROFESSIONAL ENGINEER CERTIFICATION

Gibbons Creek Steam Electric Station Site F Landfill 2021 Five Year Review Run-on and Run-off Controls for CCR Landfills Compliance with the Federal Coal Combustion Residuals Rule

The undersigned Registered Professional Engineer is familiar with the requirements of Part 257 of Title 40 of the Code of Federal Regulations (40 CFR Part 257) and has visited and examined the facility, or has supervised examination of the facility by appropriately qualified personnel. The undersigned Registered Professional Engineer attests that this Run-on and Run-off Controls System Plan has been prepared in accordance with good engineering practice, including consideration of applicable industry standards and the requirements of 40 CFR Part 257.

This Plan is valid only to the extent that the facility owner or operator maintains existing run-on and run-off controls described in this Plan to prevent flow onto the active portion and prevent surface discharges of CCR in solution or suspension.

David C. Vogt, P.E.

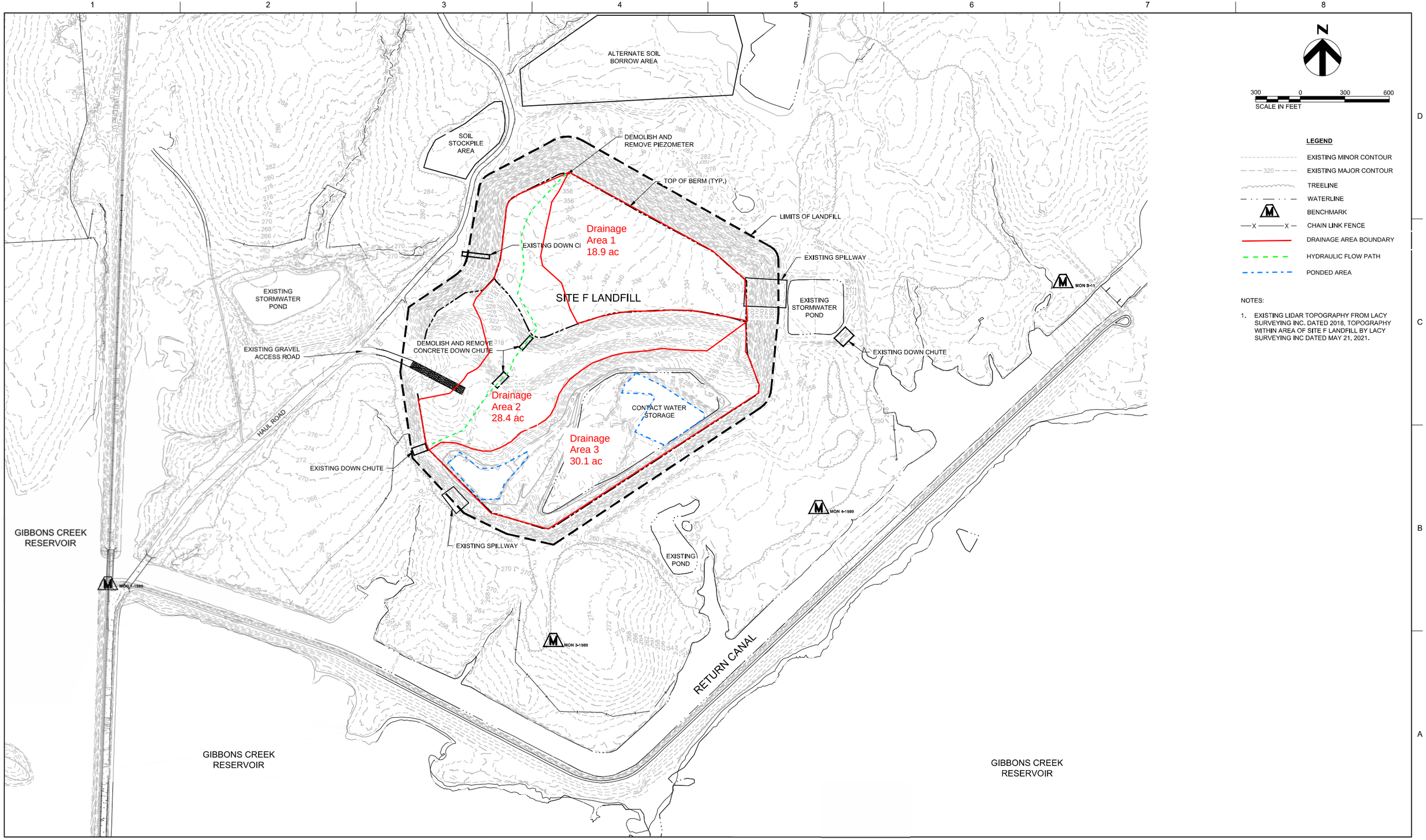
8/26/2022

Texas Professional Engineer: 93905

HDR Engineering, Inc.

Firm Registration No. F-754

Appendix A
Figures



NOTES:

1. EXISTING LIDAR TOPOGRAPHY FROM LACY SURVEYING INC. DATED 2018, TOPOGRAPHY WITHIN AREA OF SITE F LANDFILL BY LACY SURVEYING INC DATED MAY 21, 2021.

ISSUED FOR CONSTRUCTION

HDR
Firm Registration No. F-754

17111 Preston Road, Suite 300
Dallas, Texas 75248-1229
972.960.4400

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER D. VOGT, P.E.

PROJECT NUMBER 10290148

8/26/2022

STATE OF TEXAS · DAVID C. VOGT · 93905 · LICENSED · PROFESSIONAL ENGINEER

Gibbons Creek Environmental Redevelopment Group, LLC

SITE F LANDFILL CLOSURE
Anderson, Texas

EXISTING CONDITIONS

0 1" 2"

FILENAME 00C-02.dwg
SCALE 1"=300'

SHEET 00C-02

C:\pwworkingcentral\01\d23842\2\00C-02.dwg, Layout1, 8/4/2021 9:01:34 AM, JGAUL

2021 Run-On Run-Off Report

Site F Landfill

Appendix B
TR-55 Model Results

United States Department of Agriculture

Natural Resources Conservation Service

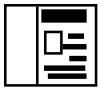
Conservation Engineering Division

Technical Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

To show bookmarks which navigate through the document. Click the show/hide navigation pane button  , and then click the bookmarks tab. It will navigate you to the contents, chapters, rainfall maps, and printable forms.

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Gibbons Creek Registration	Dave Vogt	8/26/2022
Location: Site F Landfill - Drainage Area 2	Project: 10290148	Task: 3

Check one: ☒ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
Burlewash, C	Pasture, good condition	80			7.9	632
Burlewash, E	Pasture, good condition	80			4.7	376
Elmina, A	Pasture, good condition	39			2.8	109
Shiro, D	Pasture, good condition	80			12.8	1,024
Singleton, D	Pasture, good condition	80			0.2	16
					Totals ➡	28.40 / 2,157

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{2{,}157}{28.4} = 76$; **Use CN ➡** 76

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	25		
Rainfall, P (24-hour)	in	8.99		
Runoff, Q	in	6.00		

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	Gibbons Creek Registration	By	Dave Vogt	Date	8/26/2022
Location	Site F Landfill - Drainage Area 2	Project: 10290148		Task: 3	

Check one: [X] Present [ ] Developed

Check one: [X] T_c [ ] T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

	Segment ID	1	
1.	Surface description (table 3-1)	short grass prairie	
2.	Manning's roughness coefficient, n (table 3-1)	0.15	
3.	Flow length, L (total L † 300 ft) ft	300	
4.	Two-year 24-hour rainfall, P_2 in	4.34	
5.	Land slope, s ft/ft	0.03	
6.	$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr	0.28	+ = 0.28

Shallow concentrated flow

	Segment ID	2	
7.	Surface description (paved or unpaved)	unpaved	
8.	Flow length, L ft	984	
9.	Watercourse slope, s ft/ft	.015	
10.	Average velocity, V (figure 3-1) ft/s	2.0	
11.	$T_t = \frac{L}{3600\ V}$ Compute T_t hr	.14	+ = .14

Channel flow

	Segment ID	Grass Areas	Concrete Drops
12.	Cross sectional flow area, a ft^2	30	46
13.	Wetted perimeter, p_w ft	17.6	48.2
14.	Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft	1.70	0.95
15	Channel slope, s ft/ft	.056	0.25
16.	Manning's roughness coefficient, n	0.24	0.01
17.	$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s	1.86	72
18.	~~Flow l~~ength, L ft	1,052	145
19.	$T_t = \frac{L}{3600\ V}$ Compute T_t hr	0.16	+ 0.0 = 0.16
20.	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr		0.58

Worksheet 4: Graphical Peak Discharge method

Project	Gibbons Creek Registration	By	Dave Vogt	Date	8/26/2022
Location	Site F Landfill - Drainage Area 2		Project: 10290148		Task: 3

Check one: [X] Present [ ] Developed

1. Data

Drainage area ..... A_m = .044 mi^2 (acres/640)

Runoff curve number .....CN = 76 (From worksheet 2)

Time of concentration ..... T_c = 0.58 hr (From worksheet 3)

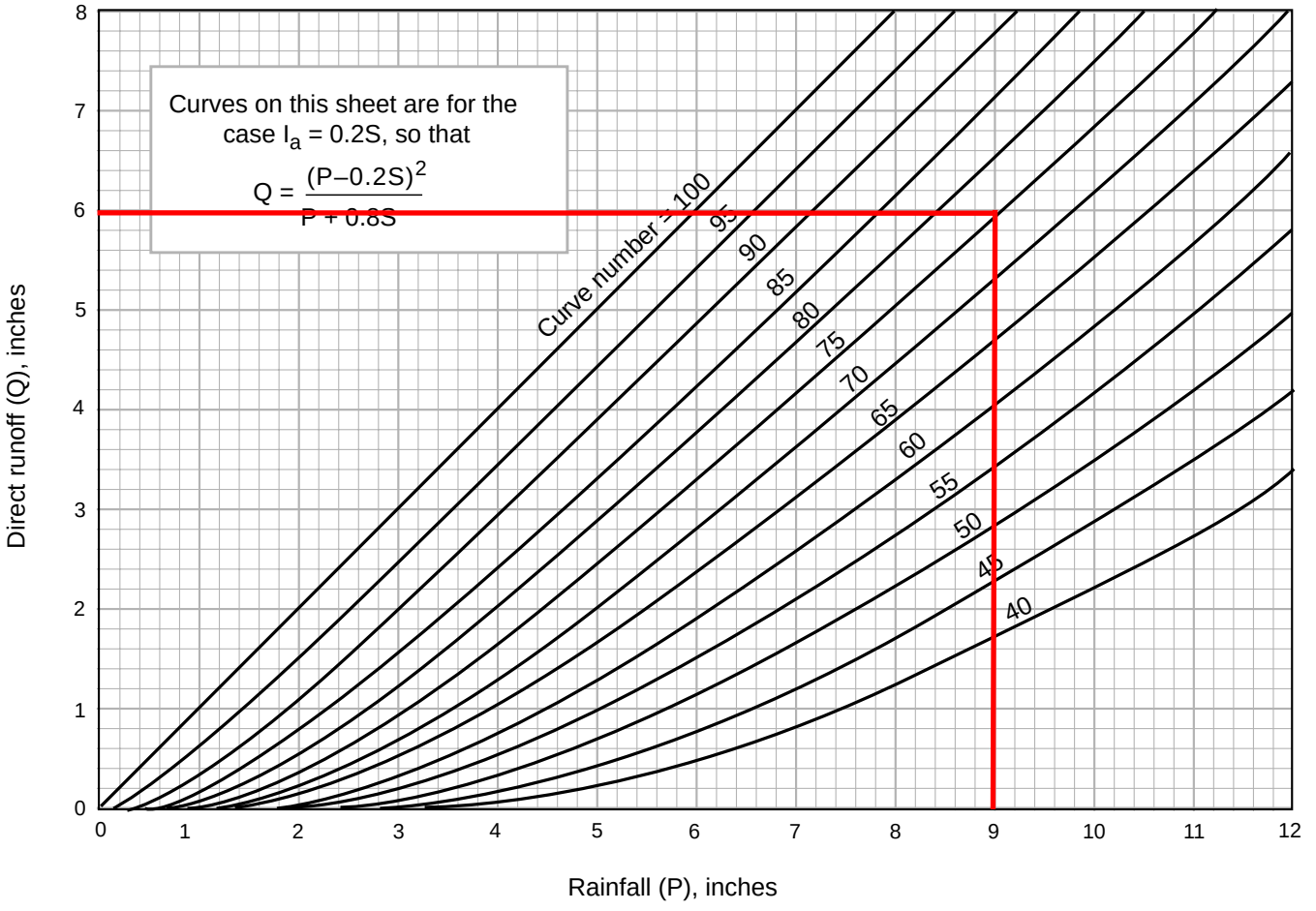
Rainfall distribution ..... = III (I, IA, II III)

Pond and swamp areas sprea throughout watershed ..... = 0 percent of A_m (_____ acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr	25		
3. Rainfall, P (24-hour) ..... in	8.99		
4. Initial abstraction, I_a ..... in (Use CN with table 4-1)	.63		
5. Compute I_a / P	0.07		
6. Unit peak discharge, q_u ..... csm/in (Use T_c and I_a / P with exhibit 4– _____)	395		
7. Runoff, Q ..... in (From worksheet 2) Figure 2-6	6.00		
8. Pond and swamp adjustment factor, F_p ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)	1.0		
9. Peak discharge, q_p ..... ft^3/s	104		

(Where $q_p = q_u A_m Q F_p$)

Figure 2-1 Solution of runoff equation.



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Treatment is a cover type modifier (used only in table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

Hydrologic condition

*Hydrologic condition i*ndicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. *Good* hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Table 2-1 Runoff depth for selected CN's and rainfall amounts [1/]

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

[1/] Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

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 Assumed for CCR	—	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.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

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

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

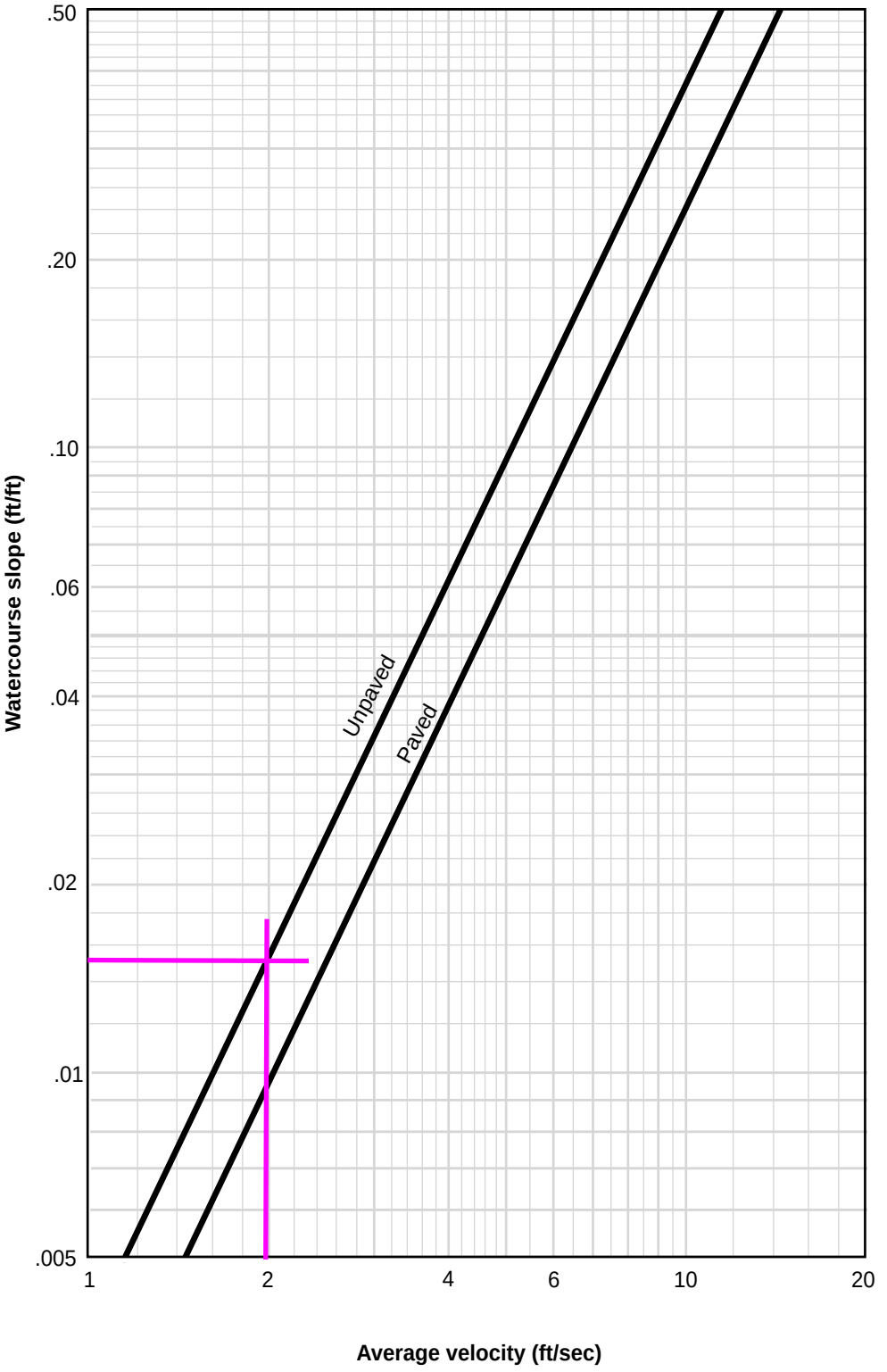
3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Figure 3-1 Average velocities for estimating travel time for shallow concentrated flow



Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass .	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).

2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

3 When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

Chapter 4 Graphical Peak Discharge Method

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation—Hydrology" (SCS 1983). The peak discharge equation used is:

$$q_p = q_u A_m Q F_p \qquad \text{[eq. 4-1]}$$

where:

q_p = peak discharge (cfs)
q_u = unit peak discharge (csm/in)
A_m = drainage area (mi^2)
Q = runoff (in)
F_p = pond and swamp adjustment factor

The input requirements for the Graphical method are as follows: (1) T_c (hr), (2) drainage area (mi^2), (3) appropriate rainfall distribution (I, IA, II, or III), (4) 24-hour rainfall (in), and (5) CN. If pond and swamp areas are spread throughout the watershed and are not considered in the T_c computation, an adjustment for pond and swamp areas is also needed.

Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from appendix B or more detailed local precipitation maps. CN and total runoff (Q) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction (I_a) from table 4-1. I_a / P is then computed.

If the computed I_a / P ratio is outside the range in exhibit 4 (4-I, 4-IA, 4-II, and 4-III) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of I_a / P to CN and P.

Peak discharge per square mile per inch of runoff (q_u) is obtained from exhibit 4-I, 4-IA, 4-II, or 4-III by using T_c (chapter 3), rainfall distribution type, and I_a / P ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix D to aid in computing the peak discharge using the Graphical method.

Figure 4-1 Variation of I_a / P for P and CN

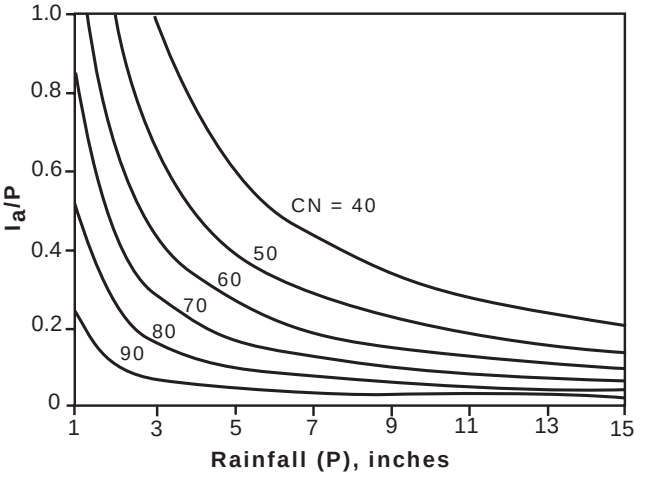
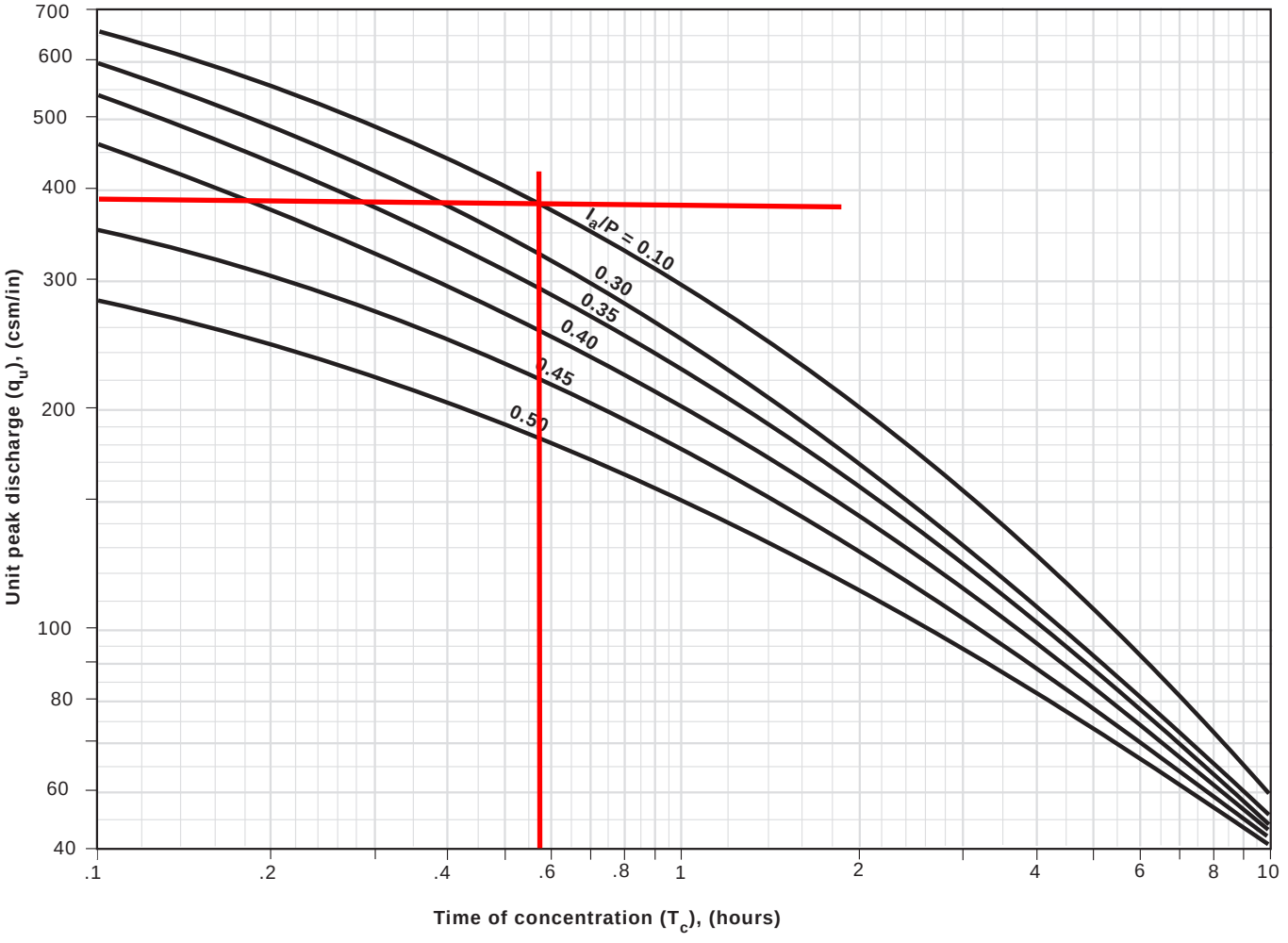


Table 4-1 I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

Exhibit 4-III Unit peal discharge (q_u) for NRCS (SCS) type III rainfall distribution



United States Department of Agriculture

Natural Resources Conservation Service

Conservation Engineering Division

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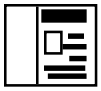
Urban Hydrology for Small Watersheds

TR-55

To show bookmarks which navigate through the document. Click the show/hide navigation pane button  , and then click the bookmarks tab. It will navigate you to the contents, chapters, rainfall maps, and printable forms.

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Gibbons Creek Registration	Dave Vogt	8/26/2022
Location		
Site F Landfill - Drainage Area 3	Project: 10290148	Task: 3

Check one: ☒ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
CCR, A	Fallow, Bare Soil	77			15.9	1,224
Shiro, D	Pasture, good condition	80			8.7	696
Water		98			5.5	539
[1/] Use only one CN source per line				**Totals** ➡	30.1	2,459

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{2{,}459}{30.1} = 82$; **Use CN** ➡ 82

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	25		
Rainfall, P (24-hour)	in	8.99		
Runoff, Q	in	6.81		

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	By	Date
Gibbons Creek Registration	Dave Vogt	8/26/2022
Location		
Site F Landfill - Drainage Area 3	Project: 10290148	Task: 3

Check one: [X] Present [ ] Developed

Check one: [X] T_c [ ] T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

	Segment ID	1	
1.	Surface description (table 3-1)	short grass prairie	
2.	Manning's roughness coefficient, n (table 3-1)	0.15	
3.	Flow length, L (total L † 300 ft) ft	300	
4.	Two-year 24-hour rainfall, P_2 in	4.34	
5.	Land slope, s ft/ft	0.03	
6.	$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr	0.28	+ = 0.28

Shallow concentrated flow

	Segment ID	2	
7.	Surface description (paved or unpaved)	unpaved	
8.	Flow length, L ft	801	
9.	Watercourse slope, s ft/ft	.015	
10.	Average velocity, V (figure 3-1) ft/s	1.37	
11.	$T_t = \frac{L}{3600\ V}$ Compute T_t hr	.16	+ = .16

Channel flow

	Segment ID		
12.	Cross sectional flow area, a ft^2		
13.	Wetted perimeter, p_w ft		
14.	Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		
15	Channel slope, s ft/ft		
16.	Manning's roughness coefficient, n		
17.	$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s		
18.	~~Flow l~~ength, L ft		
19.	$T_t = \frac{L}{3600\ V}$ Compute T_t hr		+ =

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr 0.44

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Gibbons Creek Registration	Dave Vogt	8/26/2022
Location	**Project: 10290148**	**Task: 3**
Site F Landfill - Drainage Area 3		

Check one: [X] Present [ ] Developed

1. Data

Drainage area ..... A_m = .047 mi^2 (acres/640)

Runoff curve number .....CN = 82 (From worksheet 2)

Time of concentration ..... T_c = 0.44 hr (From worksheet 3)

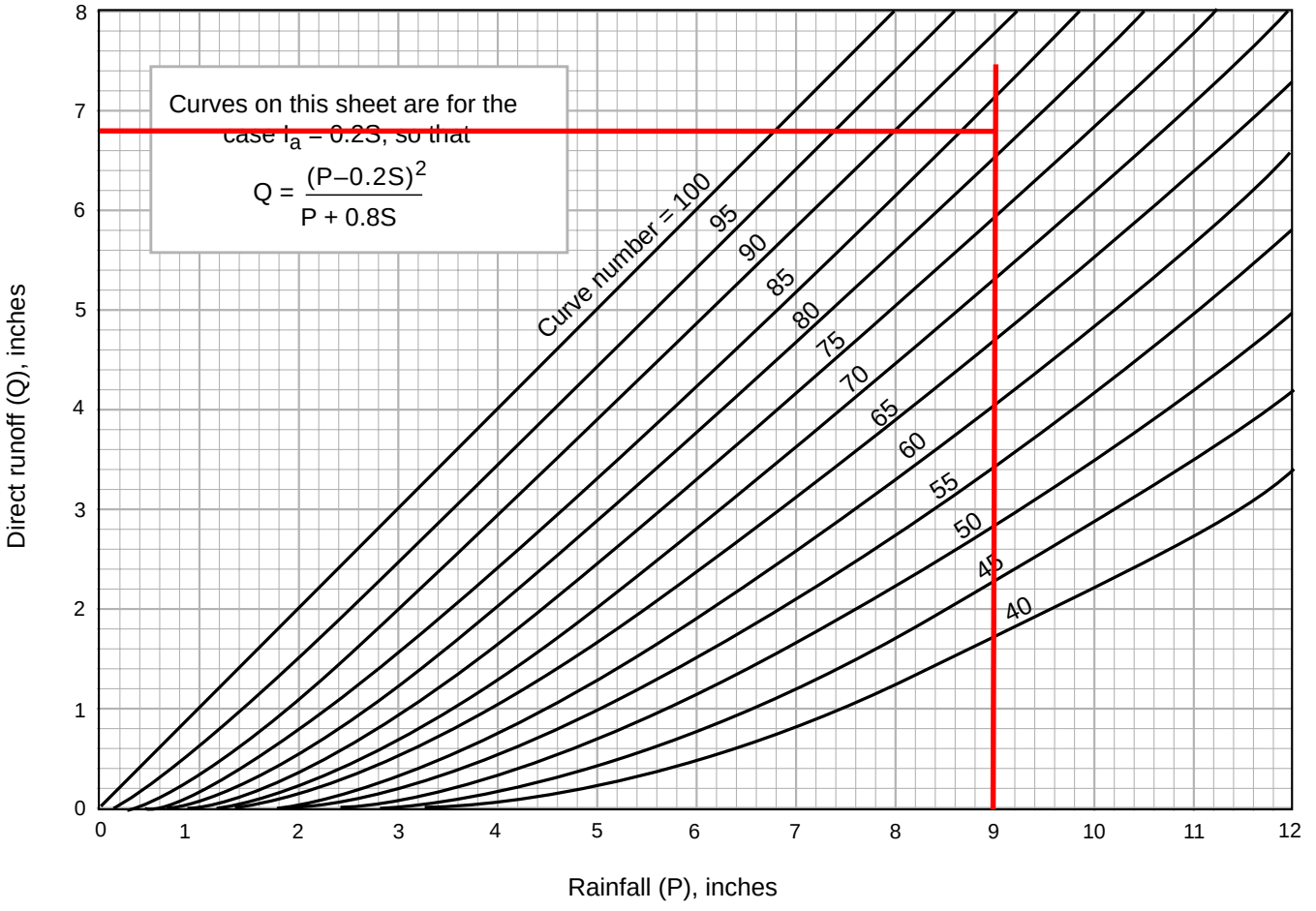
Rainfall distribution ..... = III (I, IA, II III)

Pond and swamp areas sprea throughout watershed ..... = 18 percent of A_m (5.5 acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr	25		
3. Rainfall, P (24-hour) ..... in	8.99		
4. Initial abstraction, I_a ..... in (Use CN with table 4-1)	.44		
5. Compute I_a / P	0.05		
6. Unit peak discharge, q_u ..... csm/in (Use T_c and I_a / P with exhibit 4– _____)	430		
7. Runoff, Q ..... in (From worksheet 2) Figure 2-6	6.81		
8. Pond and swamp adjustment factor, F_p ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)	0.72		
9. Peak discharge, q_p ..... ft^3/s	100		

(Where $q_p = q_u A_m Q F_p$)

Figure 2-1 Solution of runoff equation.



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*Hydrologic condition i*ndicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. *Good* hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

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	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

[1/] Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

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 Assumed for CCR	—	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.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

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

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

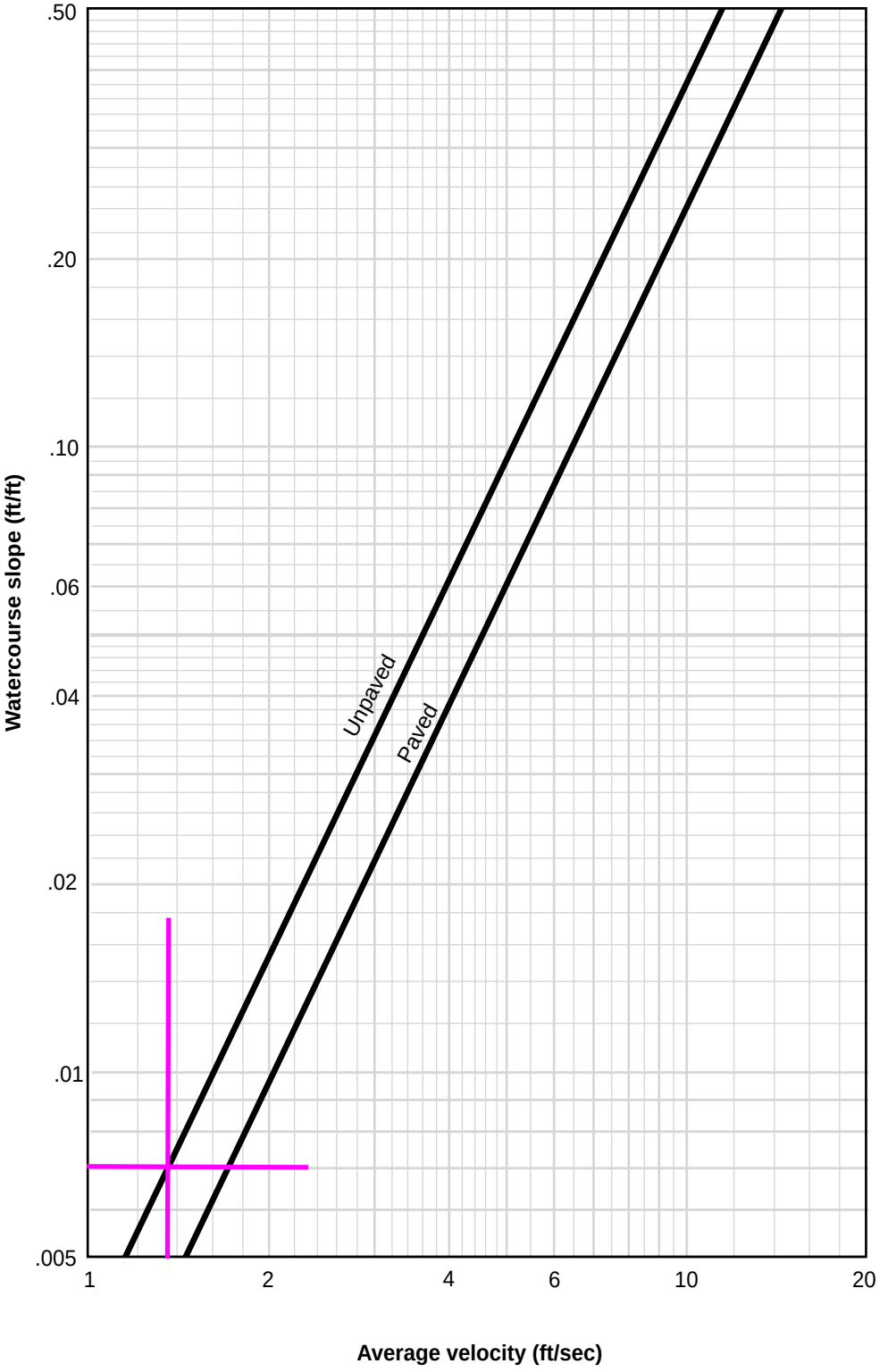
3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Figure 3-1 Average velocities for estimating travel time for shallow concentrated flow



Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass .	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).

2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

3 When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

Chapter 4 Graphical Peak Discharge Method

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation—Hydrology" (SCS 1983). The peak discharge equation used is:

$$q_p = q_u A_m Q F_p \qquad \text{[eq. 4-1]}$$

where:

q_p = peak discharge (cfs)
q_u = unit peak discharge (csm/in)
A_m = drainage area (mi^2)
Q = runoff (in)
F_p = pond and swamp adjustment factor

The input requirements for the Graphical method are as follows: (1) T_c (hr), (2) drainage area (mi^2), (3) appropriate rainfall distribution (I, IA, II, or III), (4) 24-hour rainfall (in), and (5) CN. If pond and swamp areas are spread throughout the watershed and are not considered in the T_c computation, an adjustment for pond and swamp areas is also needed.

Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from appendix B or more detailed local precipitation maps. CN and total runoff (Q) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction (I_a) from table 4-1. I_a / P is then computed.

If the computed I_a / P ratio is outside the range in exhibit 4 (4-I, 4-IA, 4-II, and 4-III) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of I_a / P to CN and P.

Peak discharge per square mile per inch of runoff (q_u) is obtained from exhibit 4-I, 4-IA, 4-II, or 4-III by using T_c (chapter 3), rainfall distribution type, and I_a / P ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix D to aid in computing the peak discharge using the Graphical method.

Figure 4-1 Variation of I_a / P for P and CN

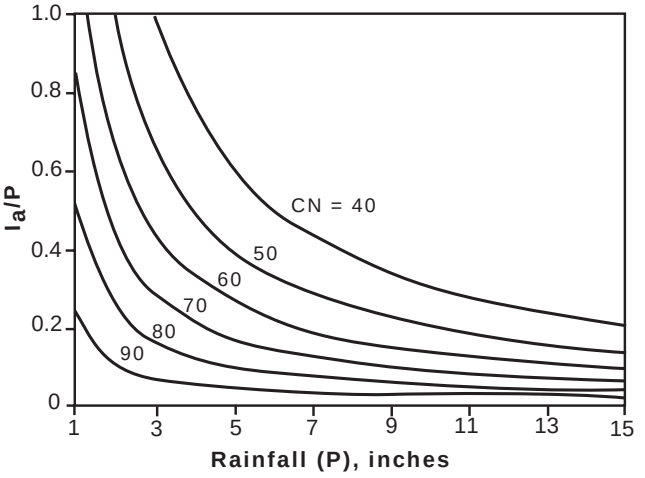


Table 4-1 I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

Exhibit 4-III Unit peal discharge (q_u) for NRCS (SCS) type III rainfall distribution

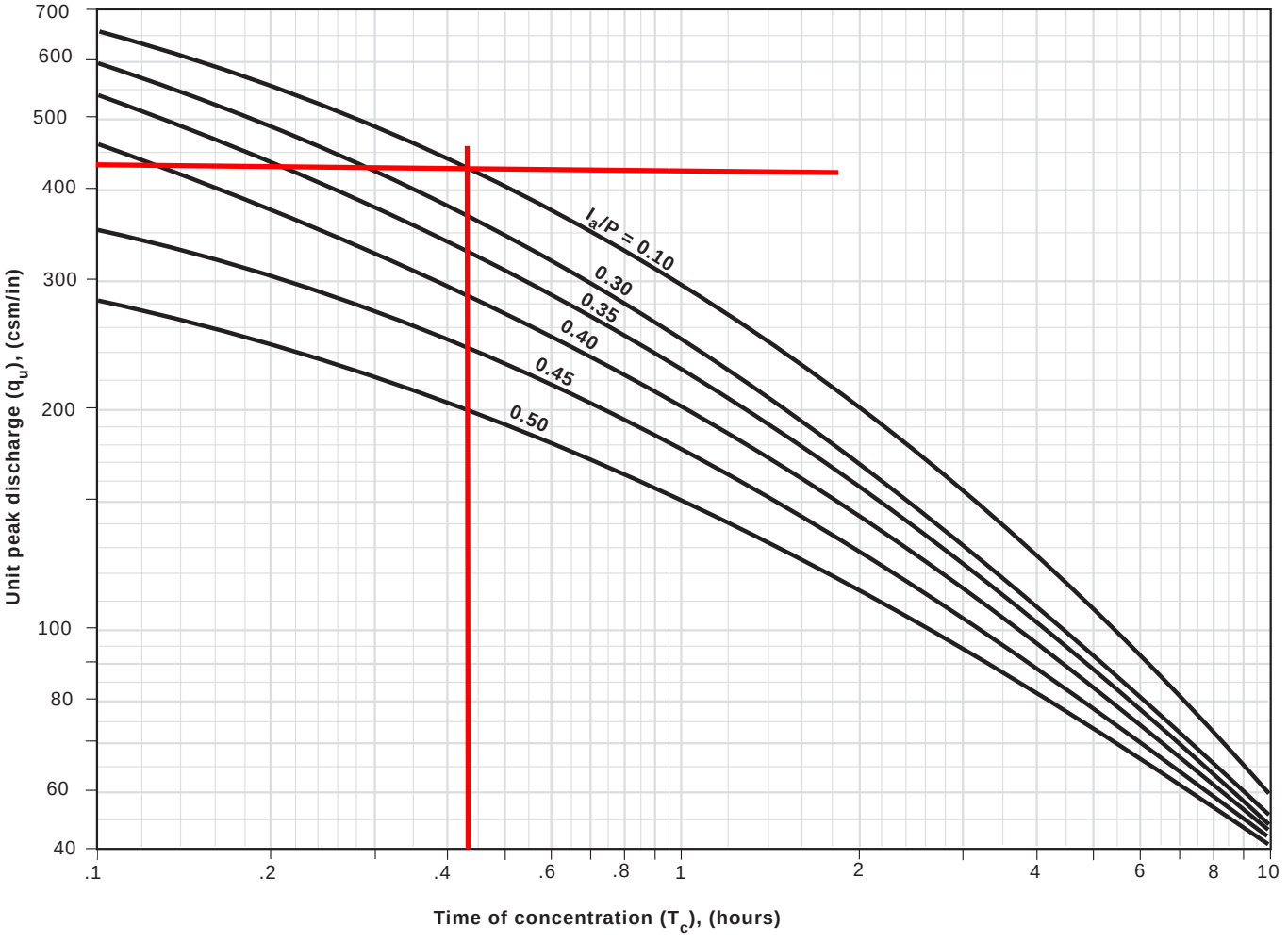


Table 4-2 Adjustment factor (F_p) for pond and swamp areas that are spread throughout the watershed

Percentage of pond and swamp areas	F_p
0	1.00
0.2	0.97
1.0	0.87
3.0	0.75
5.0	0.72

Limitations

The Graphical method provides a determination of peak discharge only. If a hydrograph is needed or watershed subdivision is required, use the Tabular Hydrograph method (chapter 5). Use TR-20 if the watershed is very complex or a higher degree of accuracy is required.

- The watershed must be hydrologically homogeneous, that is, describable by one CN. Land use, soils, and cover are distributed uniformly throughout the watershed.
- The watershed may have only one main stream or, if more than one, the branches must have nearly equal T_C' s.
- The method cannot perform valley or reservoir routing.
- The F_p factor can be applied only for ponds or swamps that are not in the T_c flow path.
- Accuracy of peak discharge estimated by this method will be reduced if I_a / P values are used that are outside the range given in exhibit 4. The limiting I_a / P values are recommended for use.
- This method should be used only if the weighted CN is greater than 40.
- When this method is used to develop estimates of peak discharge for both present and developed conditions of a watershed, use the same procedure for estimating T_c.
- T_c values with this method may range from 0.1 to 10 hours.

Example 4-1

Compute the 25-year peak discharge for the 250-acre watershed described in examples 2-2 and 3-1. Figure 4-2 shows how worksheet 4 is used to compute q_p as 345 cfs.

Appendix C
NOAA Rainfall Data

NOAA Atlas 14, Volume 11, Version 2
Location name: Iola, Texas, USA*
Latitude: 30.6379°, Longitude: -96.0674°
Elevation: 269.48 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

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	**0.462** (0.349-0.610)	**0.534** (0.409-0.701)	**0.655** (0.500-0.862)	**0.754** (0.566-1.00)	**0.887** (0.643-1.22)	**0.986** (0.697-1.39)	**1.09** (0.749-1.57)	**1.19** (0.801-1.77)	**1.33** (0.866-2.05)	**1.44** (0.914-2.28)
10-min	**0.734** (0.556-0.970)	**0.851** (0.652-1.12)	**1.05** (0.797-1.38)	**1.20** (0.904-1.60)	**1.42** (1.03-1.95)	**1.58** (1.12-2.23)	**1.74** (1.20-2.52)	**1.90** (1.28-2.82)	**2.11** (1.37-3.24)	**2.26** (1.43-3.57)
15-min	**0.927** (0.702-1.23)	**1.07** (0.820-1.41)	**1.31** (0.998-1.72)	**1.50** (1.13-2.00)	**1.76** (1.28-2.42)	**1.96** (1.38-2.76)	**2.15** (1.49-3.12)	**2.36** (1.59-3.51)	**2.63** (1.71-4.06)	**2.85** (1.80-4.49)
30-min	**1.31** (0.995-1.74)	**1.51** (1.16-1.99)	**1.84** (1.40-2.42)	**2.10** (1.58-2.80)	**2.46** (1.78-3.36)	**2.72** (1.92-3.83)	**2.98** (2.06-4.32)	**3.28** (2.20-4.87)	**3.68** (2.39-5.67)	**4.01** (2.54-6.33)
60-min	**1.72** (1.30-2.27)	**1.98** (1.52-2.61)	**2.43** (1.86-3.20)	**2.80** (2.10-3.73)	**3.29** (2.38-4.50)	**3.66** (2.58-5.14)	**4.03** (2.78-5.84)	**4.46** (3.00-6.64)	**5.07** (3.30-7.82)	**5.58** (3.53-8.80)
2-hr	**2.08** (1.58-2.72)	**2.47** (1.89-3.20)	**3.10** (2.37-4.04)	**3.64** (2.74-4.81)	**4.39** (3.20-5.96)	**4.96** (3.52-6.94)	**5.58** (3.87-8.03)	**6.30** (4.25-9.29)	**7.34** (4.79-11.2)	**8.21** (5.21-12.8)
3-hr	**2.27** (1.74-2.98)	**2.76** (2.11-3.54)	**3.52** (2.70-4.57)	**4.18** (3.16-5.51)	**5.13** (3.75-6.95)	**5.88** (4.19-8.19)	**6.70** (4.66-9.59)	**7.65** (5.18-11.2)	**9.05** (5.91-13.7)	**10.2** (6.50-15.9)
6-hr	**2.62** (2.02-3.41)	**3.27** (2.50-4.12)	**4.24** (3.27-5.46)	**5.12** (3.90-6.71)	**6.42** (4.73-8.66)	**7.49** (5.37-10.4)	**8.69** (6.06-12.3)	**10.1** (6.83-14.6)	**12.1** (7.93-18.2)	**13.8** (8.82-21.2)
12-hr	**2.99** (2.31-3.86)	**3.79** (2.88-4.69)	**4.95** (3.83-6.31)	**6.04** (4.62-7.86)	**7.68** (5.71-10.3)	**9.09** (6.57-12.5)	**10.7** (7.50-15.0)	**12.5** (8.55-18.1)	**15.3** (10.1-22.8)	**17.6** (11.3-26.9)
24-hr	**3.38** (2.63-4.35)	**4.34** (3.30-5.31)	**5.69** (4.43-7.22)	**7.00** (5.39-9.06)	**8.99** (6.74-12.0)	**10.7** (7.82-14.7)	**12.7** (8.98-17.8)	**15.0** (10.3-21.4)	**18.4** (12.1-27.1)	**21.2** (13.7-32.0)
2-day	**3.84** (3.00-4.90)	**4.96** (3.79-6.02)	**6.53** (5.11-8.23)	**8.06** (6.25-10.4)	**10.4** (7.87-13.9)	**12.5** (9.16-17.0)	**14.8** (10.5-20.5)	**17.4** (11.9-24.5)	**21.0** (13.9-30.6)	**24.0** (15.5-35.7)
3-day	**4.18** (3.28-5.31)	**5.38** (4.14-6.53)	**7.09** (5.57-8.90)	**8.72** (6.79-11.2)	**11.2** (8.50-14.9)	**13.4** (9.86-18.2)	**15.9** (11.3-21.8)	**18.5** (12.7-26.0)	**22.2** (14.7-32.2)	**25.2** (16.3-37.4)
4-day	**4.47** (3.52-5.67)	**5.71** (4.42-6.94)	**7.49** (5.91-9.39)	**9.17** (7.15-11.7)	**11.7** (8.88-15.4)	**13.9** (10.2-18.8)	**16.4** (11.6-22.4)	**19.0** (13.1-26.6)	**22.8** (15.2-32.9)	**25.9** (16.8-38.2)
7-day	**5.17** (4.09-6.53)	**6.44** (5.05-7.88)	**8.33** (6.61-10.4)	**10.1** (7.88-12.8)	**12.6** (9.57-16.5)	**14.7** (10.9-19.7)	**17.1** (12.2-23.3)	**19.8** (13.7-27.5)	**23.7** (15.8-34.0)	**26.9** (17.5-39.4)
10-day	**5.76** (4.57-7.24)	**7.06** (5.59-8.66)	**9.04** (7.20-11.3)	**10.8** (8.50-13.7)	**13.4** (10.2-17.4)	**15.5** (11.4-20.6)	**17.8** (12.7-24.1)	**20.5** (14.2-28.4)	**24.4** (16.4-34.9)	**27.7** (18.1-40.4)
20-day	**7.54** (6.02-9.42)	**8.99** (7.23-11.1)	**11.3** (9.09-14.1)	**13.3** (10.5-16.7)	**16.1** (12.3-20.7)	**18.3** (13.5-24.0)	**20.6** (14.8-27.7)	**23.2** (16.2-31.8)	**26.9** (18.1-38.0)	**29.9** (19.6-43.1)
30-day	**9.06** (7.27-11.3)	**10.6** (8.62-13.1)	**13.2** (10.7-16.4)	**15.4** (12.2-19.3)	**18.3** (14.0-23.5)	**20.6** (15.3-27.0)	**22.9** (16.5-30.7)	**25.4** (17.8-34.7)	**28.9** (19.5-40.6)	**31.6** (20.7-45.3)
45-day	**11.4** (9.14-14.1)	**13.1** (10.7-16.2)	**16.0** (13.0-19.8)	**18.4** (14.6-22.9)	**21.5** (16.5-27.4)	**23.8** (17.7-31.0)	**26.1** (18.9-34.7)	**28.4** (20.0-38.6)	**31.5** (21.3-44.0)	**33.9** (22.3-48.2)
60-day	**13.5** (10.9-16.6)	**15.3** (12.6-19.0)	**18.5** (15.1-22.9)	**21.0** (16.8-26.2)	**24.3** (18.7-30.9)	**26.6** (19.9-34.6)	**28.8** (20.9-38.3)	**31.0** (21.9-42.0)	**33.8** (22.9-47.0)	**35.9** (23.6-50.8)

[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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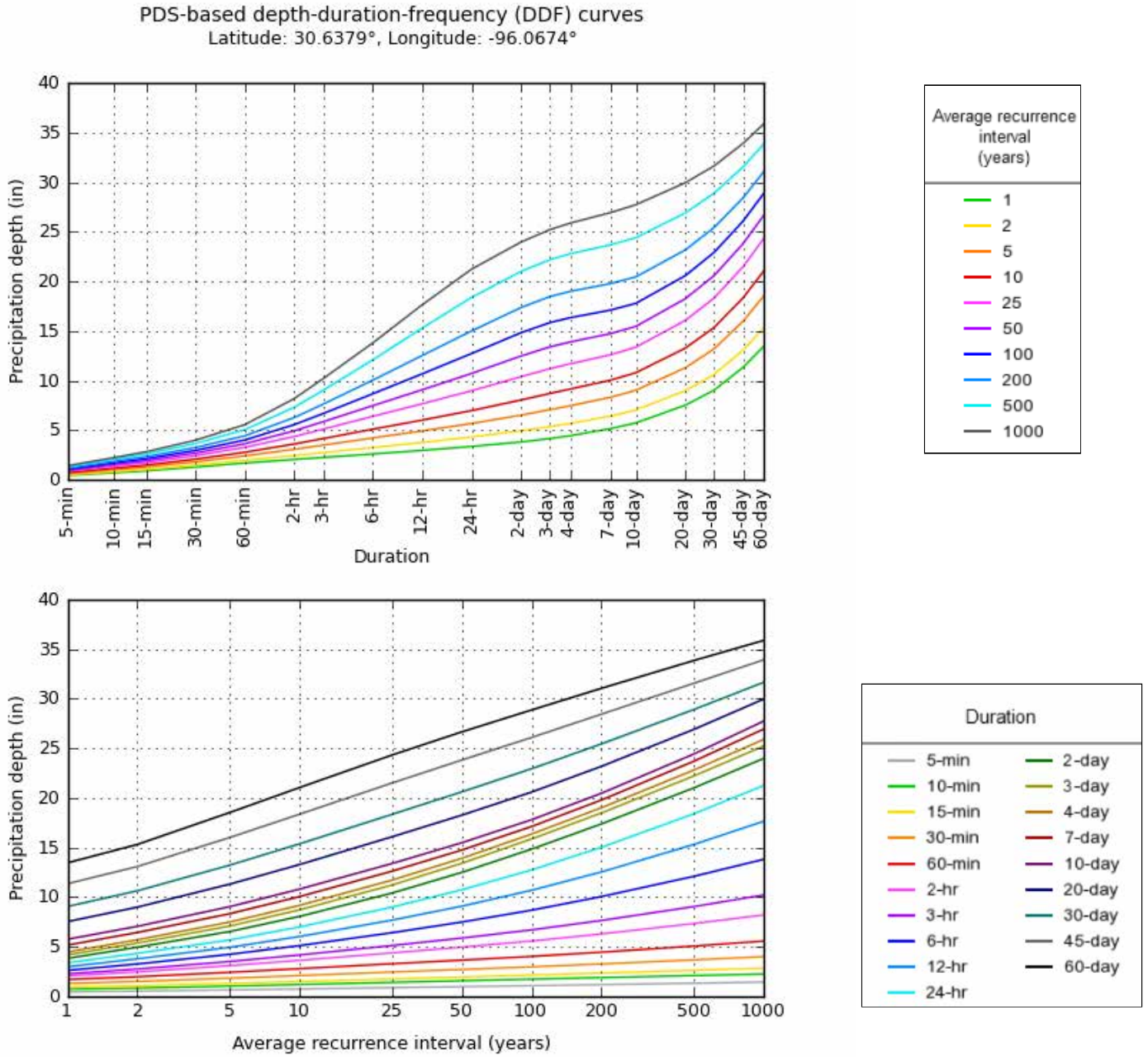
PF graphical



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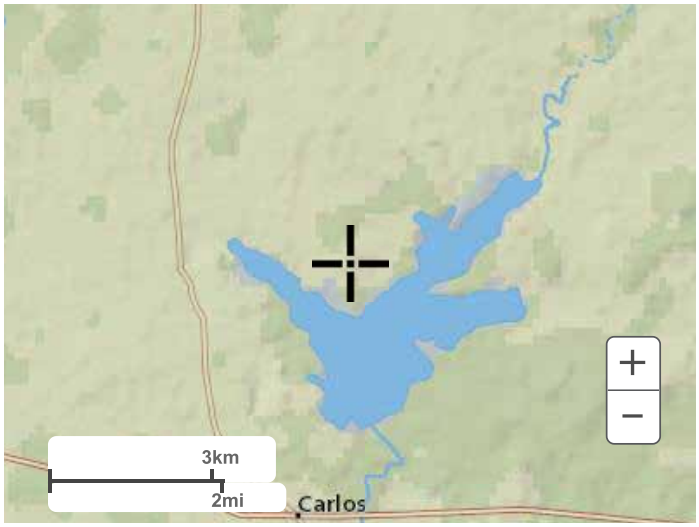
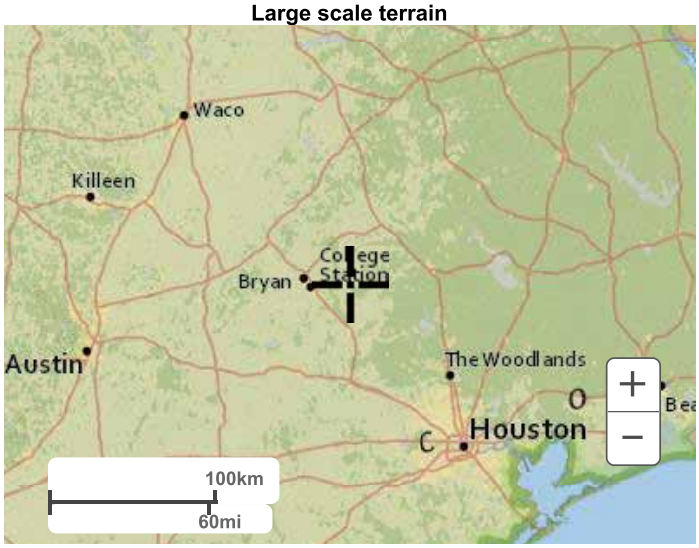
Maps & aerials

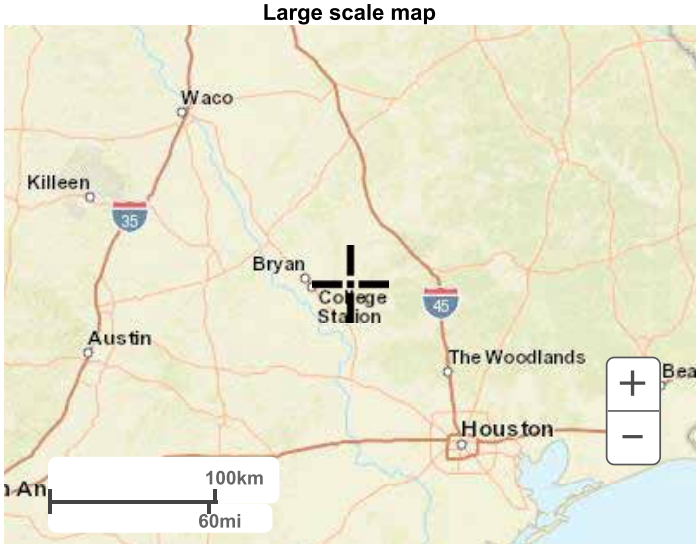
Small scale terrain



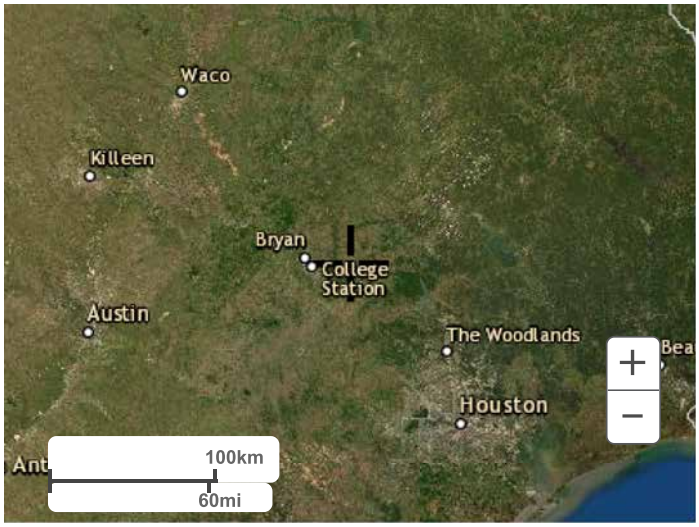
Large scale terrain



Large scale map



Large scale aerial



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National Weather Service
National Water Center
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Silver Spring, MD 20910
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Appendix D

Soil Conservation District Soil Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Grimes County, Texas

Drainage Area 2

September 2, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:4,760 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

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 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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: Grimes County, Texas
Survey Area Data: Version 17, Sep 8, 2021

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

Date(s) aerial images were photographed: Dec 14, 2019—Dec 18, 2019

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BuC	Burlewash fine sandy loam, 1 to 5 percent slopes	7.9	27.8%
BuE	Burlewash fine sandy loam, 5 to 12 percent slopes	4.7	16.4%
EmC	Elmina loamy fine sand, 1 to 5 percent slopes	2.8	10.0%
ShC	Shiro loamy fine sand, 1 to 5 percent slopes	12.8	44.9%
SnC	Singleton fine sandy loam, 1 to 5 percent slopes	0.3	0.9%
Totals for Area of Interest		**28.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Grimes County, Texas

BuC—Burlewash fine sandy loam, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2vtj0
Elevation: 200 to 450 feet
Mean annual precipitation: 35 to 46 inches
Mean annual air temperature: 67 to 69 degrees F
Frost-free period: 262 to 288 days
Farmland classification: Not prime farmland

Map Unit Composition

Burlewash and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burlewash

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Eocene age clayey residuum weathered from tuffaceous sandstone and siltstone

Typical profile

A - 0 to 8 inches: fine sandy loam
Bt - 8 to 28 inches: clay
BCt - 28 to 34 inches: clay
Cr - 34 to 45 inches: cemented bedrock

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: 26 to 34 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 3.0
Available water supply, 0 to 60 inches: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: R087AY003TX - Claypan Savannah
Hydric soil rating: No

Minor Components

Shalba

Percent of map unit: 10 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R087AY003TX - Claypan Savannah
Hydric soil rating: No

Rehburg

Percent of map unit: 10 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R087AY006TX - Sandy
Hydric soil rating: No

BuE—Burlewash fine sandy loam, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: d9mh
Elevation: 150 to 500 feet
Mean annual precipitation: 35 to 45 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 260 to 280 days
Farmland classification: Not prime farmland

Map Unit Composition

Burlewash and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burlewash

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from tuffaceous shales, sandstones and siltstones in the jackson group of eocene age

Typical profile

H1 - 0 to 6 inches: fine sandy loam
H2 - 6 to 21 inches: clay

H3 - 21 to 25 inches: clay
H4 - 25 to 60 inches: bedrock

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R087AY003TX - Claypan Savannah
Hydric soil rating: No

EmC—Elmina loamy fine sand, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: d9mz
Elevation: 170 to 350 feet
Mean annual precipitation: 40 to 46 inches
Mean annual air temperature: 66 to 68 degrees F
Frost-free period: 260 to 280 days
Farmland classification: Not prime farmland

Map Unit Composition

Elmina and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elmina

Setting

Landform: Interfluves
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey residuum weathered from mudstone

Typical profile

H1 - 0 to 5 inches: loamy fine sand
H2 - 5 to 22 inches: loamy fine sand
H3 - 22 to 55 inches: clay
H4 - 55 to 72 inches: bedrock

Properties and qualities

Slope: 1 to 5 percent

Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Drainage class: Somewhat poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F133BY002TX - Seasonally Wet Upland
Hydric soil rating: No

ShC—Shiro loamy fine sand, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: d9pm
Elevation: 250 to 550 feet
Mean annual precipitation: 35 to 40 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 260 to 280 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Shiro and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Shiro

Setting

Landform: Ridges
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from tuffaceous sandstone and siltstone in the jackson group and the catahoula formation of eocene age

Typical profile

H1 - 0 to 12 inches: loamy fine sand
H2 - 12 to 24 inches: clay
H3 - 24 to 31 inches: clay
H4 - 31 to 40 inches: bedrock

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained

Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water supply, 0 to 60 inches: Low (about 3.7 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: R087AY005TX - Sandy Loam
Hydric soil rating: No

SnC—Singleton fine sandy loam, 1 to 5 percent slopes

Map Unit Setting
National map unit symbol: d9pv
Elevation: 200 to 500 feet
Mean annual precipitation: 34 to 40 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 260 to 280 days
Farmland classification: Not prime farmland

Map Unit Composition
Singleton, variant and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Singleton, Variant

Setting
Landform: Ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from tuffaceous sandstone and siltstone in the jackson group of eocene age

Typical profile
H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 20 inches: clay
H3 - 20 to 32 inches: clay
H4 - 32 to 38 inches: clay loam
H5 - 38 to 60 inches: bedrock

Properties and qualities
Slope: 1 to 5 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock

Drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Gypsum, maximum content: 10 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: R087AY003TX - Claypan Savannah
Hydric soil rating: No

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United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

RESPONSE ITEM 16

ATTACHMENT

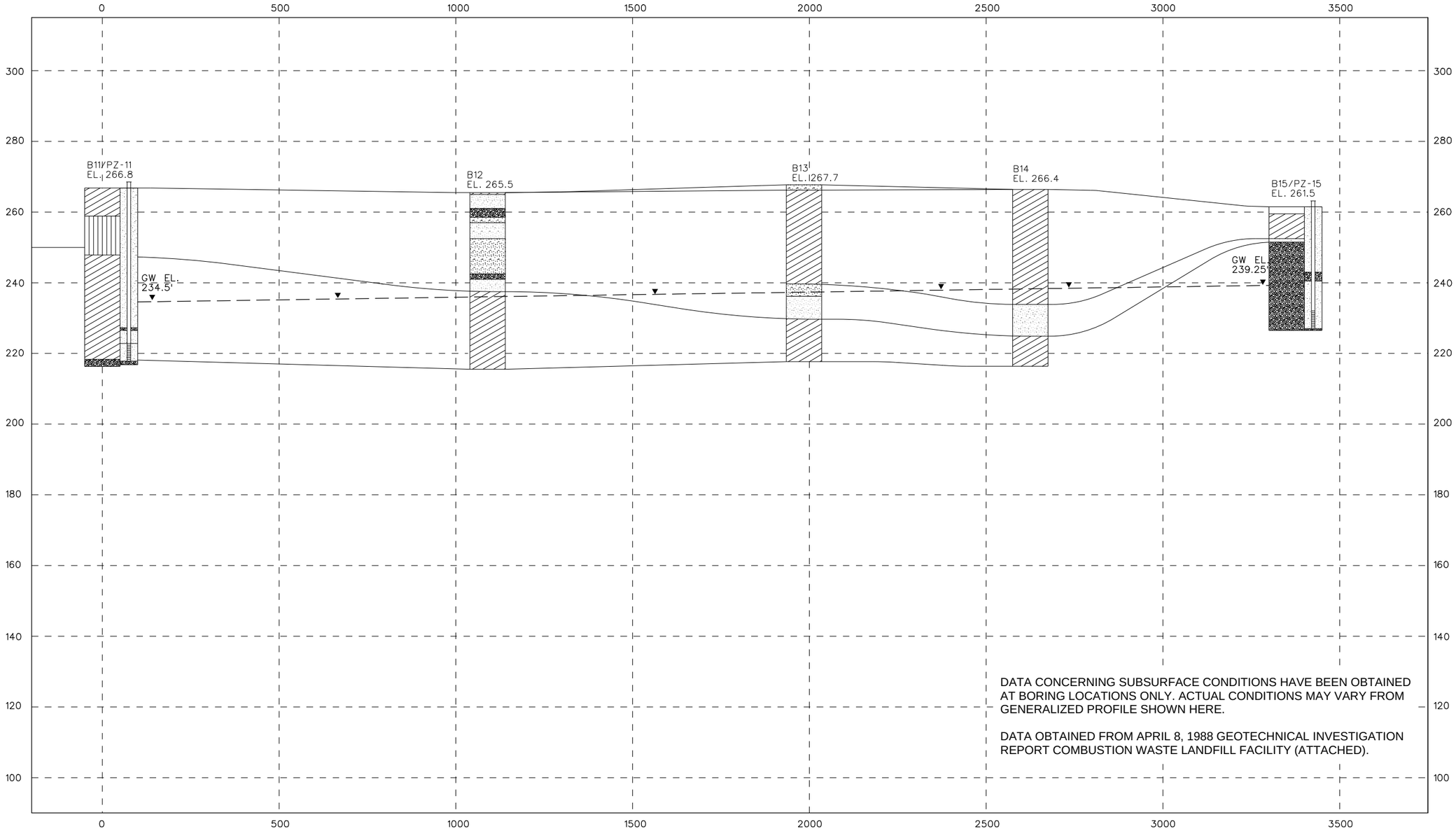
REVISED TABLE IV.D LANDFILL INSPECTION

Facility Unit(s) and Basic Elements	Possible Error, Malfunction, or Deterioration	Frequency of Inspection
Liner	Animal burrows or erosion damage	Not exceeding seven days/Annually
Temporary or Permanent Soil Cover	Animal burrows, inadequate vegetation, or erosion damage	Not exceeding seven days/Annually
Storm Water Control – Concrete Lined Stormwater Drainage	Broken concrete or vegetation	Not exceeding seven days/Annually
Storm Water Control – Drainage Swales	Erosion and vegetation	Not exceeding seven days/Annually
Storm Water Control – SFL Pond 1	Animal burrows, erosion damage, vegetation, leaks or seeps, slope slide, cracks, or berm failure	Not exceeding seven days/Annually
Storm Water Control – SFL Pond 3	Animal burrows, erosion damage, vegetation, leaks or seeps, slope slide, cracks, berm failure	Not exceeding seven days/Annually
Cover Area Slopes – Landfill Slopes	Animal burrows, erosion damage, vegetation, leaks or seeps, slope slide, cracks, berm failure	Not exceeding seven days/Annually
Active Area – Interior Slopes	Animal burrows, erosion damage, vegetation, leaks or seeps, slope slide, cracks, berm failure	Not exceeding seven days/Annually
Active Area – Exterior Slopes	Animal burrows, erosion damage, vegetation, leaks or seeps, slope slide, cracks, berm failure	Not exceeding seven days/Annually
Active Area – Impounded CCR Material	Unstable areas, CCR migration from containment	Not exceeding seven days/Annually
Roads, Culverts	Erosion rutting on roads, culverts collapsed or clogged	Not exceeding seven days/Annually

RESPONSE ITEM 19

ATTACHMENT

GEOLOGIC CROSS SECTINS



DATA CONCERNING SUBSURFACE CONDITIONS HAVE BEEN OBTAINED AT BORING LOCATIONS ONLY. ACTUAL CONDITIONS MAY VARY FROM GENERALIZED PROFILE SHOWN HERE.

DATA OBTAINED FROM APRIL 8, 1988 GEOTECHNICAL INVESTIGATION REPORT COMBUSTION WASTE LANDFILL FACILITY (ATTACHED).

PLTDRVER: $PLTDRVS$
PENTABLE: $PENTBLS$
FILENAME: $PWVAR_DOCNAME$
DATE: $DATE$
TIME: $TIME$
USER: $USER$
FILE: $PWVAR_VAULTPATHDESC$

HDR
Firm Registration No. F-754
17111 Preston Road, Suite 300
Dallas, Texas 75248-1229
972.960.4400

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	D.VOGT
CIVIL ENGINEER	D. VOGT
CHECKED BY	
DESIGNED	
DRAWN BY	D. VOGT
QA/QC	
PROJECT NUMBER	

STATE OF TEXAS
DAVID O. VOGT
83905
LICENSED
PROFESSIONAL ENGINEER
8/30/2022

Gibbons Creek Environmental Redevelopment Group, LLC

SITE F LANDFILLSUBSURFACE DIAGRAM

FILENAME	$FILES$
SCALE	

SHEET
FIG. 1

TEXAS MUNICIPAL POWER AGENCY
GIBBONS CREEK STEAM ELECTRIC STATION

GEOTECHNICAL INVESTIGATION REPORT
COMBUSTION WASTE LANDFILL FACILITY

B&V PROJECT 14578
B&V FILE 41.0100

ISSUE DATE AND REVISION NO.

040888-0

Black & Veatch
Engineers-Architects

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1.0 INTRODUCTION

This report details the geotechnical investigation for the proposed combustion waste landfill facility for the Texas Municipal Power Agency (TMPA) Gibbons Creek Steam Electric Generating Station (GCSES) located near Carlos, Texas in Grimes County.

1.1 PROJECT DESCRIPTION

TMPA has retained Black & Veatch, Engineers-Architects (B&V) to perform a geotechnical investigation of the first stage of the proposed site for the new combustion waste landfill facility. The proposed site is located approximately one mile north of GCSES, north and west of the Gibbons Creek Reservoir. The first stage (Stage I) of the proposed landfill site is approximately 80 acres with an additional 80 acres for drainage requirements, sedimentation ponds, and a buffer zone complying with Texas Water Commission (TWC) requirements for a Class II landfill. The final landfill will be developed in six stages with five years storage per stage, thus providing approximately 30 years of storage. The later five stages will require an additional 390 acres of storage area.

1.2 PURPOSE OF INVESTIGATION

The geotechnical investigation was conducted to define subsurface conditions at the Stage I landfill area as well as to qualify and quantify potential clay borrow areas to be used for landfill construction.

The subsurface investigation in the landfill area was designed to determine soil types, engineering properties of the soil, and bedrock type and quality. Six monitoring wells were installed to obtain groundwater levels.

Borrow area investigations were performed to locate suitable clay to be used to construct the Stage I landfill liner and containment dikes.

2.1.2 Clay Borrow Area Investigation

An investigation of potential clay borrow areas was conducted in the area east and west of the GCSES railroad spur northwest of the proposed landfill site. The investigation consisted of excavating 52 test pits and advancing four soil borings. The test pits were excavated using TMPA equipment and personnel under direction of a B&V geotechnical engineer who also logged the test pits. The pits were excavated to a maximum depth of 11.0 feet or until refusal of the backhoe. Jar samples were obtained from various soil layers and submitted to BSMI for laboratory classification and index testing. Bulk soil samples were collected and submitted to the laboratory to obtain moisture-density relationships, and for permeability and strength testing.

Four soil borings, CB-12 through CB-15, were advanced west of the railroad spur in the clay borrow area. These borings were 20 feet in depth and no monitoring wells were installed. Jar samples and bulk material samples were submitted to BSMI for laboratory testing. The boring logs are listed in Appendix A and test pit logs are included in Appendix C.

2.2 LABORATORY TESTING PROGRAM

A laboratory testing program was undertaken to confirm material classification and determine engineering properties of the soils. The tests were assigned by the B&V geotechnical engineers who directed the field investigation.

The laboratory tests assigned included:

Test Description	Test Designation	Number of Tests Performed
Moisture Content	ASTM D2216	89
Atterberg Limits	ASTM D4318	91
Specific Gravity	ASTM D854	5

Black & Veatch
SFL

BORING	NORTHING	EASTING	ELEVATION	DEPTH	TYPE
B-6	377453	3339384	263.6	50	II
B-7	377160	3340264	252.2	50	I
B-8	377624	3340903	272.5	10	II
B-9	377583	3341690	266.6	50	II
B-10	377502	3342439	252.3	28	II
B-11	378330	3339148	266.8	50	I
B-12	378226	3340238	265.3	50	II
B-13	378308	3341132	267.7	50	II
B-14	378277	3341775	266.4	50	II
B-15	378200	3342496	261.5	35	I
B-16	379581	3339416	261.7	39	I
B-17	381083	3340990	292.3	50	I
B-18	381539	3342922	269.1	50	I
CB-12	386388	3336793	295.4	20	III
CB-13	386433	3337893	307.6	20	III
CB-14	385176	3337758	293.6	20	III
CB-15	384180	3337723	283.5	20	III

I NEW LANDFILL BORINGS WITH MONITORING WELL
II NEW LANDFILL BORINGS
III NEW CLAY BORROW AREA BORINGS

LEGEND

- EXISTING BORINGS LANDFILL
- EXISTING BORINGS CLAY BORROW AREA
- NEW LANDFILL BORINGS
- NEW LANDFILL BORINGS WITH MONITORING WELL
- CLAY BORROW AREA TEST PITS
- NEW CLAY BORROW AREA BORINGS

SCALE: 1 = 500'

30+00
20+00
10+00
0+00

Approximate Stationing for Subsurface Cross Section

N 377500
E 3345000
N 385000
E 3337500
N 377500
E 3337500

PROPERTY BORROW AREA
EAST BORROW AREA
WEST BORROW AREA
Creek
Pipeline
Transmission Station
Dense Woods

MON. HV-1 264.41
MON. HV-2 267.13
MON. HV-3 277.72

NO.	DATE	REVISIONS AND RECORD OF ISSUE	BY
1	8-1-89	ISSUED FOR SPECIFICATION 71.0200	
0	4-8-88	ISSUED FOR GEOTECHNICAL INVESTIGATION REPORT	MCS

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF TEXAS.
SIGNED Leroy E. Kashka
DATE 4/13/90 REG NO. 52700

STATE OF TEXAS · LEROY E. KASHKA · 52700 · REGISTERED · PROFESSIONAL ENGINEER

BLACK & VEATCH
ENGINEERS-ARCHITECTS
ENGINEER MCS DRAWN MJJ
CHECKED LJA DATE 4-8-88

TEXAS MUNICIPAL POWER AGENCY
ACTING FOR THE CITIES OF
BRYAN, DENTON, GARLAND & GREENVILLE

COMBUSTION WASTE LANDFILL FACILITY
SITE INVESTIGATION PROGRAM

PROJECT 14578-S0001
DRAWING NUMBER
REV 1
CODE
AREA

FIGURE 2-1

2.0 INVESTIGATION PROGRAM

2.1 FIELD INVESTIGATION

The field program consisted of two operations; the landfill site investigation and the clay borrow area investigation. Figure 2-1 shows the north boundaries of the proposed landfill, the location of the proposed clay borrow areas and the locations of the borings and test pits.

2.1.1 Landfill Site Investigation

A total of thirteen borings ranging in depth from 10 feet to 50 feet were completed for the landfill site investigation by Buchanan/Soil Mechanics, Inc. (BSMI) of Bryan, Texas using a Failing 1500 drill rig. The soil borings were completed under the direction of B&V. Boring logs were prepared by a B&V geotechnical engineer. Soil boring locations and elevations were measured in the field by a surveying contractor employed by TMPA. Ten borings, B-6 through B-15, were advanced in the area of Stage I construction with groundwater level observation wells installed in Borings B-7, B-11, and B-15. Three additional borings, B-16, B-17, and B-18, with groundwater level observation wells, were advanced in the area north of the Stage I construction area.

The borings were advanced using a 4.5 inch rotary wash bit using water as drilling fluid. Boreholes that were to have groundwater level observation wells installed after completion were continuously sampled using thin wall tubes (ASTM D1587) in cohesive materials and standard penetration testing (ASTM D1586) in granular materials. Soil borings without observations wells were continuously sampled in the upper ten feet and at five feet intervals below ten feet. Boreholes were advanced to fifty feet below ground surface or five feet into the bedrock whichever is deeper. Where bedrock was encountered, rock coring techniques were used to advance the borehole using a standard Nx size core barrel. Rock cores were placed in wooden sample boxes for transportation to the laboratory. All samples were retained by BSMI for laboratory testing. Boring logs are included in Appendix A and observation well logs are included in Appendix B.

Test Description	Test Designation	Number of Tests Performed
Sieve Analysis	ASTM D2217	41
Hydrometer Analysis	ASTM D422	19
Moisture-Density Tests	ASTM D698	9
UU Triaxial Tests	ASTM D2850	17
Consolidation	ASTM D2435	2
Organic Content	ASTM D2974	3
Permeability	EM-1110-1906 (Falling Head)	14
Dispersive Soils	Emerson Crumb Test	4

The laboratory test results are included in Appendix D.

3.0 SITE CONDITIONS

3.1 SITE DESCRIPTION

The site for the proposed Stage I combustion waste landfill is located approximately one mile north of GCSES with the Gibbons Creek Reservoir located on the south and east sides and surrounded by private property on the other sides. Approximately half of the area is heavily wooded, and the other half pastureland. The site contains some TMPA land and some private property which must be purchased by TMPA. Topography is flat to gently undulating and generally slopes south to southwest.

The clay borrow areas are located approximately one mile north of the proposed landfill site. The borrow areas are split by the GCSES railroad spur with approximately 180 acres east and 30 acres west of the railroad. The areas are presently utilized as pastureland and have been cleared for the most part of standing timber.

3.2 LANDFILL SUBSURFACE STRATIGRAPHY

3.2.1 Soil Conditions

Borings B-6 through B-15 were performed in the immediate area of the proposed Stage I landfill. Boring depths ranged from 10 feet to 50 feet below ground surface. Subsurface stratigraphy consisted of stratified, heterogeneous layers of clays, silts and sands of varying thicknesses. The clays and silts consisted of fat clays with very high plasticity and high plastic silts with liquid limits ranging from 55 to 95 percent, plasticity indexes from 35 to 62, and natural moisture contents ranging from 12 to 44 percent. These materials are generally classified as CH, CH-MH, and MH according to the Unified Classification System. The silty sand layers were comprised of very fine grained, poorly graded dense sands with occasional high plasticity clay and silt lenses.

Some occasional sandstone layers were encountered in Borings B-7 and B-12. These layers were 2-3 feet thick and generally occurred between 20 and 30 feet below ground surface. Sandstone bedrock was encountered in Borings B-8, B-10, B-11, B-15, and B-16 at depths ranging from 5 feet to 48

feet from ground surface. The bedrock consisted of two layers, the upper being an argillaceous yellowish-tan, fine to medium grained sandstone. The lower sandstone was argillaceous, greenish-grey with lignitic seams and partings.

3.2.2 Groundwater Conditions

Observation wells were installed in Borings B-7, B-11, B-15, B-16, B-17, and B-18. Water level readings were taken by TMPA personnel March 28, 1988, approximately one month after installation. Groundwater elevations are listed in Table 3.1.

TABLE 3.1. GROUND WATER LEVEL SUMMARY

Ground Water Observation Well Number	Ground Elevation (FT)	Ground Water Elevation (FT)	Depth Below Ground Surface (FT)
B-7	252.2	245.9	6.3
B-11	266.8	229.8	37.0
B-15	261.5	249.2	12.3
B-16	261.7	249.8	11.9
B-17	292.3	252.4	39.9
B-18	269.1	231.5	37.6

3.3 CLAY BORROW AREA SUBSURFACE STRATIGRAPHY

The clay borrow investigation concentrated primarily on the two areas adjacent to the railroad spur, north of the proposed Stage I landfill site. Thirty-four test pits were excavated east of the railroad spur in an area 1,000 feet wide by 2,500 feet long. Nine test pits were excavated on the west side of the spur in conjunction with Borings CB-12 through CB-15 to define subsurface stratigraphy in the west borrow area.

Test results indicate that soil conditions from 0 to 11 feet below ground surface generally consist of three soil types below the fine grained moist silty sand topsoil of varying thickness ranging from 0.5 feet to 2.0 feet.

The topsoil layer is underlain by 1 feet to 3 feet of highly plastic firm dark brown silty clay generally classified as a CH with natural moisture contents ranging from 32 to 42 percent, liquid limits from 51 to 103 percent and plasticity indexes from 24 to 70. Organic contents in this layer varied from 3.1 to 7.2 percent and the soil was rated as highly reactive with the Emerson Crumb Test (Dispersion Test).

Below this layer a stiff tan plastic silty clay to clayey silt generally classified as CH, CH-MH was encountered in the test pits and borings. Thickness varied from 1.0 feet to 5.0 feet. Liquid limits ranged from 37 to 104 percent, plasticity indexes from 20 to 73 and natural moisture contents from 13 to 49 percent. This layer was classified as low to moderately reactive with the Emerson Crumb Test.

Underlying the tan silty clay to clayey silt was a greenish-brown firm clayey silt to silty clay generally classified as MH, CH-MH. Natural moisture contents ranged from 25 to 43 percent, liquid limit ranged from 49 to 93 percent and plasticity index ranged from 19 to 53. This layer was moderately reactive to the Emerson Crumb Test. This layer extended to maximum excavation depth of the backhoe or refusal.

Bulk material samples were obtained from seven test pits to establish moisture-density relationships using the Standard Proctor Test (ASTM D698). Samples of individual material layers and full face samples were retained. Optimum moisture contents for the tests ranged from 19.3 to 35.6 percent. Maximum dry densities ranged from 77.3 to 102.6 pounds per cubic foot (pcf). Permeability of the samples remolded at 95 percent of maximum density and at moisture contents ranging from optimum to 3 percent above optimum varied from 1.06×10^{-8} cm/sec to 8.98×10^{-9} cm/sec. Specific gravities of these samples ranged from 2.66 to 2.69.
Unconsolidated-undrained (UU) triaxial compression tests were performed on samples remolded to 95 percent of maximum density at moisture contents ranging from optimum to 3 percent above optimum.

An additional nine test pits, TP-70 through TP-78, were excavated in the northern portion of the proposed landfill site. These pits revealed a brown stiff high plasticity silty clay with natural moisture contents from 23.9 to 38.0 percent, liquid limit ranged from 54 to 108 percent, and

plasticity index ranged from 34 to 71. Moisture-density testing demonstrated optimum moisture contents of 24.5 percent and 28.5 percent with maximum dry densities of 85.4 pcf and 93.0 pcf respectively. Permeabilities of these samples remolded at 95 percent of maximum density and at moisture contents ranging from optimum to 3 percent above optimum ranged from 1.16×10^{-8} cm/sec to 7.94×10^{-9} cm/sec. UU triaxial tests were performed on samples remolded at 95 percent of maximum density and at moisture contents ranging from optimum to 3 percent above optimum. This clay deposit was not found in all of the test pits excavated in this area as demonstrated by the test pit logs indicating that this deposit is limited in areal extent at this location.

3.4 ESTIMATED QUANTITIES OF CLAY BORROW

Estimates of the quantity of clay borrow available in the area investigated north of the proposed landfill site east and west of the railroad spur have been included herein. The quantity estimates were developed using the boring and test pit logs and laboratory testing results.

Quantity estimates were made using: (1) the total thickness of highly plastic material available above refusal, or maximum excavation reach of the backhoe, less the topsoil, and (2) the thickness of clay material considered acceptable for landfill liner, Type I clay.

The Type I clay material, the stiff tan plastic silty clay to clayey silt, and the underlying greenish-brown firm clayey silt to silty clay layers, meet the TWC requirement for plasticity. The permeability results obtained from testing samples remolded to 95 percent of maximum density and at moisture contents ranging from optimum to three percent above optimum ranged from 8×10^{-9} cm/sec to 1.2×10^{-8} cm/sec which are less than the 1×10^{-7} cm/sec required by TWC.

The Type I clay is overlain by a highly plastic material (Type II) classified as a highly plastic firm dark brown silty clay. The thickness of this highly plastic dark brown material varied from 1 to 3 feet in the potential borrow areas. Based on laboratory testing, this upper dark brown material has a high organic content and exhibits high dispersive

characteristics. The Type II material has similar plasticity and permeability characteristics as the Type I clay. However, the Type II material is considered unacceptable for use in a thin liner (less than 3 feet) application. This Type II material should adequately perform as an impervious barrier when used in a homogeneous embankment section.

Refusal was experienced on sandstone and in very hard layers of the greenish brown clayey material during the test pit excavations.

Table 3.2 provides the estimated quantities of Type I and Type II clay materials available in the east and west clay borrow areas. Figure 3.1 shows the thickness of the combined Type I and Type II clay layers. Figure 3.2 shows the thickness of only the Type I material.

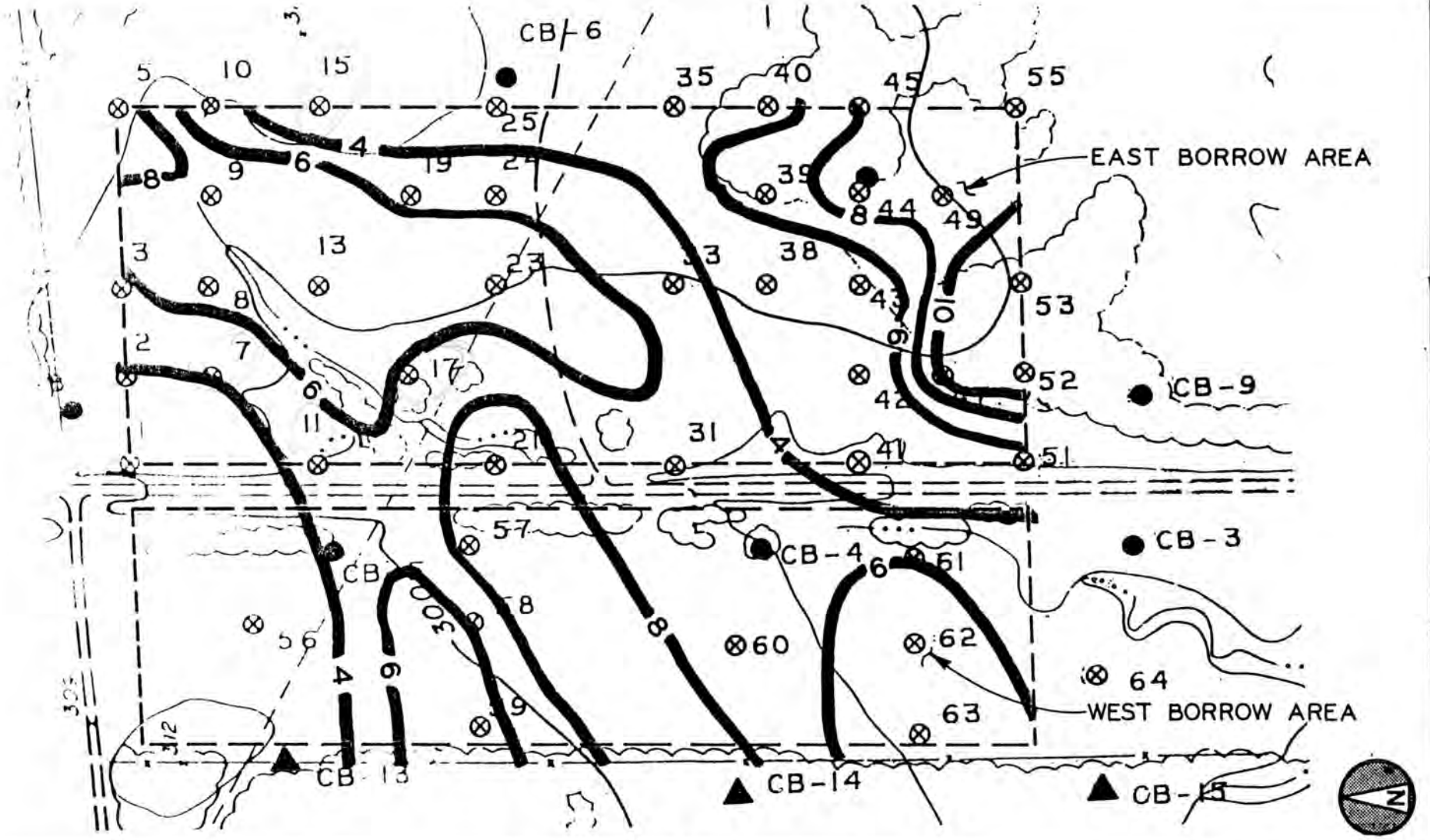
TABLE 3-2. CLAY BORROW QUANTITIES

Area	Average Clay Depth		Borrow Quantity		Total Quantity	
	Type I and Type II	Type I Only	Type I and Type II	Type I Only	Type I and Type II	Type I Only
East of * Railroad Spur	6.0'		556,000 c.y.			
West of ** Railroad Spur	6.7'		372,000 c.y.		928,000 c.y.	
East of * Railroad Spur		4.1'		380,000 c.y.		
West of ** Railroad Spur		5.3'		294,000 c.y.		674,000 c.y.

* Area used for calculations - 57 acres

** Area used for calculations - 34 acres

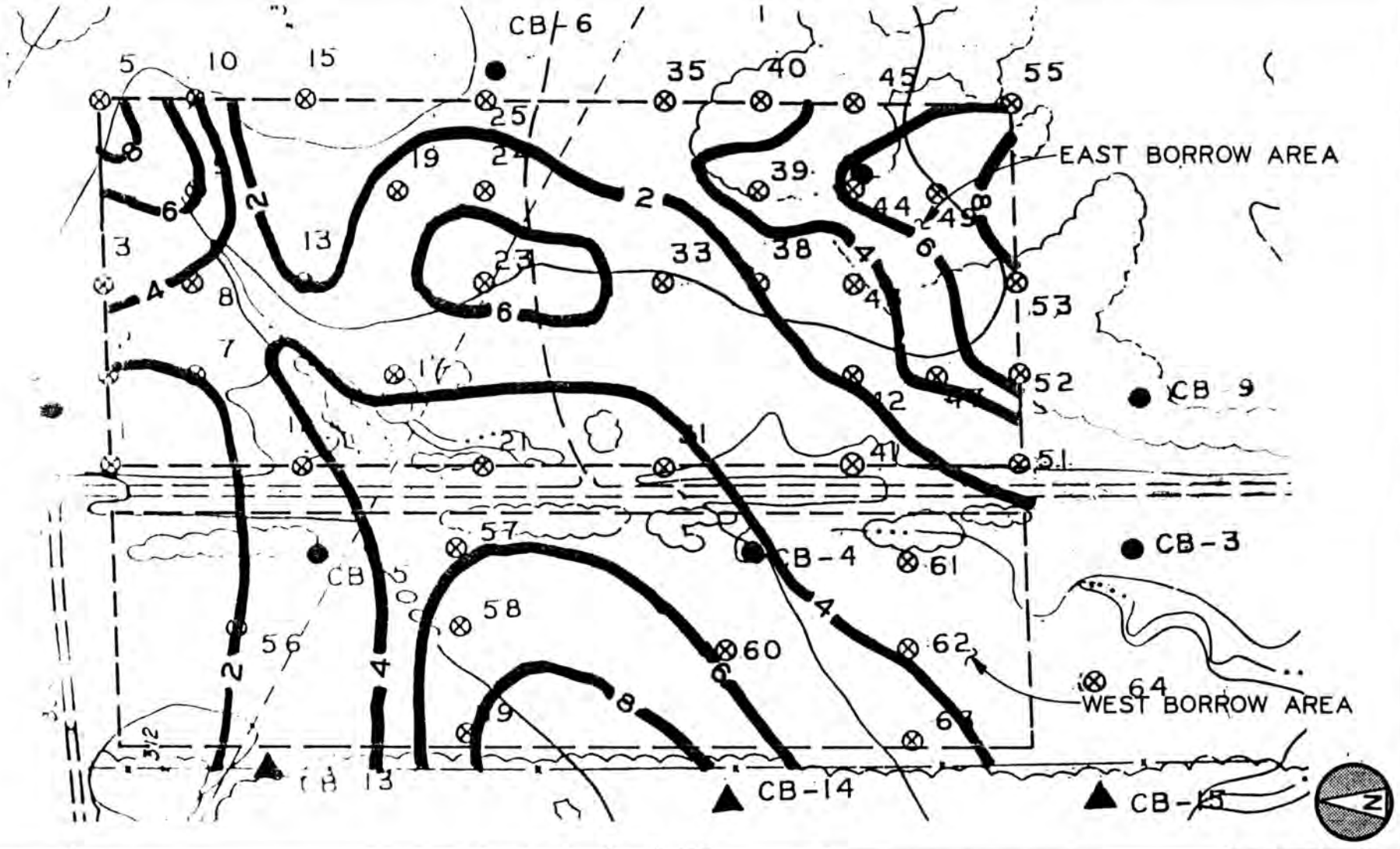
P-GN-260B



NO	DATE	REVISIONS AND RECORD OF ISSUE	BY	CHK	APP	FLM

BLACK & VEATCH ENGINEERS-ARCHITECTS	TEXAS MUNICIPAL POWER AGENCY	PROJECT 14578 DRAWING NUMBER	REV
ENGINEER / DRAWN / CHECKED / DATE	CLAY BORROW THICKNESS TYPE I AND TYPE II CLAY	CODE / AREA	FIGURE 3-1

P-GN-260B



NO	DATE	REVISIONS AND RECORD OF ISSUE	BY	CHK	APP	FLM

BLACK & VEATCH ENGINEERS-ARCHITECTS	TEXAS MUNICIPAL POWER AGENCY	PROJECT DRAWING NUMBER 14578	REV
ENGINEER / DRAWN / CHECKED / DATE	CLAY BORROW THICKNESS TYPE I CLAY ONLY	CODE / AREA	FIGURE 3-2

APPENDIX A

BORING LOGS

EXPLANATION

BORING LOG TERMINOLOGY

GENERAL

PP	- Compressive strength as determined by penetrometer
TV	- Compressive strength as determined by torvane
Gravel	- From 1/4 inch to 3 inches in diameter
Cobble	- From 3 to 12 inches in diameter
Boulder	- Greater than 12 inches in diameter
60°	- Represents 60 degrees measured from a plane perpendicular to the longitudinal axis of the core
Trace	- Represents 0 to 10 per cent by volume
Some	- Represents 10 to 25 per cent by volume
N Value	- Indicates the number of blows required to drive a standard split spoon sampler 12 inches with a 140-pound weight falling 30 inches
REC	- Recovery indicates total amount of core recovered for each run. Expressed as a percentage of the total length of the core run
RQD	- A modified core recovery in which all pieces of sound core over 4 inches in length are counted as recovery. The modified sum of core recovered is then expressed as a percentage of the total length of the core run
---	- Dashed line in classification column indicates approximate or gradational change

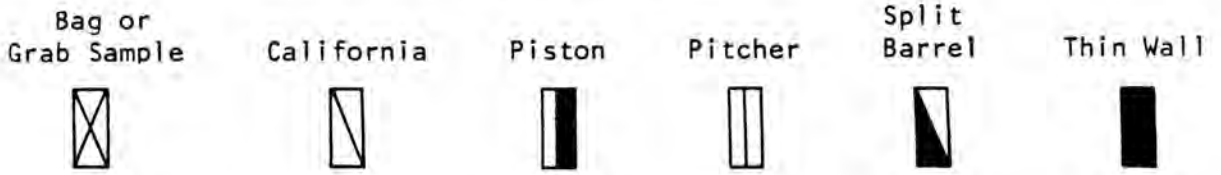
WEATHERING

Fresh	- The rock shows no discoloration, loss of strength, or any other effect due to weathering (unweathered rock)
Slightly Weathered	- Rock is slightly discolored with a slightly lower strength than unweathered rock
Moderately Weathered	- Rock is considerably discolored with a significantly lower strength than unweathered rock
Highly Weathered	- Rock is discolored and weakened so intensely that 2-inch diameter rock cores can be broken readily by hand. Wet strength is usually much lower than dry strength

BEDDING

Laminated	- Less than 0.001 foot to 0.01 foot (.1 inch)
Thin Bedded	- 0.01 foot to 0.1 foot (.1 to 1.2 inches)
Medium Bedded	- 0.1 foot to 1.0 foot (1.2 to 12 inches)
Thick Bedded	- Greater than 1.0 foot
Massive	- Denotes no discernible internal bedding structure

SAMPLE SYMBOLS



BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-6
SHEET 1 of 2

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES		PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N377453 E3339384	ELEVATION (DATUM): 263.6	TOTAL DEPTH: 50.0'	DATE START: 2-26-88
SURFACE CONDITIONS: Dirt road in woods		INSPECTOR: K. M. Blevins-McCosh		DATE FINISH: 2-26-88
		CHECKED BY: M. C. Schluter		APPROVED BY: L. J. Almaleh

SAMPLING: SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING: CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
TW	1												1.0	1		Silty SAND; brown; poorly graded; fine grained; moist; trace clay; organics & roots	Advanced boring using 4 1/2" rotary wash
TW	2												1.0	3		Silty CLAY; reddish-brown; low plasticity; moist; w/some sand; very iron stained; grading to high plasticity below 4.5'	
TW	3												1.3	5			TW 3 pp. 4+
TW	4												1.2	7		Silty CLAY; brownish-grey; high plasticity; moist; w/some sand; iron staining; 15" silty sand layer at 7.8'	
TW	5												0.9	10		Sandy CLAY; tan; low plasticity; moist; w/some silt; iron staining; w/cemented sand nodules	
TW	6												1.2	15		Clayey SAND; tan; low plasticity; moist w/some sandy clay seams; iron staining w/sandstone fragments and inclusions SANDSTONE seam at 17.75'	
TW	7												1.5	22		8" silty sand seam at 22'	
TW	8												0.9	25		Silty CLAY; dark grey; high plasticity; moist; w/trace sand	

P-ST-0360

BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-6
SHEET 2 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N377453 E3339384	263.6	50.0'	2-26-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Dirt road in woods	K. M. Blevins-McCosh	2-26-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
														1		
														2		
														3	1" SAND/SILT layer at 33.0'	
TW	9					0.6								4		
														35		
														6		
														7		
														8		
TW	10					0.8								9	Interbedded w/some sandy silt	
														40		
														1		
														2	Grading to greenish-grey	
														3		
TW	11					0.9								4	Clayey SILT; greenish-grey; low plasticity; moist; w/some sand	
														45		
														6		
														7		
														8		
TW	12					1.5								9	CLAY; greenish-grey; high plasticity; moist; w/some silt	
														50		Bottom of boring at 50.0'. Backfilled boring w/grout inserted concrete plug at surface. Groundwater level unknown.
														1		
														2		
														3		
														4		
														55		
														6		
														7		
														8		
														9		
														60		

P-ST-0360

BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-7
SHEET 1 of 2

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N377160 E3340264	ELEVATION (DATUM): 252.2' / TOTAL DEPTH: 50.0'	DATE START: 2-24-88
SURFACE CONDITIONS: Clearing in woods near cooling lake canal		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-25-88
	CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh	

SAMPLING: SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING: CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
TW	1												0.8	1		Silty SAND; brown; poorly graded; fine grained; moist; some organics; roots (top soil)	Boring advanced using 4 1/2" rotary wash
														2		Silty SAND; brown; poorly graded; moist; iron stained with gravel	
TW	2												1.3	3			
TW	3												1.4	4			
														5		Silty CLAY; brown; hard; low plasticity; moist with some sand	
TW	4												2.0	6			
														7		Sandy CLAY; seam at 7.5'	
TW	5												1.1	8			
														9			
										10'				10			Started coring at 10' - hit gravel
3"	1	5								0.7'	0		0	1		GRAVEL; tan to brown; poorly graded with some clay .5" - 2" diameter	
														2			
														3			
														4			
										15'				15		Silty SAND; grey; poorly graded; fine grained; moist; iron staining; with trace clay; 1" clay layer at 15'	
TW	6												1.8	6			
														7			
TW	7												0.8	8			
														9		Few SANDSTONE nodules below 19'	
														20			
TW	8												0.9	1		Sandy CLAY; tan; hard; low plasticity; moist; w/clayey sand seams; iron stained	
TW	9												1.0	2			
														3		4" sand seam at 22.5' 1" SANDSTONE at 24' 4" SAND seam at 24.2'	
														4			
TW	10												0.7	25		Silty CLAY; greenish-grey; hard; low plasticity; moist; w/some sand	
SPT	11	32/5											0.2	6		Grading to silty SAND w/clay below 26.5'	
										27'				7			Started coring at 27' SPT bouncing in hole
3"	2	2'								1'	0	0.5	0	8		SANDSTONE; argillaceous; greenish-grey; thin bedded; fine grained; clay partings; fractures every 1/2 - 2"; weathered	
3"	3	1'								1'	0	100	0	9			
										30'				30			

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BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-7
SHEET 2 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N377160 E3340264	252.2'	50.0'	2-24-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Clearing in woods near cooling lake canal	K. M. Blevins-McCosh	2-25-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING							DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD				
TW	12					0.9	TW	12					0.9	1		Silty CLAY; greenish-grey; very hard; low plasticity; moist; with sandstone layers	
														2		Sandy SILT; greenish-grey; poorly graded; fine grained; moist; with some clay	
TW	13					0.8	TW	13					0.8	3			
														4		Silty CLAY; greenish-grey; very hard; high plasticity; moist; some sand; iron stained on joints	
TW	14					0.8	TW	14					0.8	35			
														6			
TW	15					0.3	TW	15					0.3	7		Cemented sand seams below 37' to 38'	
														8		Silty SAND filled joints below 38'	
TW	16					0.8	TW	16					0.8	9			
														40			
TW	17					2.0	TW	17					2.0	1			
														2		Sandy CLAY; greenish-grey; hard; high plasticity; moist; with silt and sand filled joints	
TW	18					1.4	TW	18					1.4	3			
														4		Silty CLAY; greenish-grey; very hard; high plasticity; moist with little sand and sand filled seams; laminated	
TW	19					1.4	TW	19					1.4	45			
														6		Cemented sand seam 45.7'	
TW	20					1.4	TW	20					1.4	7			
														8			
TW	21					1.1	TW	21					1.1	9		Silty SAND seams at 49.0'	
														50			Bottom of boring at 50'. Groundwater level unknown. Reamed hole to 50.5' w/4 1/2" bit first 3' of hole reamed w/6 3/4" bit. Washed cuttings from hole. Installed 2-20' sections 2" PVC pipe and 1-6.7' section 2" PVC pipe and 5' screen.
														1			
														2			
														3			
														4			
														55			
														6			
														7			
														8			
														9			
														60			

PIST-0360

BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-8
SHEET 1 of 1

CLIENT		PROJECT		PROJECT NO.
Texas Municipal Power Agency		Gibbons Creek SES		14578
PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N377624 E3340903	272.5'	10'	2-24-88
SURFACE CONDITIONS		INSPECTOR		DATE FINISH
Clearing in woods		K. M. Blevins-McCosh		2-24-88
CHECKED BY		APPROVED BY		
M. C. Schluter		L. J. Almaleh		

SAMPLING SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
TW	1					1.8								1		Sandy SILT; brown; poorly graded; moist; w/some clay; iron staining; trace organics; roots; (Top soil)	Boring advanced using 4 1/2" rotary wash
SPT	2	50	30/2 50/1.5			1.2								2 3 4		Clayey SAND; tan; poorly graded; moist w/iron staining and sandstone fragments; lignitic below 3' (extremely weathered sandstone)	
										5'				5			Rock fragments showing up in cuttings at 5'
3"	1	5				15		1	5	2.8	0.75	56	15	6 7 8 9		SANDSTONE; thin bedded; fine grained; fracture spacing .5-4"; iron staining on fracture surface; some sand seams; highly weathered.	
										10'				10			Bottom of boring at 10'. Groundwater level unknown. Backfilled hole w/grout to surface inserted concrete plug.
														1 2 3 4 15 6 7 8 9 20 1 2 3 4 25 6 7 8 9 30			

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LOG OF BORING

BORING NO. B-9
SHEET 1 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N377583 E3341690	266.6'	50'	2-24-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Open pasture	K. M. Blevins-McCosh	2-24-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING							DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD				
TW	1					0.9								1		Silty SAND; brown; poorly graded; fine grained; wet; with some clay and organics; roots (Top soil)	Advanced boring w/4 1/2" rotary wash
SPT	2	3	4	10	14	0.5								2 3 4		Sandy CLAY; brown; stiff; high plasticity; moist; with some silt	
TW	3					1.2								5 6 7		Silty CLAY; brown; hard; high plasticity; moist; with some sand; trace iron staining	
SPT	4	8	12	18	30	1								8 9 10		Grading to tan below 7.5'	
TW	5					1.4								1 2 3 4		Grading few silt seams and iron stained seams; sand grading out	
SPT	6	12	25	25/5	50	1.3								15 6 7 8 9		Grading trace iron-staining, silt seams grading out	
TW	7					1.1								20 1 2 3 4		Silt seams every 3-6", very iron stained	
SPT	8	23	40	32	72	1.7								25 6 7 8 9 30		Grading with trace sand	

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LOG OF BORING

BORING NO. B-9
SHEET 2 of 2

CLIENT		PROJECT		PROJECT NO.
Texas Municipal Power Agency		Gibbons Creek SES		14578
PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N377583 E3341690	266.6'	50'	2-24-88
SURFACE CONDITIONS		INSPECTOR		DATE FINISH
Open pasture		K. M. Blevins-McCosh		2-24-88
		CHECKED BY		APPROVED BY
		M. C. Schluter		L. J. Almaleh

SAMPLING							CORING									
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
TW	9					0.7								1 2 3 4 35 6 7 8 9 40 1 2 3 4 45 6 7 8 9 50 1 2 3 4 55 6 7 8 9 60		Grading dark brown; lignitic below 33'; iron staining on joints	
SPT	10	30	100/4 50/3 50/1		100+	1.2										Grading with some silt pockets	
TW	11					1.5										Grading to some sand; trace lignite	
SPT	12	44	65	77		1.6										Grading laminated w/silt seams	Bottom of boring at 50'. Ground water level unknown. Filled hole with grout and concrete plug.

SAMPLE TYPE

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LOG OF BORING

BORING NO. B-10
SHEET 1 of 1

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N377502 E3342439	ELEVATION (DATUM): 252.3 / TOTAL DEPTH: 28.0'	DATE START: 2-24-88
SURFACE CONDITIONS: Open Pasture		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-24-88
	CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh	

SAMPLING: SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING: CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
TW	1					0.9								1		Silty SAND; brown; poorly graded; fine; wet; with some clay; roots (Top soil)	Boring advanced using a 4 1/2" rotary wash
SPT	2	5	12	20	32	0.8								2		Clayey SAND; tan to brown; medium dense; poorly graded; moist; with some silt	
TW	3					1.2								5		Silty SAND; brown to grey; poorly graded; fine grain; moist; with some clay	
SP	4	16	24	26/4		0.8								7		Sandy CLAY; dark brown; hard; high plasticity; moist with silt and sandstone stringer	
														10		Clayey SAND; tan to brown; poorly graded; fine; moist; with hard clay seams	
SPT	5	50				0.5								13.5		Clay seams grading out below 13.5	
														18.5		Lignitic below 18.5' with lignite seams; sandstone in cuttings at about 19'	
SPT	6	24	26/1											19		SANDSTONE; lignitic greenish-grey; thin bedded; fine; highly weathered; with lignite seams; fractures horizontal w/.5-4" spacing	
			23'											25			
3"	1	5	1.3	0.3	26	6								28			Bottom of boring at 28'. Ground water level unknown. Backfilled hole w/grout to surface; placed concrete plug.
			28'											30			

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BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-11
SHEET 1 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N378329 E3339148	266.7'	50'	2-26-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Clearing in woods	K. M. Blevins-McCosh	2-26-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING						
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD
TW	1					1.6							
TW	2					0.8							
TW	3					1.1							
TW	4					1.2							
TW	5					1.4							
TW	6					1.2							
TW	7					1.5							
TW	8					1.3							
TW	9					1.5							
TW	10					1.5							
TW	11					1.8							
TW	12					1.9							
TW	13					1.9							
TW	14					1.7							
TW	15					2.0							

DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
1		Silty CLAY; reddish-brown; stiff; high plasticity; moist; organics; roots; iron staining (Top soil)	Advanced boring w/4 1/2" rotary wash
2		Grading brown w/some sand; trace gravel below 2'	pp. 2.75
3		Grading w/some sandstone seams and some gravel w/trace roots below 4'	
4			
5			
6			
7		Sandy CLAY; tan to buff; stiff; low plasticity; moist; iron stained; w/trace gravel and some silt	
8			
9		Clayey SILT; tan to buff; hard; high plasticity; moist; some sand; iron staining especially on joints; joints spaced 2-6" horizontal	
10			
1		Interbedded with silty sand below 10'	
2		Grading tan to brown with iron nodules and few cemented sand fragments; platy below 12'	
3			
4		Blocky structure below 14'	
15		Cemented sand grades out below 14';	
6			
7			
8		Cemented sand layer at 18'	
9		CLAY; greenish-grey; hard; high plasticity; moist w/silt filled joints and some silt; trace sand; trace lignite 22'-24'	
20			
1			
2			
3		Grading greenish-grey and dark grey banded below 23'	
4			
25			
6		Slickensided below 26'	
7			
8			
9			
30			

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BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-11
SHEET 2 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N378329 E3339148	266.7'	50'	2-26-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Clearing in woods	K. M. Blevins-McCosh	2-26-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING							DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD				
TW	16					1.8								1			
														2		Trace pyrite below 32'	pp. 4+
TW	17					1.9								3			
														4		Bands grading out below 34'	
TW	18					1.9								35			
														6			
TW	19					2.0								7			
														8			pp. 4+
TW	20					1.7								9			
														40			
TW	21					1.9								1		Trace lignite below 41'	
														2		Grading dark grey below 42'; 1/2" silt seam at 42.3'	
TW	22					2.0								3			
														4			pp. 4+
TW	23					1.1								45		Silty CLAY; dark grey; hard; high plasticity; dry; some iron staining	
														6			
TW	24					0								7			TW 24 no sample cored w/2' core barrel
			48'											8			
3"	1	2	1.3	0.3	65	17								9		SANDSTONE; argillaceous; grey; fine grained; slightly weathered; w/trace lignite; horizontal joints	
			50'											50			Bottom of boring 49.8'. Groundwater level unknown. Reamed 0-3' w/6 7/8" bit Reamed 3-50' w/4 1/2" bit. Installed 2-20' sections of 2" PVC pipe; 1-7.2' section of 2" PVC and 1-5' screen.
														1			
														2			
														3			
														4			
														55			
														6			
														7			
														8			
														9			
														60			

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BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-12
SHEET 1 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N378225 E3340238	265.3'	50'	2-29-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Clearing in woods	K. M. Blevins-McCosh	2-29-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
															SAMPLE TYPE / GRAPHICS LOG	
							TW	1					0.3	1	Silty SAND; brown; poorly graded; fine grained; moist; trace clay; roots; iron staining; w/sandstone seam at 0.3' (Top soil)	Advanced boring using 4 1/2" rotary wash
							TW	2					1.4	2		
														3	Clayey SAND; brown; poorly graded; fine grained; moist w/some silt and silty sand seams; sandstone nodules at 3.8' and 4.5'; iron staining	
							TW	3					0.5	4		
														5	SANDSTONE; silty; buff; fine grained; joint spacing 1/2" - 3" horizontal; slightly weathered; iron staining	
			6'				3"	1	1.25	0.7	0		0	6		
			7'											7	Silty SAND; yellowish-buff; poorly graded; fine grained; moist	
							TW	4					0.8	8		
														9	Clayey SAND; brown; poorly graded; fine grained; moist w/some silt; trace limonite and iron staining	
														10		
														1		
														2		
							TW	5					0.5	3		
														4		
														15		
														6	Silty SAND; tan; poorly graded; fine-grained; moist; iron stained; blocky structure	
														7		
							TW	6					1.5	8		
														9	Grading with interbedded clayey sand below 18.5'	
														20		
														1		
														2		
			23'											3	SANDSTONE; silty; buff; fine grained; weathered; iron stained	
			1				3"	2	2		0	50	0	4	SANDSTONE; argillaceous; greenish-grey; fine grained; weathered; joint spacing 1/2-3" horizontal	
			25'											25		
							TW	7					0.9	6	Clayey SAND; dark grey; poorly graded; fine grained; moist w/some silt	
														7		
														8		
							TW	8					1.3	9	Sandy CLAY; greenish-grey; low plasticity; moist w/some silt and silt filled joints; laminated	
														30		

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LOG OF BORING

BORING NO. B-12
SHEET 2 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N378225 E3340238	265.3'	50'	2-29-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Clearing in woods	K. M. Blevins-McCosh	2-29-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING						
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD
TW	9					1.5							
TW	10					1.4							
TW	11					1.9							
TW	12					1.4							

DEPTH IN FEET | SAMPLE TYPE / GRAPHICS LOG | CLASSIFICATION OF MATERIAL | REMARKS

1 2 3 4 35 6 7 8 9 40 1 2 3 4 45 6 7 8 9 50 1 2 3 4 55 6 7 8 9 60

Silty CLAY; greenish-grey; high plasticity; dry to moist; silt filled joints w/trace sand; laminated; blocky structure; jointed

CLAY; greenish-grey; high plasticity; moist; some silt; silt filled joints; trace sand; slickensided

Grey and greenish-grey banded below 48'

Bottom of boring at 50'. Groundwater level unknown. Backfill hole w/grout to surface.

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BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-13
SHEET 1 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N378309 E3341132	267.7'	50.0'	2-29-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Open pasture	K. M. Blevins-McCosh	2-29-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING							DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD				
TW	1					1.0								1		Silty SAND; brown; poorly graded; fine grained; moist; w/some clay; organics and roots (Topsoil)	Boring advanced using 4 1/2" rotary wash
TW	2					1.5								2		CLAY; brown; med. dense; high plasticity; moist; w/some silt; trace iron staining; trace sand	pp. 1.25
TW	3					1.1								3			
TW	4					1.4								4		Grading to silty clay below 4'	
TW	5					1.3								5			
TW	6					1.2								6		Lignitic below 6'	
TW	7					1.4								7			
TW	8					1.3								8		Gypsum crystals at 9.8'	
TW	9					0.6								9			
														10			
														1			
														2			
														3			
														4		Grading dark brown; lignitic w/gypsum crystals in joints; jointed; laminated; w/blocky structure	
														15			
														6			
														7			
														8			
														9		Grading dry	
														20			
														1			
														2			
														3			
														4		Grading medium brown w/some iron staining	
														25			
														6		Sandy CLAY; brown; low plasticity; moist w/some silt; some iron staining	
														7			
														8			
														9		Silty SAND; brown; poorly graded; fine grained; moist w/some clay	
														30			

PIST-036D

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ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-13
SHEET 2 of 2

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N378309 E3341132	ELEVATION (DATUM): 267.7' / TOTAL DEPTH: 50.0'	DATE START: 2-29-88
SURFACE CONDITIONS: Open pasture		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-29-88
	CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh	

SAMPLING: SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING: CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
TW	10					0.5								1 2 3 4 35 6 7 8		Clayey SAND; greenish-grey; poorly graded; fine grained; some cemented seams; moist; w/some silt	
TW	11					0.9								9 40 1 2 3		Silty CLAY; dark grey; hard; high plasticity; moist	
TW	12					1.6								4 45 6 7 8		Grading greenish-grey w/silt filled joints 2-4" spacing; 4 1/2" sandy clay layer at 43.5'; slickensided	
TW	13					1.5								9 50 1 2 3 4 55 6 7 8 9 60		2" silty sand layer at 49'; grading dark grey below 48.5'	Bottom of boring at 50'. Groundwater level unknown. Hole backfilled w/grout to surface. Placed concrete plug at top.

PI-ST-0360

BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-14
SHEET 1 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N378277 E3341774	266.4'	50.0'	2-29-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Open pasture	K. M. Blevins-McCosh	2-29-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
TW	1					1.0								1	Sandy CLAY; brown; loose; low plasticity; moist; w/some silt; organics and roots (Topsoil)	Boring advanced using 4 1/2" rotary wash
TW	2					2.0								3	CLAY; brown; soft to hard; high plasticity; wet to moist w/some silt	pp. 1.0
TW	3					1.3								4		pp. .75
TW	4					1.6								5		pp. 4+
TW	5					1.6								6	Trace organics below 6'; iron staining	
TW	6					1.2								7		
TW	7					1.3								8	1" sand seam at 9.9'; iron stained and limonitic	
TW	8					0.9								9	Sandy CLAY; tan; firm; moist; w/some silt	
TW	9					0.9								10		
														11		
														12		
														13		
														14		
														15		
														16		
														17		
														18		
														19		
														20	Silty CLAY; brown; hard; high plasticity; moist; w/trace sand; iron staining; jointed	
														21		
														22		
														23		
														24		
														25	Silty CLAY; dark grey; hard; high plasticity; moist; w/silt filled joints; trace cemented sand fragments	
														26		
														27		
														28		
														29	Lignitic below 28'	
														30		

P-ST-0360

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ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-14
SHEET 2 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N378277 E3341774	266.4'	50.0'	2-29-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Open pasture	K. M. Blevins-McCosh	2-29-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG
TW	10					1.2								1 2 3 4 35 6 7 8 9 40 1 2 3 4 45 6 7 8 9 50 1 2 3 4 55 6 7 8 9 60	
TW	11					1.2									
TW	12					1.0									
TW	13					1.7									

CLASSIFICATION OF MATERIAL

Clayey SAND; grey; poorly graded; fine grained; moist; some silt; grading from grey to dark brown; interbedded with clayey SAND; lignitic below 33.5'

Sandy CLAY; dark brown; hard; high plasticity; moist; some silt; lignitic

REMARKS

Bottom of boring at 50'. Groundwater level unknown. Filled hole w/grout to surface; inserted concrete plug near surface.

P I S E I 0 3 6 D

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LOG OF BORING

BORING NO. B-15
SHEET 1 of 2

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N378200 E3342496	ELEVATION (DATUM): 261.5' / TOTAL DEPTH: 35.0'	DATE START: 2-23-88
SURFACE CONDITIONS: Open pasture		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-23-88
		CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh

SAMPLING SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
TW	1					1.2								1	Undifferentiated overburden	Advanced hole using 4 1/2" rotary wash
TW	2					0.8								2	Silty CLAY; brown; medium dense; stiff to hard; low plasticity; moist; some sand Grading to more silt at 3'-3.5'	
TW	3					0.5								5		
TW	4					0.8								6	Sandy CLAY; tan to brown; hard; low plasticity; moist; trace silt	
														8		pp. 4+
														9	Clayey SAND; tan to brown; poorly graded; fine grained; some silt; iron staining	Tried to push TW Tried SPT - cored at 10' so reamed w/rotary wash looked at cuttings
							3"	1	2	10' 0	0	0	0	10		
							3"	2	2	12' 1.3	0	65	0	12	SANDSTONE; argillaceous; yellowish-tan; fine to medium grained; iron staining; highly weathered	Sample recovery below 12' in 1-3" sections
							3"	3	2	14' 1.2	0	60	0	14	Argillaceous grading out below 14'	
							3"	4	2	16' 0	0	0	0	16	Grading grey below 16'	
							3"	5	2	18' 0	0	0	0	18		Missed sample at 18-20' rotary washed. Continued drilling with 3" diameter 5' core barrel below 20'.
							3"	6	5	20' 4.5	0.33	90	7	20	Iron staining on joints below 20'	
														21	Lignite partings starting at 21.7'	
														23	Grading greenish-grey below 23' and slightly argillaceous	
							3"	7	5	25' 4	0.83	80	12	25		
										30'				27	Lignite partings grading out below 27.5'	
														30		

BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-15
SHEET 2 of 2

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N378200 E3342496	ELEVATION (DATUM): 261.5' / TOTAL DEPTH: 35.0'	DATE START: 2-23-88
SURFACE CONDITIONS: Open pasture		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-23-88
		CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh

SAMPLING: SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING: CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
							3"	8	5	30' 2.2	0	44	0	1 2 3 4		Horizontal fractures spaced generally from 1-3" apart; numerous lignite partings below 30'	
										35'				35 6 7 8 9 40 1 2 3 4 45 6 7 8 9 50 1 2 3 4 55 6 7 8 9 60			Bottom of boring 35'. Ground water level unknown. Reamed hole using 4 1/2" bit. Flush cuttings out of hole installed 1-20' section and 1-11' section of 2" PVC and 5' section of screen.

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LOG OF BORING

BORING NO. B-16
SHEET 1 of 2

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N379581 E3339416	ELEVATION (DATUM): 261.7' / TOTAL DEPTH: 39.0'	DATE START: 2-25-88
SURFACE CONDITIONS: Clearing in woods		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-25-88
	CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh	

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
TW	1												0.7	1	Silty CLAY; dark brown; medium dense; high plasticity; moist; organics; roots (Top soil)	Boring advanced using 6 7/8" rotary wash
TW	2												1.5	2	CLAY; dark brown; stiff; high plasticity; moist; some silt	
TW	3												1.1	3		
TW	4												1.8	4	Trace gravel and iron staining below 4'	pp. 1.25
TW	5												1.7	5		pp. 1.5
TW	6												1.8	6		
TW	7												1.5	7	Silty CLAY; brown; stiff; high plasticity; moist; iron staining; jointed	pp. 2.0
TW	8												1.7	8	Gypsum seam at 7.5' and 9'; slickensided below 7'	
TW	9												1.7	9		
TW	10												1.7	10	Horizontal and 45° to vertical joints below 10' filled w/gypsum crystals and iron staining	
TW	11												1.6	1		pp. 2.5
TW	12												1.3	2		pp. 2.75
TW	13												1.3	3		
TW	14												1.2	4	Gypsum filled vertical joint at 14'- joint is 4" long; banded brown and dark brown below 14'. Gypsum filled joint spacing generally 8"-1.5'	
TW	15												0.4	15		pp. 2.75 pp. 3.5
														6		
														7		pp. 3.0
														8	CLAY; olive grey to dark grey; hard; high plasticity; moist; with silt seams on joints below 20'; trace iron staining; trace sand in joints; occasional silty sand pockets below 16'; thinly bedded	
														9		
														20		pp. 4+
														1		
														2		pp. 4+
														3		
														4		pp. 4+
														25		
														6		pp. 4+
														7		
														8		
														9	Lignitic below 29' - lignite seams up to 1"	
														30		

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BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-16
SHEET 2 of 2

CLIENT		PROJECT		PROJECT NO.
Texas Municipal Power Agency		Gibbons Creek SES		14578
PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N379581 E3339416	261.7'	39.0'	2-25-88
SURFACE CONDITIONS		INSPECTOR		DATE FINISH
Clearing in woods		K. M. Blevins-McCosh		2-25-88
CHECKED BY		APPROVED BY		
M. C. Schluter		L. J. Almaleh		

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	GRAPHICS LOG (SAMPLE TYPE)	CLASSIFICATION OF MATERIAL	REMARKS
3"	1	1	0.2	0	20	0								1		SANDSTONE; argillaceous; greenish-grey; fine grained; weathered	
			31'											2			
TW	16					0.5								3		Clayey SAND; greenish-grey; partially cemented; fine grained; poorly graded; some silt (maybe extremely weathered sandstone)	
			34'											4			
3"	2	5	4	1.3	80	26								35		SANDSTONE; argillaceous; greenish-grey; fine grained; weathered; w/lignite seams; horizontal and vertical joints - weathering on joints	
														6			
														7			
														8			
			39'											9			Bottom of boring at 39'. Groundwater level unknown. Reamed hole w/6 7/8" bit. Installed 3-10' sections 4" PVC and 1-5.8' section 4" PVC; set 1-5' section .01" slot screen.
														40			
														1			
														2			
														3			
														4			
														45			
														6			
														7			
														8			
														9			
														50			
														1			
														2			
														3			
														4			
														55			
														6			
														7			
														8			
														9			
														60			

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LOG OF BORING

BORING NO. B-17
SHEET 1 of 2

CLIENT		PROJECT		PROJECT NO.
Texas Municipal Power Agency		Gibbons Creek SES		14578
PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N381083 E3340991	292.3'	50.0'	2-17-88
SURFACE CONDITIONS		INSPECTOR		DATE FINISH
Clearing in pasture		K. M. Blevins-McCosh		2-17-88
CHECKED BY		APPROVED BY		
M. C. Schluter		L. J. Almaleh		

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
														1	10" Undifferentiated overburden	Advanced hole by rotary wash
TW	1					1.5								2	Silty CLAY; brown; stiff; med. plasticity; very moist; w/some roots	pp. 1.0
TW	2					1.2								3	Roots grade out below 3' Grading grey below 2.5 with trace sand	
TW	3					1.1								4	1" sand layer at 4.25'	pp. 4+
TW	4					0.9								5		pp. 4+
TW	5					1.2								6		
TW	6					0.9								7	Clayey SILT; brown to tan; hard; poorly graded; moist; with sand; trace lignite below 11'	
TW	7					0.7								8		
TW	8					1.3								9		
TW	9					1.5								10		
TW	10					0.9								1		
TW	11					0.8								2	CLAY; tan; hard; high plasticity; moist with cemented sand stringers; platy in areas with iron staining at plate faces	pp. 4+
TW	12					1.2								3		
TW	13					1.8								4		
TW	14					1.2								15	Grading silty with 2" sandy silt seam at approximately 15.7'	
TW	15					1.4								6		
														7	Clayey SILT; tan to buff; hard; low plasticity; moist; with some sand and iron staining on plates	
														8		
														9	Sandy SILT; tan to buff; poorly graded; moist with some clay; trace iron staining	
														20		
														1	Silty CLAY; brown/tan mottled; hard; high plasticity; moist; with trace sand and iron staining; platy	
														2		
														3	3" sandy silt layer at 22.5'; grading brown below 23	
														4		
														25	CLAY; brown; hard; high plasticity; moist; iron staining on plates and joints; gypsum crystals at 25.8'	
														6		pp. 4+
														7	Clayey SILT; brown; high plasticity; moist; iron staining	
														8		
														9	CLAY; greenish-grey; high plasticity; hard; moist; with trace silt; trace iron	
														30		

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BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-17
SHEET 2 of 2

CLIENT		PROJECT		PROJECT NO.
Texas Municipal Power Agency		Gibbons Creek SES		14578
PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N381083 E3340991	292.3'	50.0'	2-17-88
SURFACE CONDITIONS		INSPECTOR		DATE FINISH
Clearing in pasture		K. M. Blevins-McCosh		2-17-88
CHECKED BY		APPROVED BY		
M. C. Schluter		L. J. Almaleh		

SAMPLING SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
TW	16												2.0	1			
TW	17												1.8	2			
TW	18												1.8	3			
TW	19												1.7	4			
TW	20												1.9	35		Grading to trace silt below 35'	
TW	21												1.9	6			
TW	22												1.8	7			
TW	23												2.0	8		Grading to laminated banded (greenish-grey and grey) below 38' with trace lignite at 39.8';	
TW	24												1.8	9			
TW	25												1.6	40			
														1			
														2			
														3			
														4		Banding grading out below 44'	
														45			
														6			pp. 4+
														7		Banded below 47'	
														8			
														9			
														50			Bottom of boring at 50'. Groundwater level unknown. Hole reamed using 6 1/2" diameter auger bit.
														1			
														2			
														3			
														4			Set 4-10' and 1-4.6' section of 4" diameter schedule 40 threaded flush-jointed PVC pipe, 5' screen.
														55			
														6			
														7			
														8			
														9			
														60			

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ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-18
SHEET 1 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N381539 E3342922	269.1	50.0'	2-17-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Clearing in pasture	K. M. Blevins-McCosh	2-17-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
														1	Undifferentiated overburden	Boring advanced using 4 1/2" rotary wash
														2		
TW	1					0.6								3	Sandy SILT; tan; poorly graded; moist; with cemented sand stringers; some clay; iron staining	
														4		
TW	2					1.5								5	Clayey SILT; reddish-brown; hard; high plasticity; moist; trace sand; iron staining; grading some sand below 7'	
														6		
TW	3					1.3								7		pp. 4+
														8		
TW	4					1.7								9	Sandy SILT; reddish-brown; poorly graded; moist; with clay and iron staining; grading to silty clay; interbedding with lignitic clay below 10'; few gypsum crystals	
														10		
TW	5					1.3								1		
														2		
TW	6					1.5								3	Silty CLAY; dark brown to black; hard; highly plastic; moist; lignitic; iron staining; with trace sand below 16'	
														4		pp. 4+
TW	7					0.9								15		
														6		
TW	8					0.9								7		pp. 4+
														8	Silty SAND; tan; poorly graded; moist; trace clay; iron staining	
TW	9					0.7								9		pp. 4+
														20	Clayey SILT; greenish-grey; highly plastic; moist; with trace thin silty sand laminae; trace iron staining	
TW	10					1.4								1		
														2		
TW	11					1.8								3		
														4		
TW	12					0.8								25	Sandy SILT; greenish-grey; poorly graded; moist; with trace to some clay	
														6		
TW	13					1.2								7	Silty CLAY; greenish-grey; high plasticity; moist; with some sandy silt layers	
														8		
TW	14					1.3								9		
														30		

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ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. B-18
SHEET 2 of 2

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N381539 E3342922	269.1	50.0'	2-17-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Clearing in pasture	K. M. Blevins-McCosh	2-17-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING								
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	GRAPHICS LOG
TW	15					1.4								1	
TW	16					1.4								2	
TW	17					1.5								3	
TW	18					0.9								4	
TW	19					2.0								35	
TW	20					2.1								6	
TW	21					2.0								7	
TW	22					1.7								8	
TW	23					1.9								9	
TW	24					1.6								40	
														1	
														2	
														3	
														4	
														45	
														6	
														7	
														8	
														9	
														50	
														1	
														2	
														3	
														4	
														55	
														6	
														7	
														8	
														9	
														60	

SAMPLE TYPE

CLASSIFICATION OF MATERIAL

2" sandy silt seam at 32.5'; grading to low plasticity; sandy silt filled fractures spacing about 4" in sample

Grading to interbedded green and greenish grey silty clay below 34'; trace cemented sand

2" sandy silt seam at 37.8'
Grading greenish-grey below 38'

Grading to high plasticity below 40'; sandy silt seam grading out; becoming greenish grey and grey banded clay

Slickensides at 44.5'

REMARKS

Bottom of boring at 50'. Groundwater level unknown. Reamed hole twice using 6 3/4" auger bit. Installed 4-10' and 1-5.5' section of 4" PVC, 1-5' section of screen.

P-ST-0366

BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. CB 12
SHEET 1 of 1

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N386388 E3336793	ELEVATION (DATUM): 295.4' / TOTAL DEPTH: 20'	DATE START: 2-16-88
SURFACE CONDITIONS: Clearing in pasture		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-16-88
		CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh

SAMPLING SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
														0		Undifferentiated Overburden	Boring advanced with 3" continuous flight auger
TW	1					0.9								1		Silty CLAY; dark brown; hard; high plasticity; moist with roots	
														2			
TW	2					1.4								3		Roots grading out Grading hard with trace sand and iron staining	
														4		Grading grey below 2 1/2'	
TW	3					1.0								5		Grading with sand stringers below 4'	
														6			
TW	4					1.8								7		Trace organics at 7.8'; 1" silt seam	pp. 4+
														8			
TW	5					1.2								9		Sandy SILT; tan to light brown; hard; low plasticity; moist; iron staining	
														10		Clayey SILT; tan to light brown; hard; low plasticity; moist; iron staining 3" sandy silt at 11.2'	
TW	6					1.4								1			
														2		Silty CLAY; tan to light brown; hard; high plasticity; moist; iron staining; with sand stringers	
TW	7					1.7								3			
														4		Sandy SILT; tan to light brown; poorly graded; moist with some clay; iron staining	
TW	8					1.9								15			
														6		Silty CLAY; tan to light brown; hard; low plasticity; moist; iron staining; trace sand	pp. 4+
TW	9					1.4								7			
														8		Grading to dark brown below 16' Mottled below 18'	
TW	10					1.8								9			
														20			Bottom of boring at 20'. Groundwater level unknown. Hole backfilled with cuttings and 2' concrete plug.
														1			
														2			
														3			
														4			
														25			
														6			
														7			
														8			
														9			
														30			

P-ST-0366

BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. CB 13
SHEET 1 of 1

CLIENT	PROJECT	PROJECT NO.
Texas Municipal Power Agency	Gibbons Creek SES	14578

PROJECT LOCATION	COORDINATES	ELEVATION (DATUM)	TOTAL DEPTH	DATE START
Carlos, Texas	N386433 E3337896	307.6'	20.0'	2-16-88

SURFACE CONDITIONS	INSPECTOR	DATE FINISH
Pasture	K. M. Blevins-McCosh	2-16-88

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh

SAMPLING							CORING						
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD
TW	1					1.3							
TW	2					1.4							
TW	3					1.2							
TW	4					1.1							
TW	5					1.5							
TW	6					1.2							
TW	7					1.6							
TW	8					1.3							
TW	9					1.8							
TW	10					0.8							

DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
1		10 1/2" Undifferentiated overburden	Boring advanced using 3" continuous flight auger
2		Silty SAND; brown; grey; poorly graded; fine; moist; with roots and some clay	
3		Silty CLAY; dark brown; hard; high plasticity; moist with some sand pockets below 3.5'	pp. 1.20
4			
5		Grading to grey with little sand	pp. 1.25
6		Sandy CLAY; med. brown to grey; hard; high plasticity; moist	pp. 4+
7		Silty CLAY; grey to brown; hard; high plasticity; moist; with some sand	pp. 4+
8			
9		Grading to tan	
10		Silty CLAY or clayey SILT; light brown to tan; hard; low plasticity; moist; with some sand; some iron staining below 14'	pp. 4+
1			pp. 3.5
2			
3			
4			
15			
6		Grading to grey below 16'	pp. 4+
7			
8		Grading to sandy below 18'; laminated in areas	
9			
20		Sandy CLAY; tan; hard; low plasticity; dry; with cemented sand layers (weathered rock stringers)	pp. 4+
1			
2			End of boring at 20'. Groundwater level unknown. Backfill with cuttings and 2' concrete plug.
3			
4			
25			
6			
7			
8			
9			
30			

PIST036D

BLACK & VEATCH
ENGINEERS-ARCHITECTS

LOG OF BORING

BORING NO. CB-14
SHEET 1 of 1

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N385176 E3337758	ELEVATION (DATUM): 293.6' / TOTAL DEPTH: 20.0'	DATE START: 2-16-88
SURFACE CONDITIONS: Clearing in pasture		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-16-88
	CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh	

SAMPLING							CORING							
SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET
TW	1					1.1	TW	1					1.1	1
TW	2					0.9	TW	2					0.9	3
TW	3					0.9	TW	3					0.9	5
TW	4					0.6	TW	4					0.6	7
TW	5					1.0	TW	5					1.0	9
TW	6					1.2	TW	6					1.2	1
TW	7					1.0	TW	7					1.0	3
TW	8					1.0	TW	8					1.0	4
TW	9					0.3	TW	9					0.3	15
TW	10					1.0	TW	10					1.0	6
TW	11					1.0	TW	11					1.0	7
TW	12					2.0	TW	12					2.0	8
TW	13					1.8	TW	13					1.8	20

SAMPLE TYPE / GRAPHICS LOG

CLASSIFICATION OF MATERIAL	REMARKS
Undifferentiated overburden	Advanced boring with 3" continuous flight auger
Silty CLAY; grey; hard; high plasticity; moist; with some sand; trace roots	
Grading brown; sand grading to trace; trace gravel	pp. 4+ pp. 2.0
Grading grey with iron staining below 7'; with occasional fine sand pockets	pp. 4+
Silty SAND; light brown; fine grained; poorly graded; dry with iron staining	pp. 4+
Silty CLAY; greyish-brown; hard; low plasticity; dry; iron staining	
Silty SAND: light brown to tan; fine grained; poorly graded; dry with iron staining; trace gravel	
Silty CLAY; greyish-brown; hard; high plasticity; moist; iron staining; some sand pockets 4" silty sand layer at 13.5 6" sand seam between 14' and 15'	pp. 4+ pp. 4+
Grading to tan below 16'	
Sand pockets grading out below 18'	pp. 4+
	Bottom of boring at 20'. Groundwater level unknown. Backfill with cuttings and 2' concrete plug.

P-ST-0356

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LOG OF BORING

BORING NO. CB-15
SHEET 1 of 1

CLIENT: Texas Municipal Power Agency		PROJECT: Gibbons Creek SES	PROJECT NO.: 14578
PROJECT LOCATION: Carlos, Texas	COORDINATES: N384180 E3337723	ELEVATION (DATUM): 283.5' / TOTAL DEPTH: 20.0'	DATE START: 2-16-88
SURFACE CONDITIONS: Clearing in pasture		INSPECTOR: K. M. Blevins-McCosh	DATE FINISH: 2-16-88
	CHECKED BY: M. C. Schluter	APPROVED BY: L. J. Almaleh	

SAMPLING: SAMP TYPE	SAMP NO.	SET 6"	2ND 6"	3RD 6"	N VAL	SAMP RECV	CORING: CORE SIZE	RUN NO.	RUN LENG	RUN RECV	RQD RECV	% RECV	RQD	DEPTH IN FEET	SAMPLE TYPE / GRAPHICS LOG	CLASSIFICATION OF MATERIAL	REMARKS
TW	1					1.1								1		Undifferentiated overburden	Advanced boring with 3" continuous flight auger
TW	2					1.1								2		Silty CLAY; brownish-grey; moist; high plasticity; hard; trace roots	pp. 1.25
TW	3					1.1								3			
TW	4					1.3								4		Grading trace sand w/gypsum	pp. 4 at 4'
TW	5					1.5								5			
TW	6					1.7								6			pp. 4+ at 6'
TW	7					1.8								7		Grading silty and medium plastic at 7'	
TW	8					1.5								8		Clayey SILT; light brown; moist; high plasticity; very stiff; w/some sand; and iron staining	pp. 3.5
TW	9					1.8								9			pp. 4+
TW	10					1.4								10		Sandy SILT; light brown; moist; hard; low plasticity; some clay; iron staining; with thin stringers of sand	pp. 4+
														1			pp. 4+
														2		Silty CLAY; dark brown; moist; hard; plastic; iron staining; trace limonite	
														3			
														4		Fine sand seams below 14'	pp. 3.5
														15			
														6			pp. 4+
														7			
														8		Silty SAND; light brown; moist; fine grained; poorly graded; trace clay	
														9			
														20		Silty CLAY; dark brown; moist; hard; plastic; iron staining with sand seams	Bottom of boring at 20'. Groundwater level unknown.
														1			
														2			Backfill with cuttings, concrete plug placed to 2'.
														3			
														4			
														25			
														6			
														7			
														8			
														9			
														30			

P-ST-0360

APPENDIX B

GROUND WATER LEVEL OBSERVATION WELL LOGS

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PIEZOMETER INSTALLATION LOG

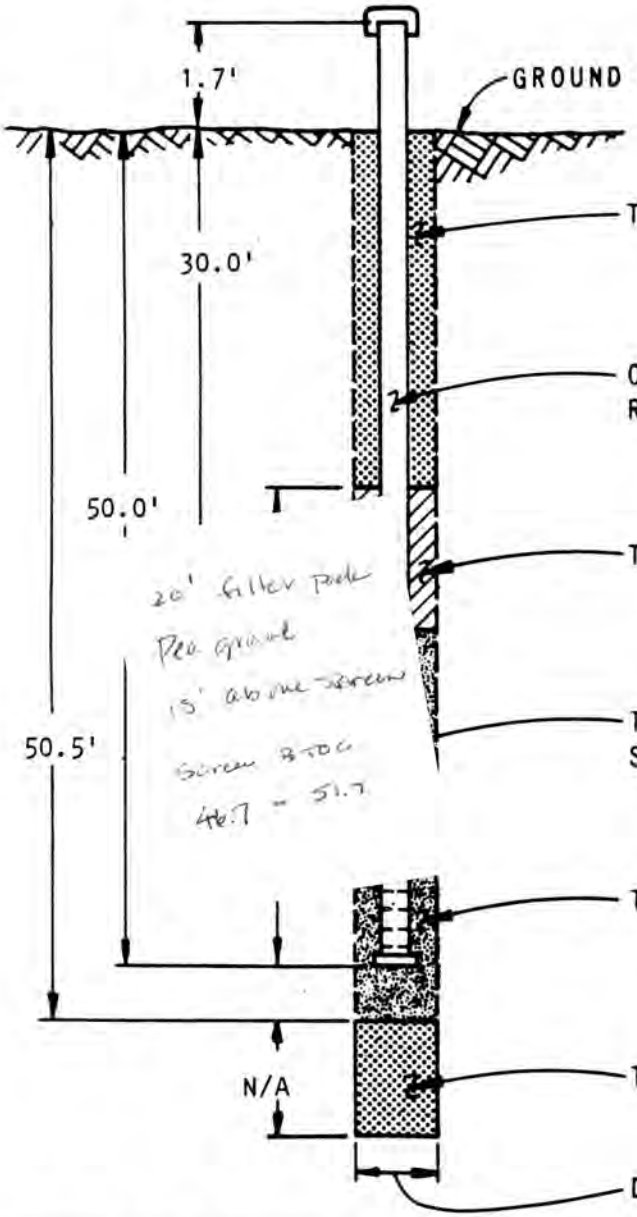
PIEZOMETER NO. B-7

CLIENT	PROJECT	PROJECT NO
Texas Municipal Power Agency	Gibbons Creek	14578

PROJECT LOCATION	COORDINATES	GROUND ELEVATION	DATE
Carlos, Texas	N377160 E3340264	252.2'	2-25-88

STRATUM MONITORED	INSPECTOR
Sandstone, Silty Clay, Sandy Silt	K. M. Blevins-McCosh

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh



TYPE OF SEAL	Volclay grout Cement/Bentonite
O.D. & RISER I	2" PVC glued joints Schedule 40
TYPE O	Bentonite Pellets 1/2"
TYPE / SCREEN OR OPENING	.01" Slots
TYPE OF FILTER	Pea Gravel
TYPE OF SEAL	N/A
DIAMETER OF BOREHOLE	4 1/2"

METHOD OF INSTALLATION: Boring drilled to completion; set riser pipe and screen; placed filter and seal; grouted to surface; poured surface pad.

REMARKS: Installed piezometer in fluid-filled hole; developed well by flushing w/clean water for 8 minutes on 2-27-88; blew out water w/compressed air; water level recorded at 37.25' from TOC

P-ST-0218

BLACK & VEATCH
CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

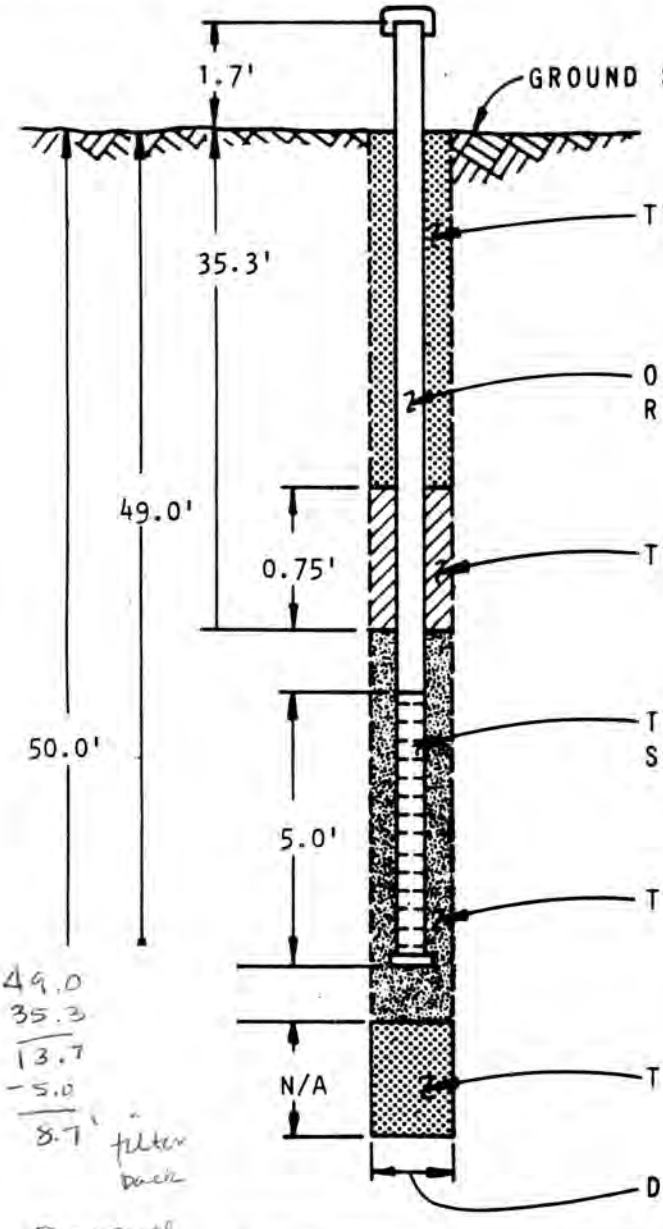
PIEZOMETER NO. B-11

CLIENT	PROJECT	PROJECT NO
Texas Municipal Power Agency	Gibbons Creek	14578

PROJECT LOCATION	COORDINATES	GROUND ELEVATION	DATE
Carlos, Texas	N378330 E3339148	266.8'	2-26-88

STRATUM MONITORED	INSPECTOR
Sandstone and clay	K. M. Blevins-McCosh

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh



TYPE OF SEAL	Volclay Grout and Initiator Cement/Bentonite
O.D. & TYPE OF RISER PIPE	2" PVC glued joints Schedule 40
TYPE OF SEAL	Bentonite Pellets 1/2"
TYPE AND SIZE OF SCREEN OR OPENINGS	.01" Slots
TYPE OF FILTER	Pea gravel
TYPE OF SEAL	N/A
DIAMETER OF BOREHOLE	4 1/2"

49.0
35.3
13.7
-5.0
8.7' filter pack

Pea gravel

Boring drilled to completion; set riser pipe and screen; placed filter and seal; grouted to surface; poured surface pad

REMARKS: Installed piezometer in fluid-filled hole; added approximately 2 gallons of bentonite pellets for seal but only 9" arrived at 35'- rest hung up- didn't have any more bentonite developed well on 2-27-88 by flushing w/clean water for 3 minutes and blowing it out w/air

P-ST-021B

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CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

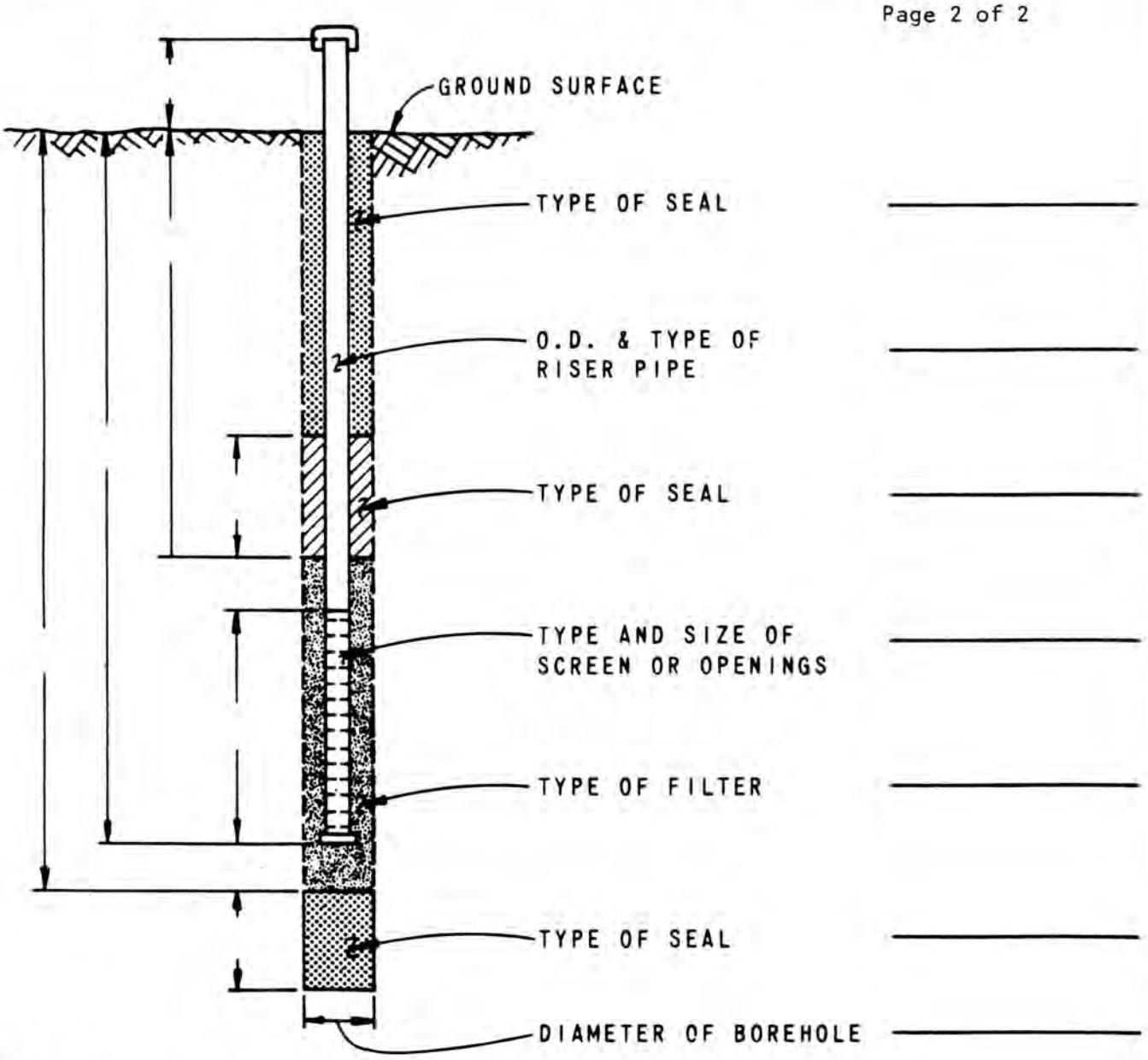
PIEZOMETER NO. B-11

CLIENT	PROJECT	PROJECT NO
Texas Municipal Power Agency	Gibbons Creek	14578

PROJECT LOCATION	COORDINATES	GROUND ELEVATION	DATE
Carlos, Texas	N378330 E3339148	266.8	2-26-88

STRATUM MONITORED	INSPECTOR
Sandstone and clay	K. M. Blevins-McCosh

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh



METHOD OF INSTALLATION

REMARKS Pump gave out after 3 min. so continued flushing well by pouring clean water in hole and blowing out repeatedly, decided wasn't working very well, quit - finished developing by flushing w/clean water for 10 min. and blowing out w/air on 2-29-88, water level recorded at 34'

P-ST-021B

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CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

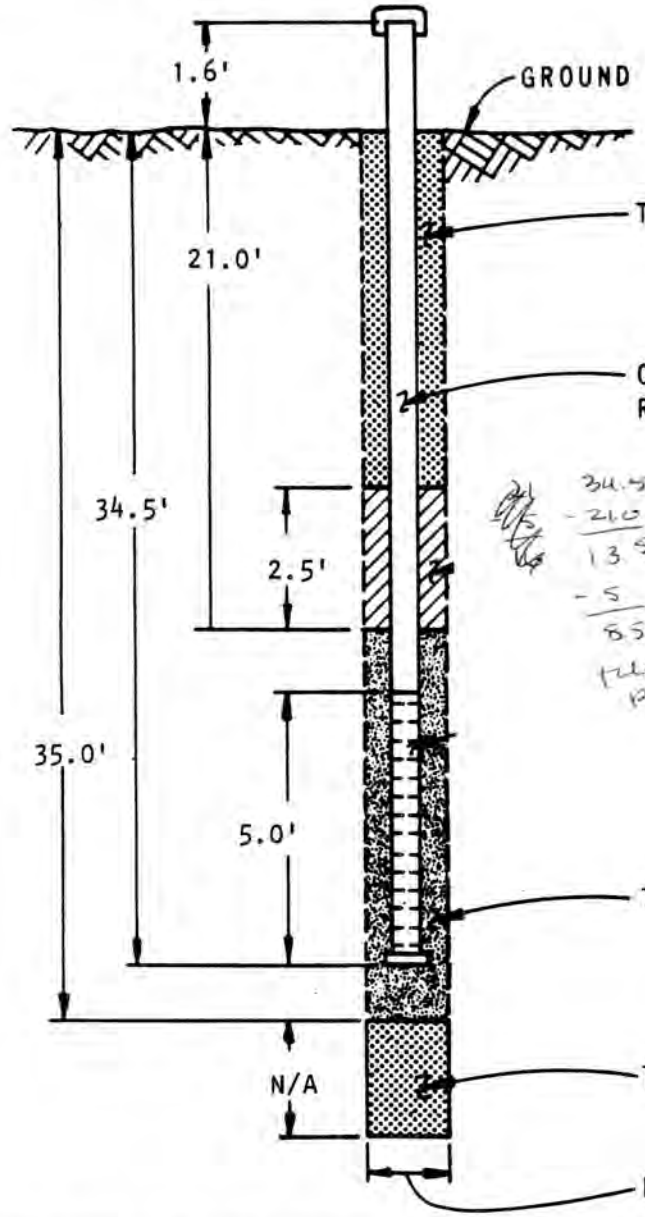
PIEZOMETER NO. B-15

CLIENT	PROJECT	PROJECT NO
Texas Municipal Power Agency	Gibbons Creek	14578

PROJECT LOCATION	COORDINATES	GROUND ELEVATION	DATE
Carlos, Texas	N378200 E3342496	261.5'	2-23-88

STRATUM MONITORED	INSPECTOR
Sandstone	K. M. Blevins-McCosh

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh



Volclay grout and Initiator / Cement-Bentonite

2" PVC-glued joints / Schedule 40

Bentonite 1/2" Tablets

.01" Slots

Pea gravel

N/A

4 1/2"

METHOD OF INSTALLATION: Boring drilled to completion; set riser pipe and screen; placed filter and seal; grouted to surface; poured surface pad.

REMARKS: Flushed cuttings from hole; hole remained fluid filled during installation. Developed well on 2-27-88 by flushing well with clean water for 6 min. blew out water from well with air compressor water level recorded at 23'-10" from TOC

P-ST-0218

BLACK & VEATCH
CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

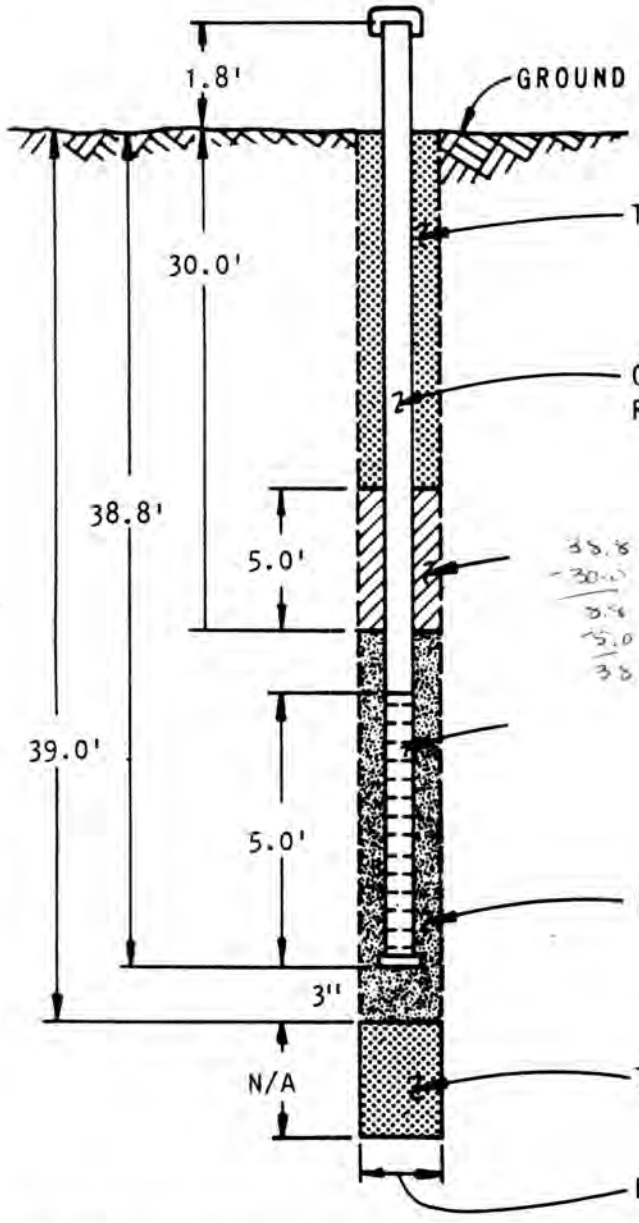
PIEZOMETER NO. B-16

CLIENT	PROJECT	PROJECT NO
Texas Municipal Power Agency	Gibbons Creek	14578

PROJECT LOCATION	COORDINATES	GROUND ELEVATION	DATE
Carlos, Texas	N379581 E3339416	261.7'	2-25-88

STRATUM MONITORED	INSPECTOR
Sandstone	K. M. Blevins-McCosh

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh



TYPE OF SEAL	Volclay grout Cement/Bentonite
O.D. & TYPE OF RISER PIPE	4" PVC flush jointed Schedule 40
EAL	Bentonite Pellets 1/2"
SIZE OF OPENINGS	.01" Slots
TYPE OF FILTER	Pea Gravel
TYPE OF SEAL	N/A
DIAMETER OF BOREHOLE	7"

35.8 − 30.0 = 5.8 − 5.0 = 3.8 filter pack

METHOD OF INSTALLATION Boring drilled to completion; set riser pipe and screen; placed filter and seal; grouted to surface; poured surface pad

REMARKS Cuttings washed from hole; piezometer installed in fluid-filled hole; well developed on 2-27-88 by flushing hole w/clean water for 8 min. and pumping until dry. Water level recorded at 38.2' from TOC.

P-ST-021B

BLACK & VEATCH
CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

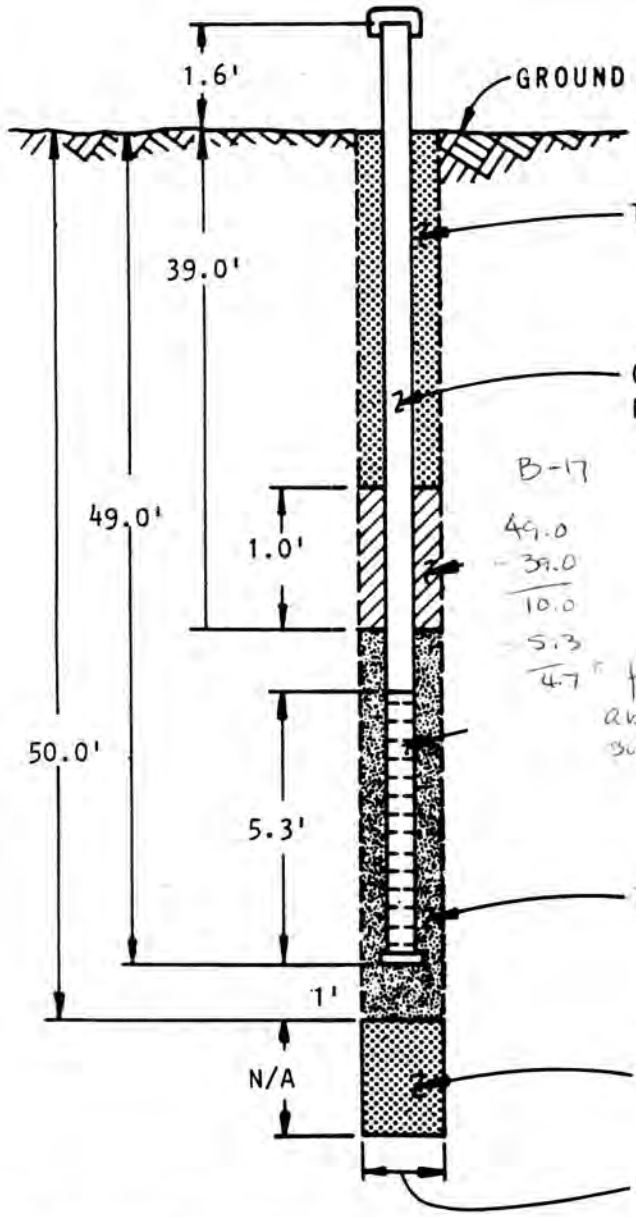
PIEZOMETER NO. B-17

CLIENT	PROJECT	PROJECT NO
Texas Municipal Power Agency	Gibbons Creek	14578

PROJECT LOCATION	COORDINATES	GROUND ELEVATION	DATE
Carlos, Texas	N381087 E3340991	292.3'	2-17-88

STRATUM MONITORED	INSPECTOR
Clay	K. M. Blevins-McCosh

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh



Volclay grout & Initiator (Cement-Bentonite)

4" PVC flush-jointed Schedule 40

Bentonite Pellets 1/4"

.01" Slots

Pea Gravel

N/A

7"

METHOD OF INSTALLATION: Boring drilled to completion' set riser pipe and screen; placed filter and seal; grouted to within 5' of ground surface filled remaining 5' with dry grout and cuttings

REMARKS: Developed well on 2-27-88 by flushing w/clean water for 7 min.; pumped well dry; water level recorded at 48.5' from TOC.

P-ST-0218

BLACK & VEATCH
CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

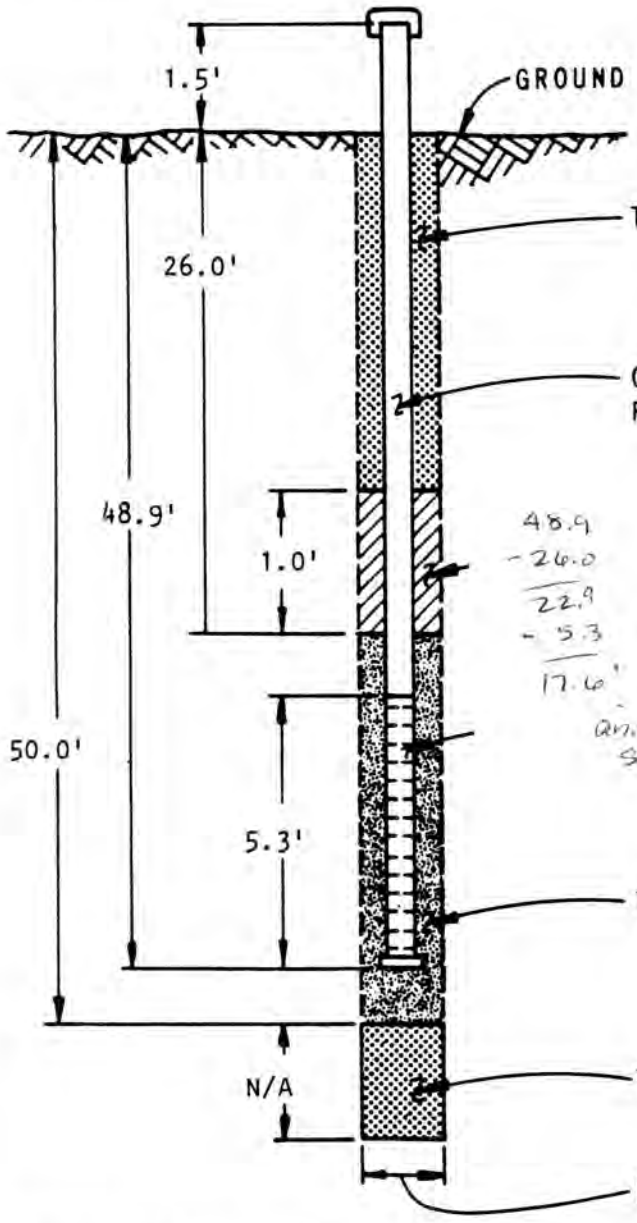
PIEZOMETER NO. B-18

CLIENT	PROJECT	PROJECT NO
Texas Municipal Power Agency	Gibbons Creek	14578

PROJECT LOCATION	COORDINATES	GROUND ELEVATION	DATE
Carlos, Texas	N381539 E3342922	269.1'	2-18-88

STRATUM MONITORED	INSPECTOR
Clay	K. M. Blevins-McCosh

CHECKED BY	APPROVED BY
M. C. Schluter	L. J. Almaleh



METHOD OF INSTALLATION: Boring drilled to completion; set riser pipe and screen; placed filter and seal; grouted to surface; poured surface pad.

REMARKS: Riser pipe started to rise so had to fill with water during installations; well developed on 2-27-88 by flushing w/clean water for 7 min., and then pumping well dry. Water level 50' from TOC.

P-ST-021B

RESPONSE ITEM 20

ATTACHMENT

GROUNDWATER DETECTION AND ASSESMENT MONITORING PARAMETERS

Table VI.C-1. – Groundwater Detection Monitoring Parameters

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)[5]	Concentration Limit[1,3]
Boron	Semi-Annual	EPA 6020B	0.080	0.621 and 1.490
Calcium	Semi-Annual	EPA 6020B	0.500	542 and 728
Chloride	Semi-Annual	EPA 9056A	2.50	649 and 1,770
pH	Semi-Annual	EPA 150.2	N/A	6.02-7.56 and 5.26-6.35
Sulfate	Semi-Annual	EPA 9056A	25.0	2,640 and 3,320
TDS	Semi-Annual	SM 2540C	20.0	4,930 and 8,180
Antimony	Semi-Annual	EPA 6020B	0.002	0.006
Arsenic	Semi-Annual	EPA 6020B	0.001	0.01
Barium	Semi-Annual	EPA 6020B	0.010	2
Beryllium	Semi-Annual	EPA 6020B	0.001	0.004
Cadmium	Semi-Annual	EPA 6020B	0.001	0.005
Chromium	Semi-Annual	EPA 6020B	0.002	0.1
Cobalt	Semi-Annual	EPA 6020B	0.0005	0.006
Fluoride	Semi-Annual	EPA 9056A	0.250	4
Lead	Semi-Annual	EPA 6020B	0.001	0.015
Lithium[4]	Semi-Annual	EPA 6020B	0.005	0.552 and 1.66
Mercury	Semi-Annual	EPA 7470A	0.0002	0.002
Molybdenum	Semi-Annual	EPA 6020B	0.005	0.1
Selenium	Semi-Annual	EPA 6020B	0.005	0.05
Thallium	Semi-Annual	EPA 6020B	0.001	0.002
Radium 226+228 [4]	Semi-Annual	EPA 903 / 904	5.00	10.1 and 5

1 The concentration limit is the basis for determining whether a release has occurred from the CCR unit/area.

2 The limit varies by CCR Unit. In the table, limits are presented in the order of SFL and SSP/AP.

3 Limits for Appendix III constituents are based on background threshold values. Appendix IV constituents are based on EPA maximum contaminant levels or 40 CFR 257.95(h)(2), unless otherwise specified.

4 Background threshold values are used for Lithium limits. Also for the SFL Radium limit.

5 Limits based on the reporting limits in the most recent 2021 sampling event.

Table VI.D. – CCR Units Under Assessment Monitoring

N.O.R. Unit No.	Unit Description[1,2]	Well(s)	Constituent(s)	Date of SSI Determination[4]	Date of Assessment Monitoring Notification[3]
	Site F Landfill (SFL)	SFL MW-2 SFL MW-3 SFL MW-4 SFL MW-5 SFL MW-6 SFL MW-7 SFL MW-15	Arsenic, Beryllium, Boron, Cadmium, Calcium, Chloride, Cobalt, Lead, Lithium, Mercury, Radium 226+228, Thallium, TDS, and pH.	January 2022	August 18, 2018
	Scrubber Sludge Pond (SSP)	SSP MW-2 SSP MW-3 SSP MW-4	Arsenic, Cadmium, Calcium, Chloride, Chromium, Cobalt, Beryllium, Boron, Molybdenum, Radium 226+228, Thallium, TDS, and pH.	January 2022	August 18, 2018
	Ash Ponds (AP)	AP MW-1D AP MW-3 AP MW-4 AP MW-5	Arsenic, Beryllium, Boron, Cadmium, Cobalt, Fluoride, Mercury, Molybdenum, TDS, and pH.	January 2022	August 18, 2018

1 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been requested pursuant to 40 CFR §257.103.
2 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been made pursuant to 40 CFR §257.103.
3 Enter month, day, and year

4 Most recent determination reported in the 2021 annual report.

Table VI.D-2 Groundwater Assessment Monitoring Parameters

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)[5]	Concentration Limit[1,3]
Boron	Semi-Annual	EPA 6020B	0.080	0.621 and 1.490
Calcium	Semi-Annual	EPA 6020B	0.500	542 and 728
Chloride	Semi-Annual	EPA 9056A	2.50	649 and 1,770
pH	Semi-Annual	EPA 150.2	N/A	6.02-7.56 and 5.26-6.35
Sulfate	Semi-Annual	EPA 9056A	25.0	2,640 and 3,320
TDS	Semi-Annual	SM 2540C	20.0	4,930 and 8,180
Antimony	Semi-Annual	EPA 6020B	0.002	0.006
Arsenic	Semi-Annual	EPA 6020B	0.001	0.01
Barium	Semi-Annual	EPA 6020B	0.010	2
Beryllium	Semi-Annual	EPA 6020B	0.001	0.004
Cadmium	Semi-Annual	EPA 6020B	0.001	0.005
Chromium	Semi-Annual	EPA 6020B	0.002	0.1
Cobalt	Semi-Annual	EPA 6020B	0.0005	0.006
Fluoride	Semi-Annual	EPA 9056A	0.250	4
Lead	Semi-Annual	EPA 6020B	0.001	0.015
Lithium[4]	Semi-Annual	EPA 6020B	0.005	0.552 and 1.66
Mercury	Semi-Annual	EPA 7470A	0.0002	0.002
Molybdenum	Semi-Annual	EPA 6020B	0.005	0.1
Selenium	Semi-Annual	EPA 6020B	0.005	0.05
Thallium	Semi-Annual	EPA 6020B	0.001	0.002
Radium 226+228 [4]	Semi-Annual	EPA 903 / 904	5.00	10.1 and 5

1 The concentration limit is the basis for determining whether a release has occurred from the CCR unit/area.

2 The limit varies by CCR Unit. In the table, limits are presented in the order of SFL and SSP/AP.

3 Limits for Appendix III constituents are based on background threshold values. Appendix IV constituents are based on EPA maximum contaminant levels or 40 CFR 257.95(h)(2), unless otherwise specified.

4 Background threshold values are used for Lithium limits. Also for the SFL Radium limit.

5 Limits based on the reporting limits in the most recent 2021 sampling event.

RESPONSE ITEM 21

ATTACHMENT

HISTORICAL GROUNDWATER LEVELS

Historical Water Surface Level Data[1] at Gibbons Creek SES Monitoring Wells, Years 2018 through 2022

Well	TOC Elevation	2021		2020		2019		2018	
		Jul 2021	Feb 2022	Jun 2020	Dec 2019	Jun 2019	Jan 2019	Jun 2018	Mar 2018
AP MW-1	271.56	258.53	258.34	264.40	264.45	265.21	264.73	264.74	265.17
AP MW-1D	272.04	257.56	257.21	257.53	257.07	257.90	257.94	258.16	258.38
AP MW-2	274.97	262.32	267.46	NC[2]	NC[2]	NC[2]	NC[2]	NC[2]	NC[2]
AP MW-3	274.68	262.09	263.29	263.50	263.18	264.04	264	264.06	264.04
AP MW-4	274.16	259.47	260.64	260.79	260.15	261.06	261	261.07	261.4
AP MW-5	274.13	259.66	262.04	262.38	261.89	262.86	262.75	263.01	262.94
AP MW-6	277.95	260.92	261.31	261.39	261.05	261.76	261.62	261.41	262.19
AP PZ-1	265.67	260.31	259.03	258.97	259.56	259.28	260.05	257.98	259.26
AP PZ-2	274.91	257.84	254.45	256.00	254.39	257.72	257.76	256.15	256.81
AP PZ-3	259.11	254.35	253.11	253.85	253.46	254.52	254.46	254.3	254.68
AP PZ-4	273.65	259.62	263.30	263.41	262.76	264.11	264.79	264.94	264.97
SSP MW-1	281.18	267.23	265.32	264.40	264.45	265.21	264.73	264.74	265.17
SSP MW-2	283.66	260.64	259.82	260.01	260.26	262.48	261.84	261.48	261.64
SSP MW-3	283.97	256.85	255.79	256.30	256.07	257.62	257.53	256.38	257.14
SSP MW-4	283.86	259.38	259.21	259.16	259.35	259.99	260.04	259.49	260.02
SSP/AP MW-1	272.53	264.82	264.19	264.40	264.45	265.21	264.73	264.74	265.17
SFL MW-2	268.31	257.93	256.74	257.60	257.3	258.2	257.5	257.4	257.43
SFL MW-3	275.00	257.08	256.88	257.45	258.02	258.61	258	258.08	258.24
SFL MW-4	269.53	254.75	253.85	254.32	255.18	255.32	254.93	254.73	255.1
SFL MW-5	276.25	260.17	259.81	260.52	260.35	261.22	260.45	260.42	260.46
SFL MW-6	286.66	267.66	268.07	268.35	269.41	269.35	268.17	268.09	268.36
SFL MW-7	264.63	251.41	250.05	250.63	249.66	251.66	252.19	251.7	251.86
MNW-11	267.95	247.25	247.68	247.58	248.11	247.25	248.67	248.15	248.38
MNW-15	257.331	252.45	251.11	252.27	251.44	253.52	253.73	253.23	253.61
MNW-16	263.191	250.69	249.07	250.16	248.94	250.84	251.39	250.71	251.02
MNW-17	293.724	264.36	260.22	248.22	253.85	250.01	259.04	248.39	260.73
MNW-18	270.755	262.05	262.40	263.41	261.59	262.54	265.28	261.98	262.49

[1] Historical data is from annual groundwater monitoring reports. 2022 levels have not yet been reported.

[2] NC for Not Collected. The reason for not collecting the water surface elevation is unknown.

RESPONSE ITEM 22

ATTACHMENT

REVISED FIGURES

LEGEND

Site Location

8/26/22

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER

TEXAS ENGINEERING FIRM F-754

GIBBONS CREEK STEAM ELECTRIC STATION
GC ENVIRONMENTAL REDEVELOPMENT GROUP
SITE LOCATION MAP

2021 GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

DATE
MAY 2021

FIGURE
FIGURE 1

N

700 0 700 1400

SCALE IN FEET

LEGEND:

MONITORING WELL

WASTE BOUNDARY

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER

8/26/22

TEXAS ENGINEERING FIRM F-754

GIBBONS CREEK STEAM ELECTRIC STATION
GC ENVIRONMENTAL REDEVELOPMENT GROUP
MONITORING NETWORK - SITE F LANDFILL

2021 GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

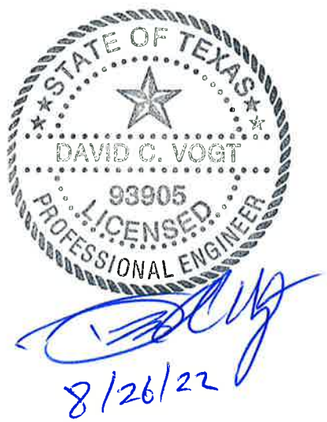
DATE
MAY 2021

FIGURE
FIGURE 2

LEGEND:

Ⓦ MONITORING WELL

POND BOUNDARIES



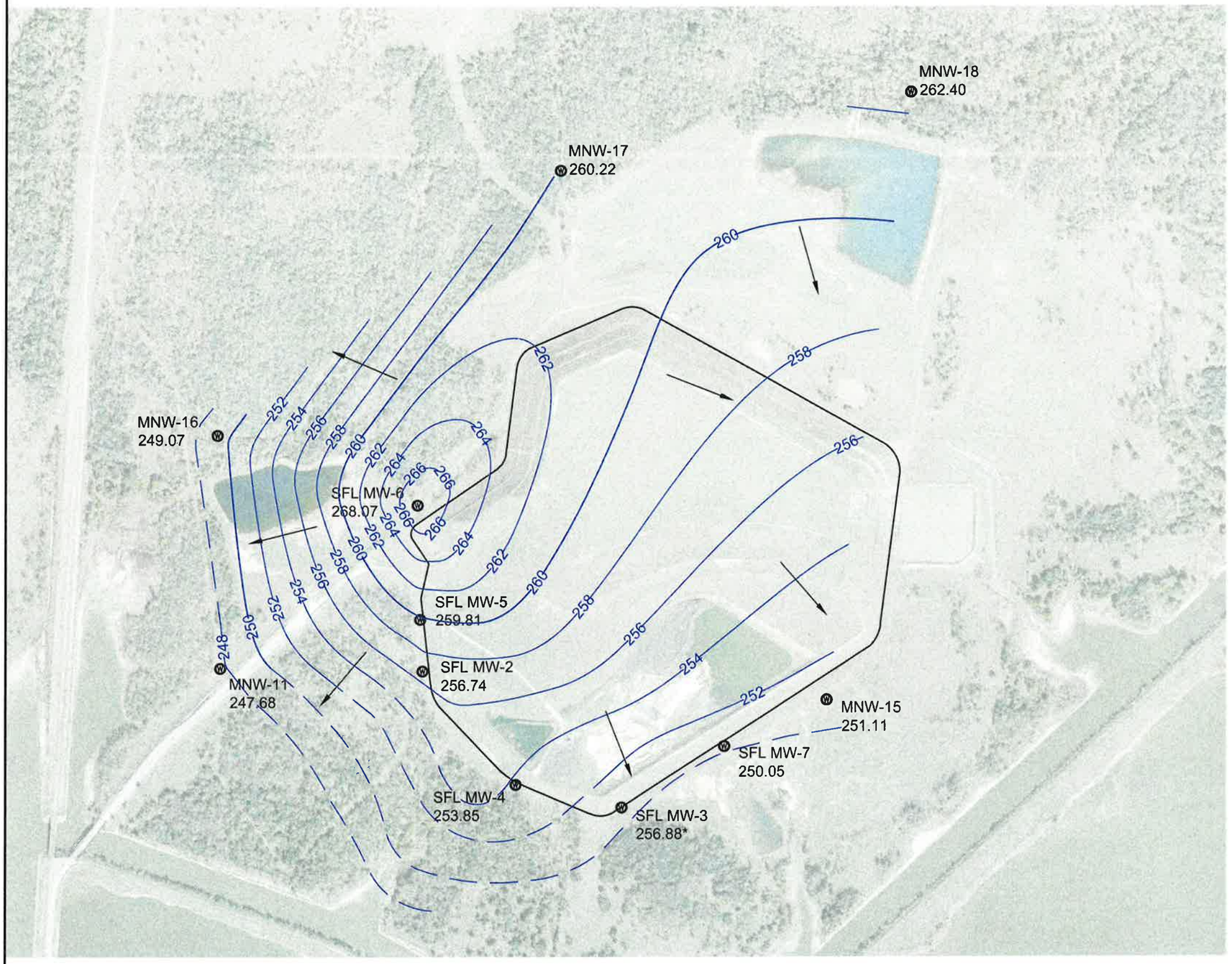
TEXAS ENGINEERING FIRM F-754

GIBBONS CREEK STEAM ELECTRIC STATION
GC ENVIRONMENTAL REDEVELOPMENT GROUP
MONITORING NETWORK - ASH PONDS/SCRUBBER SLUDGE

2021 GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

DATE
MAY 2021

FIGURE
FIGURE 3



N

600 0 600 1200

SCALE IN FEET

LEGEND:

- MONITORING WELL
- WASTE BOUNDARY
- GROUNDWATER CONTOUR
- INFERRED GROUNDWATER CONTOUR
- FLOW DIRECTION

NOTES:

1. " * " DENOTES STATIC WATER LEVEL WAS NOT UTILIZED IN GENERATION OF GROUNDWATER CONTOUR MAP DUE TO ANOMALOUS VALUE COMPARED TO SURROUNDING WELLS.

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
8/26/22

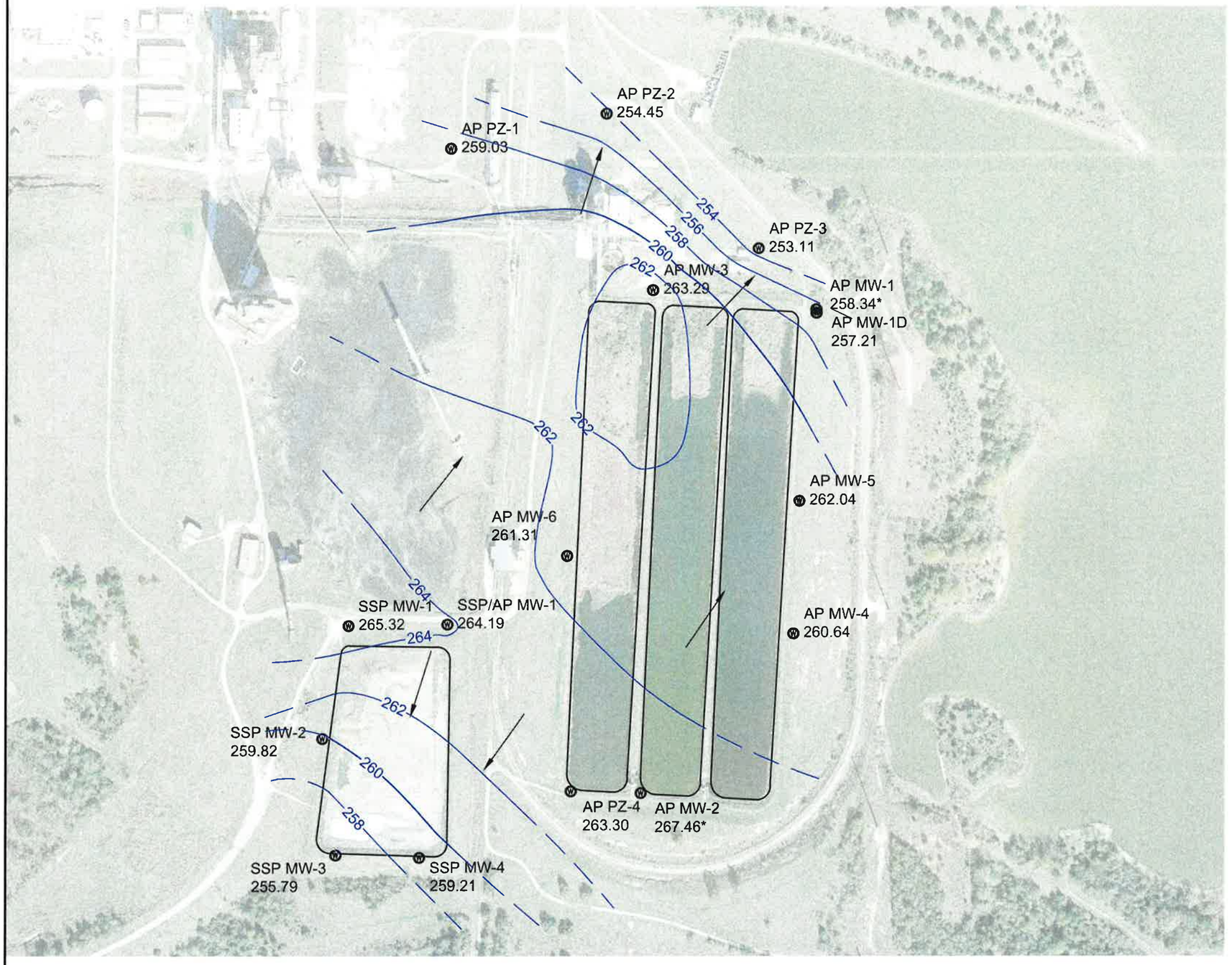
TEXAS ENGINEERING FIRM F-754

GIBBONS CREEK STEAM ELECTRIC STATION
GC ENVIRONMENTAL REDEVELOPMENT GROUP
SITE F LANDFILL - FEBRUARY 2021 CONTOUR MAP

2021 GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

DATE
MAY 2021

FIGURE
FIGURE 4



N

400 0 400 800

SCALE IN FEET

LEGEND:

- MONITORING WELL
- POND BOUNDARIES
- GROUNDWATER CONTOUR
- INFERRED GROUNDWATER CONTOUR
- FLOW DIRECTION

NOTES:

1. " * " DENOTES STATIC WATER LEVEL WAS NOT UTILIZED IN GENERATION OF GROUNDWATER CONTOUR MAP DUE TO ANOMALOUS VALUE COMPARED TO SURROUNDING WELLS.

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
8/26/22

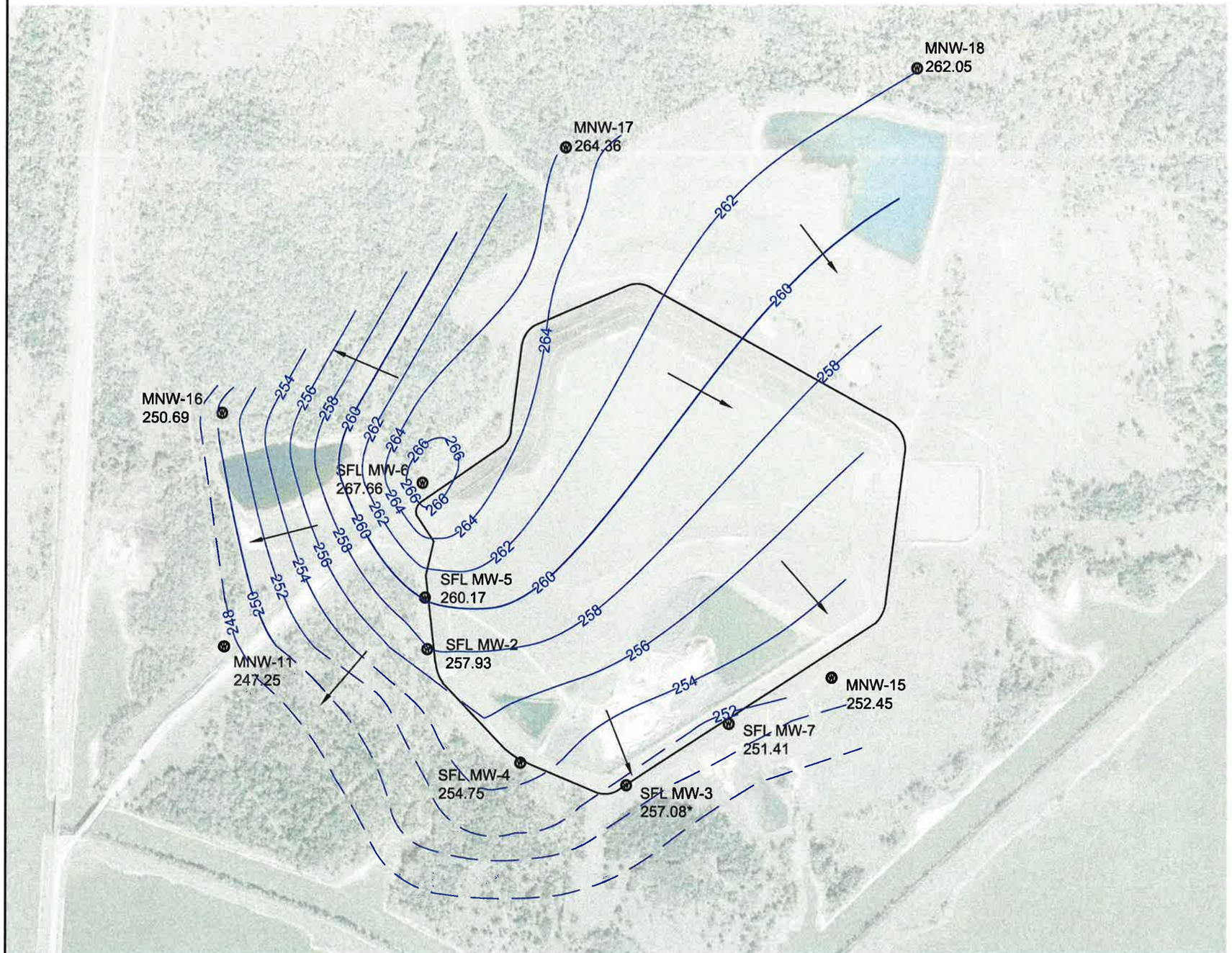
TEXAS ENGINEERING FIRM F-754

GIBBONS CREEK STEAM ELECTRIC STATION
GC ENVIRONMENTAL REDEVELOPMENT GROUP
ASH PONDS/SCRUBBER SLUDGE - FEBRUARY 2021 CONTOUR MAP

2021 GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

DATE
MAY 2021

FIGURE
FIGURE 4



N

600 0 600 1200

SCALE IN FEET

LEGEND:

- MONITORING WELL
- WASTE BOUNDARY
- GROUNDWATER CONTOUR
- INFERRED GROUNDWATER CONTOUR
- FLOW DIRECTION

NOTES:

1. " * " DENOTES STATIC WATER LEVEL WAS NOT UTILIZED IN GENERATION OF GROUNDWATER CONTOUR MAP DUE TO ANOMALOUS VALUE COMPARED TO SURROUNDING WELLS.

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
8/26/22

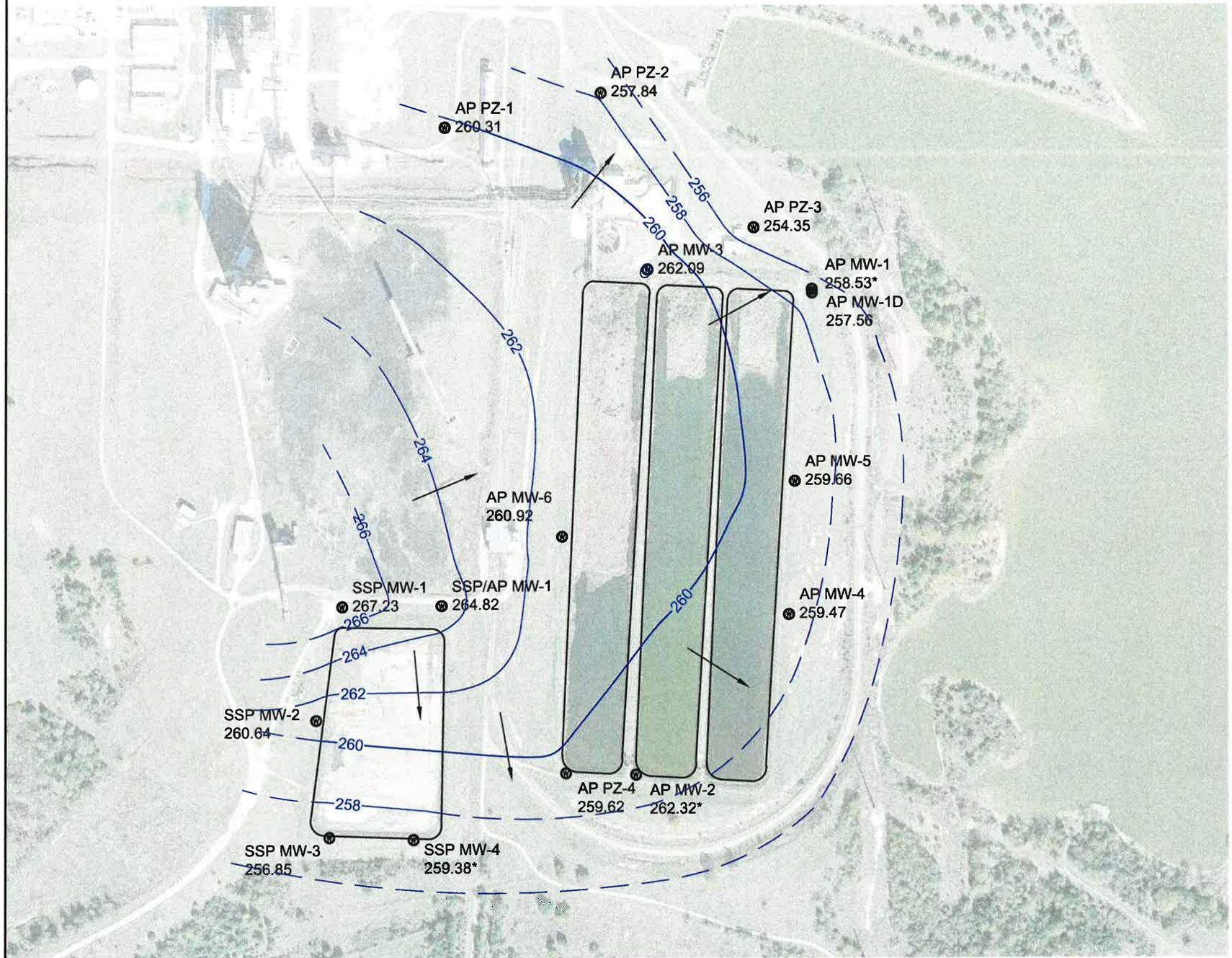
TEXAS ENGINEERING FIRM F-754

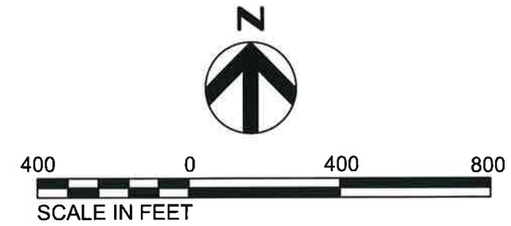
GIBBONS CREEK STEAM ELECTRIC STATION
GC ENVIRONMENTAL REDEVELOPMENT GROUP
SITE F LANDFILL - JULY 2021 CONTOUR MAP

2021 GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

DATE
AUGUST 2021

FIGURE
FIGURE 6





LEGEND:

- MONITORING WELL
- POND BOUNDARIES
- GROUNDWATER CONTOUR
- INFERRED GROUNDWATER CONTOUR
- FLOW DIRECTION

NOTES:

1. " * " DENOTES STATIC WATER LEVEL WAS NOT UTILIZED IN GENERATION OF GROUNDWATER CONTOUR MAP DUE TO ANOMALOUS VALUE COMPARED TO SURROUNDING WELLS.

TEXAS ENGINEERING FIRM F-754

GIBBONS CREEK STEAM ELECTRIC STATION
GC ENVIRONMENTAL REDEVELOPMENT GROUP
ASH PONDS/SCRUBBER SLUDGE - JULY 2021 CONTOUR MAP

2021 GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

DATE
AUGUST 2021

FIGURE
FIGURE 7

RESPONSE ITEM 23

ATTACHMENT

REVISED TABLE V.A

AP AND SSP DIMENSIONS AND CAPACITIES

Table I.6. – CCR Waste Management Units

CCR Unit No.[1]	Unit Name	N.O.R. No.[1]	Unit Description[3]	Capacity	Unit Status[2]
001	Site F Landfill	32271	Landfill	7,398,346 cy	Active
004	Scrubber Sludge Pond	32271	Surface Impoundment	190,000 cy (117.8 acre-feet)	Undergoing Closure by Removal
006	Ash Ponds A, B and C	32271	Surface Impoundment	720,000 cy (148.8 acre-ft)	Undergoing Closure by Removal

1 Registered Unit No. and N.O.R. No. cannot be reassigned to new units or used more than once.
2 Unit Status options: Active, Closed, Inactive (built but not managing waste), Proposed (not yet built), Never Built, Transferred, Post-Closure.
3 If a unit has been transferred, the applicant should indicate which facility/permit it has been transferred to in the Unit Description column.

Table V.A. – Surface Impoundment Characteristics

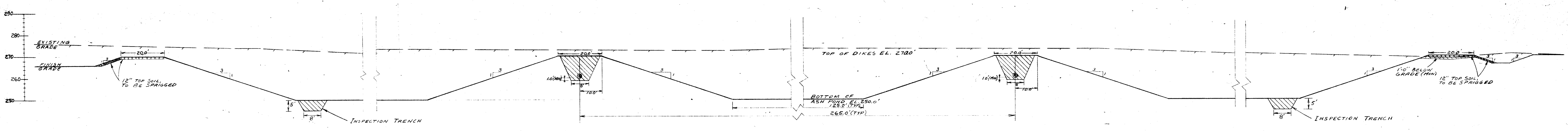
Registered Unit No.	Surface Impoundment Name	N.O.R. No.	Waste Nos.[1]	Rated Capacity	Dimensions[2]	Distance from lowest liner to groundwater	Action Leakage Rate (if required)	Unit will manage CCR Waste and non-CCR Waste (state all that apply)
2	Scrubber Sludge Pond	32271		190,000 cy (117.8 acre-feet)	750' x 425' x 20' 7.3 acres (total surface acreage)	8-feet	N/A	Unit is undergoing closure by removal and all CCR and non-CCR wastes are being removed and disposed at the Site F Landfill
6	Ash Ponds	32271		720,000 cy (148.8 acre-ft)	1820' x 245' x 20' (each Ash Pond) 30.7 acres (total surface acreage combined)	6-feet	N/A	Unit is undergoing closure by removal and all CCR and non-CCR wastes are being removed and disposed at the Site F Landfill

1 From Table I.6.A., first column
2 Dimensions should be provided as average length, width and depth, also include the surface acreage for the unit.

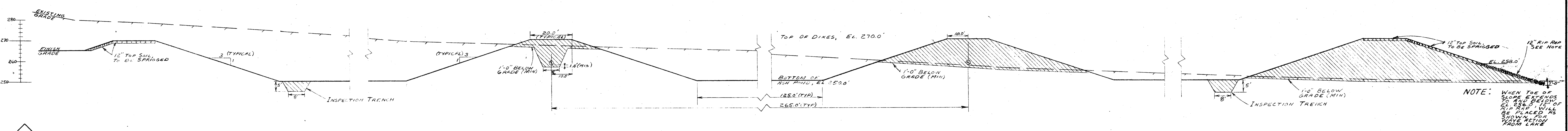
RESPONSE ITEM 24

ATTACHMENT

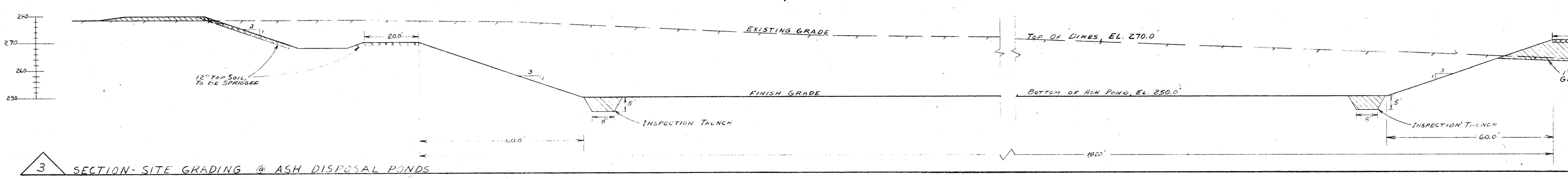
TMPA DRAWINGS



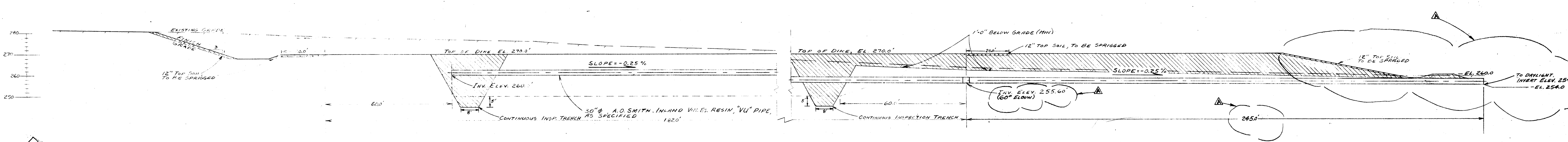
1 SECTION - SITE GRADING @ ASH DISPOSAL PONDS



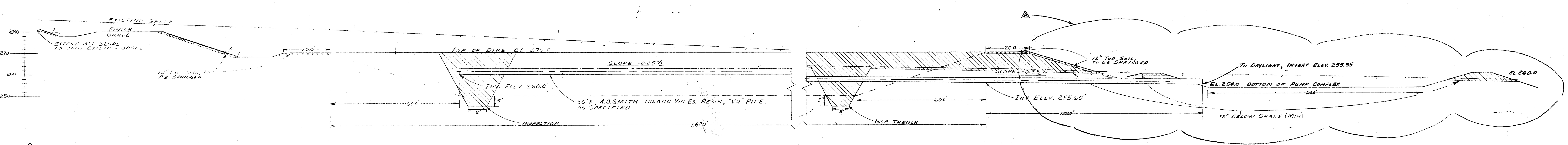
2 SECTION - SITE GRADING @ ASH DISPOSAL PONDS



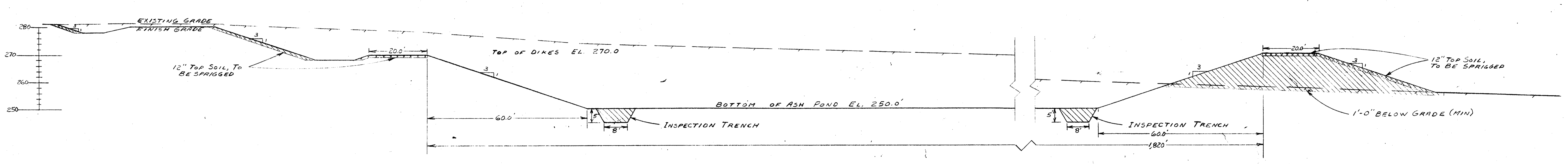
3 SECTION - SITE GRADING @ ASH DISPOSAL PONDS



4 SECTION - SITE GRADING @ ASH DISPOSAL PONDS



5 SECTION - SITE GRADING @ ASH DISPOSAL PONDS



6 SECTION - SITE GRADING @ ASH DISPOSAL PONDS

NOTES

REV	DATE	BY	DESCRIPTION
A	10-28-77	JLW	ADDED 30' OF PIPE TO SEC. 4 & 11' OF PIPE TO SEC. 5

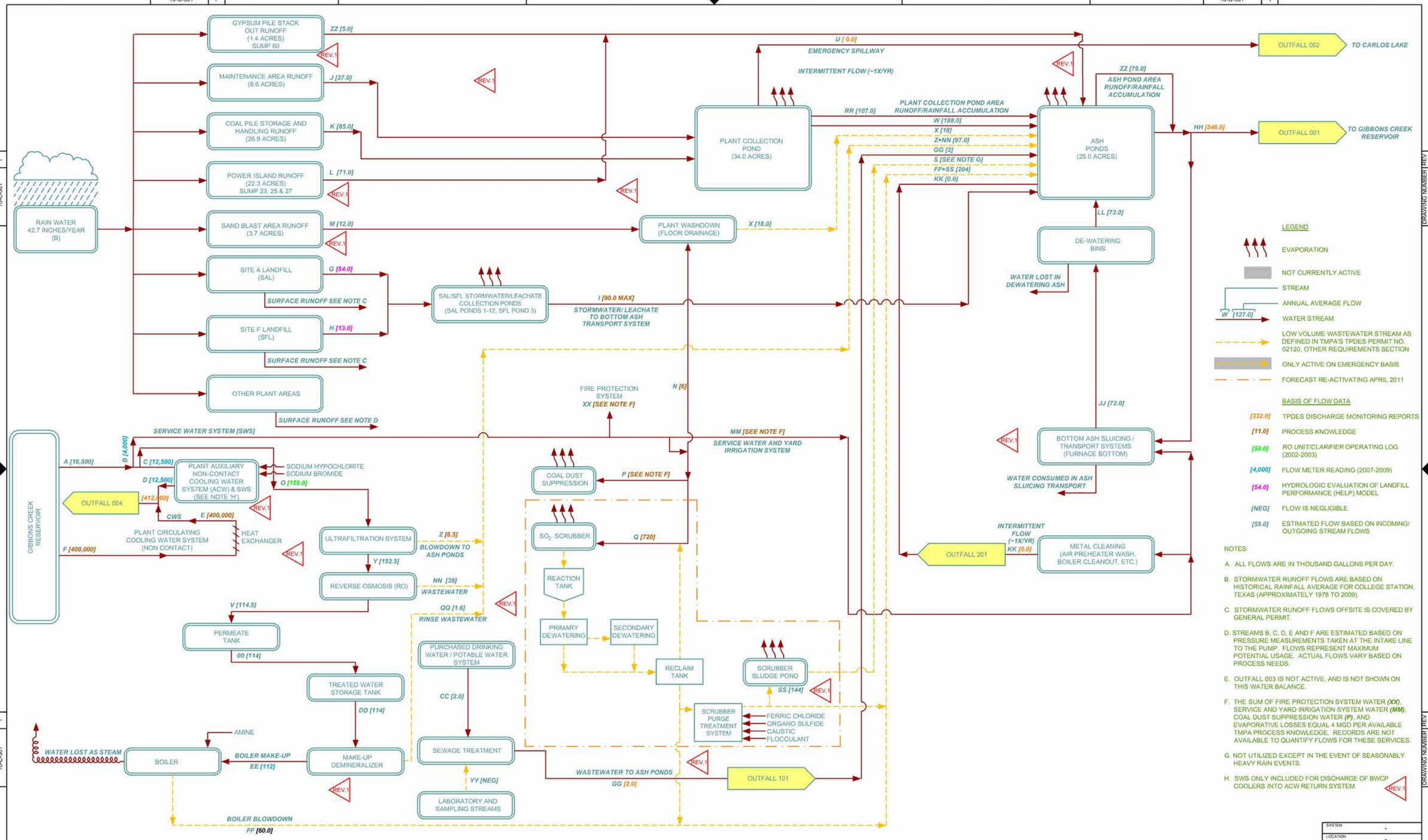
SCALE 1" = 20'
DRAWN JLW
DATE 4-21-77
CHECKED WGH
APPROVED WGH, JLW

TIPPETT & GEE, INC.
CONSULTING ENGINEERS
ABILENE TEXAS

GIBBONS CREEK S.E.S.
UNIT NO. 1
TEXAS MUNICIPAL POWER AGENCY

SECTIONS
SITE-GRADING

JOB NO. GC-1022
REV. A
DRAWING NUMBER C-2



REV	DATE	BY	APP	DESCRIPTION
1	02/17/2016	PR	KW	REVISED PER RED LINE, ABN 1626

NOTE:
1. This drawing was provided by ERM (Environmental Resource Management), September 24, 2010

TEXAS MUNICIPAL POWER AGENCY
PROUDLY SERVING THE TEXAS CITIES OF BRYAN, DENTON, GARLAND, GREENVILLE

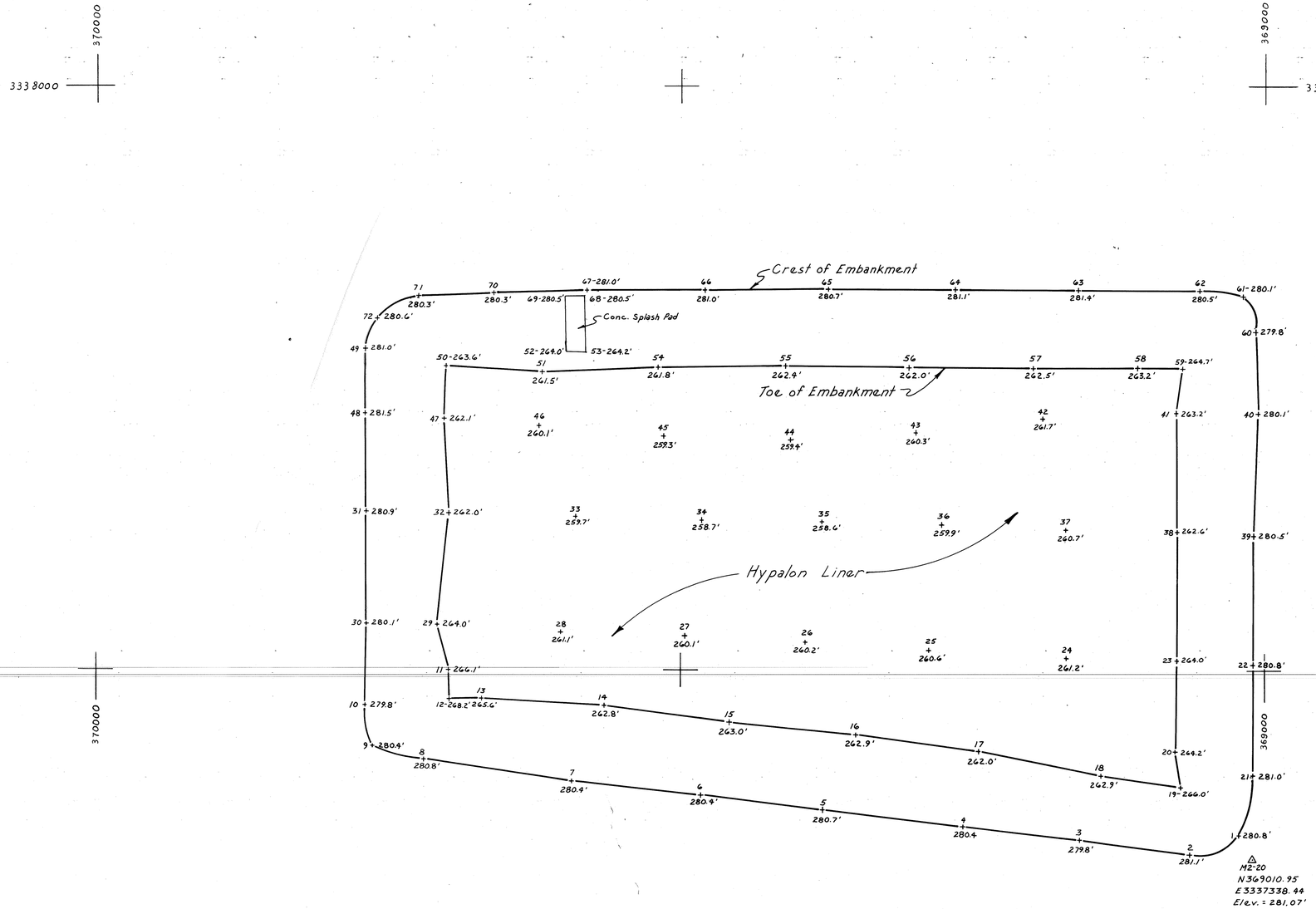
TMPA
WATER BALANCE
DIAGRAM

SYSTEM	-	
LOCATION	-	
SCALE: N.T.S.	SIZE D	DATE
DRAWN	PAR	08-15-13
DEPT.	PWRPR	08-15-13
CHECKED	JF	08-15-13
APPROVED	JF	08-15-13

PROPERTY OF TMPA

ABN NO.	REV
13443	1

DRAWING NO: 10-C-301



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3337359.381	3337474.072	3337588.462						
280.8000	268.1700	264.8200						
2.0000	13.0000	24.0000						
369863.6709	369669.9725	369179.4469						
3337343.775	3337476.993	3337512.858						
281.8700	265.5800	261.2100						
3.0000	14.0000	25.0000						
369167.4568	369565.1555	369287.1443						
3337356.102	3337469.796	3337517.682						
279.8100	262.8400	260.6000						
4.0000	15.0000	26.0000						
369267.2696	369457.8595	369393.4218						
3337367.664	3337456.848	3337524.848						
280.4000	263.0300	260.1800						
5.0000	16.0000	27.0000						
369377.3727	369350.1153	369496.3412						
3337381.380	3337445.848	3337529.770						
280.6600	262.8500	260.1400						
6.0000	17.0000	28.0000						
369483.2411	369244.5611	369604.4745						
3337393.590	3337431.242	3337533.191						
280.3600	262.0300	261.1400						
7.0000	18.0000	29.0000						
369593.2493	369137.9744	369708.3918						
3337405.693	3337411.604	3337539.482						
280.4200	262.8600	264.8100						
8.0000	19.0000	30.0000						
369729.2299	369872.6135	369768.5234						
3337424.188	3337408.657	3337539.771						
280.7800	266.0300	280.1300						
9.0000	20.0000	31.0000						
369762.7854	369876.8761	369767.9788						
3337435.772	3337431.158	3337636.757						
280.3900	264.1700	280.9100						
10.0000	21.0000	32.0000						
369770.4872	369885.4433	369698.2803						
3337475.916	3337412.381	3337635.875						
279.8400	280.9600	261.9800						
11.0000	22.0000	33.0000						
369698.6360	369808.8760	369598.5998						
3337560.396	3337506.633	3337632.381						
266.0900	280.8300	259.6800						

34.0000	45.0000	56.0000	67.0000					
369482.9465	369515.7558	369384.8985	369582.5532					
3337628.822	3337708.134	3337759.780	3337825.788					
258.7300	259.2700	261.9700	280.9900					
35.0000	46.0000	57.0000	68.0000					
369328.5112	369622.3975	369198.9978	369583.7787					
3337627.412	3337708.494	3337757.188	3337821.693					
258.6400	260.1200	262.5200	280.4700					
36.0000	47.0000	58.0000	69.0000					
369277.1258	369782.8315	369188.6582	369598.6868					
3337625.653	3337716.642	3337757.621	3337828.978					
259.9400	262.0700	263.2000	280.4600					
37.0000	48.0000	59.0000	70.0000					
369165.4811	369768.8340	369871.8498	369661.9942					
3337621.334	3337719.665	3337757.858	3337823.655					
260.6800	281.4900	264.7000	280.3400					
38.0000	49.0000	60.0000	71.0000					
369074.2725	369768.3766	369887.3879	369724.9342					
3337615.348	3337774.655	3337790.922	3337821.935					
262.5600	280.9000	-279.7600	280.2900					
39.0000	50.0000	61.0000	72.0000					
369008.1973	369702.2894	369818.3436	369762.2245					
3337616.272	3337761.868	3337821.579	3337802.377					
280.5400	263.5700	280.1000	280.6300					
40.0000	51.0000	62.0000						
369086.1150	369618.9639	369856.1540						
3337719.255	3337756.829	3337826.718						
280.0800	261.5100	280.5300						
41.0000	52.0000	63.0000						
369876.8498	369598.6664	369168.3908						
3337722.382	3337773.854	3337826.291						
263.2300	263.9600	281.3800						
42.0000	53.0000	64.0000						
369189.7483	369583.3352	369266.5332						
3337715.362	3337773.267	3337827.486						
261.7000	264.1700	281.1300						
43.0000	54.0000	65.0000						
369297.9878	369518.8188	369374.4830						
3337703.927	3337759.366	3337827.829						
260.2900	261.6700	280.7100						
44.0000	55.0000	66.0000						
369406.7338	369411.8413	369481.9448						
3337697.428	3337762.980	3337826.633						
255.4200	262.3800	281.0000						

NOTES
1. ON THE CHART TO THE RIGHT; THE FIRST NUMBER IS THE SURVEY POINT. THE SECOND AND THIRD NUMBERS SPECIFY THE LOCATION OF THAT POINT ON THE TEXAS STATE COORDINATE SYSTEM. THE FOURTH NUMBER IS THE ELEVATION OF THE SURVEY POINT ABOVE SEA LEVEL.

REV.	DATE	BY	DESCRIPTION
0	4/16/87	FJC	COPIED FROM NAVASOTA MINING DWG. / DATE SURVEYED 2/20/85

REV.	DATE	BY	DESCRIPTION

SCALE 1" = 50'
DRAWN FJC
DEPT. PWR ENG
DATE 4/16/87
CHECKED
APPROVED RWA

TMPA

TEXAS MUNICIPAL POWER AGENCY
SERVING THE CITIES OF
BRYAN • DENTON • GARLAND • GREENVILLE

SLUDGE POND SURVEY

JOB NO. GC-1050
REV. 0
DRAWING NO. 11-C-019.1

RESPONSE ITEM 25

ATTACHMENT

REVISED CLOSURE/POST-CLOSURE PLAN

3.0 CCR UNIT CLOSURE PLAN

The closure concept for this revised closure plan is to close the APs and SSP by removing the CCR and by leaving CCR in place at the SFL. Closure by removal procedures will comply with the requirements found in 40 CFR §257.102(c) for the surface impoundments. Closure of the landfill by leaving CCR material in place will comply with requirements in 40 CFR §257.102(d). This section describes the steps necessary to close the CCR units consistent with recognized and generally accepted good engineering practices and in accordance with 40 CFR§257.102(b), including:

A written closure plan for each CCR unit is required by 40 CFR 256.102(b). Each closure plan is required to include:

- the closure performance standard;
- a narrative description of the closure;
- a description of the procedures to remove the CCR and decontaminate the CCR unit;
- a description of the final cover system;
- the maximum CCR inventory;
- the maximum area covered; and,
- the closure schedule.

The CCR unit closure plan is described in this section.

3.1 CLOSURE PERFORMANCE STANDARDS

The performance standards for closure by removal of CCR for the surface impoundments is in accordance with 40 CFR §257.102(c)(closure by removal).

The performance standards for closure by leaving CCR in place at the landfill is in place in accordance with 40 CFR §257.102(d)(closure in place).

3.1.1 Closure By Removal

GCERG will close the APs and SSP by removing the CCR material in accordance with the performance standards stated in 40 CFR §257.102(c):

- *Remove and decontaminate all areas affected by releases from the CCR unit.*
- *Groundwater monitoring concentrations do not exceed the groundwater protection standard established pursuant to §257.95(h) for constituents listed in appendix IV to this part.*

3.1.2 Closure In Place

GCERG will close the Site F Landfill by leaving CCR in place and constructing a final cover system in accordance with the performance standards stated in 40 CFR §257.102(d)~~(1)~~:

- *Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;*
- *Preclude the probability of future impoundment of water, sediment, or slurry;*
- *Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;*
- *Minimize the need for further maintenance of the CCR unit; and,*

- *Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.*

~~In addition, requirements for closure of the CCR unit using TRRP Remedy Standard B in accordance with 30 TAC §350 will also apply to closure of a CCR unit by leaving CCR in place.~~

3.2 NARRATIVE DESCRIPTION OF CLOSURE BY REMOVAL

Closure by removal of CCR at the surface impoundments will be accomplished in steps related to the closure performance standard 40 CFR §257.102(c).

3.2.1 Description of Closure by Removal

Remove Liquids: Free liquids will be eliminated by removing liquid wastes and/or solidifying the remaining CCR and CCR residues in the CCR unit.

- Liquids may be pumped from SSP to APs or from APs to SSD to dewater the CCR unit.
- Liquids may be pumped from APs, SSP, and/or SFL and discharged to the reservoir in accordance with the TPDES permit. If treatment is required, liquids will be treated before discharge.
- Liquids may be transferred from SSP and APs to SFL and evaporated by pumping it through an evaporator (atomizer) system and spraying over CCR material.
- Coagulants, flocculants, and/or chemical stabilizers may be mixed with the scrubber sludge to promote dewatering and solidification.

Remove CCR Material: Once the ponds have been sufficiently dewatered, CCR material and any contaminated soil and sediment will be mechanically excavated with standard earthmoving equipment. The excavated material will be hauled by trucks to the SFL for disposal. The pond will be visually inspected to verify all CCR materials and any contaminated soils and sediment have been removed from the impoundment.

Stabilization: After the CCR material has been removed, the area will be seeded to establish vegetation and stabilize the bare soils. Additional surface grading, spillways, outfalls, berms, swales, and other measures may be installed to minimize erosion and control stormwater.

Conceptual representations of the APs and SSP grading plans are presented in Figures 2 through 3.

3.3 NARRATIVE DESCRIPTION OF CLOSURE IN PLACE

Closure of the SFL will be accomplished in steps related to the closure performance standard (40 CFR §257.102(d)), the characteristics of the bottom liner, the CCR properties contained in the landfill, and the surrounding area.

~~In addition, requirements for closure of the CCR unit using TRRP Remedy Remedy Standard B for closure in place in accordance with 30 TAC §350 will also be implemented for the closure chosen by TMPA.~~

3.3.1 Description of Closure In Place

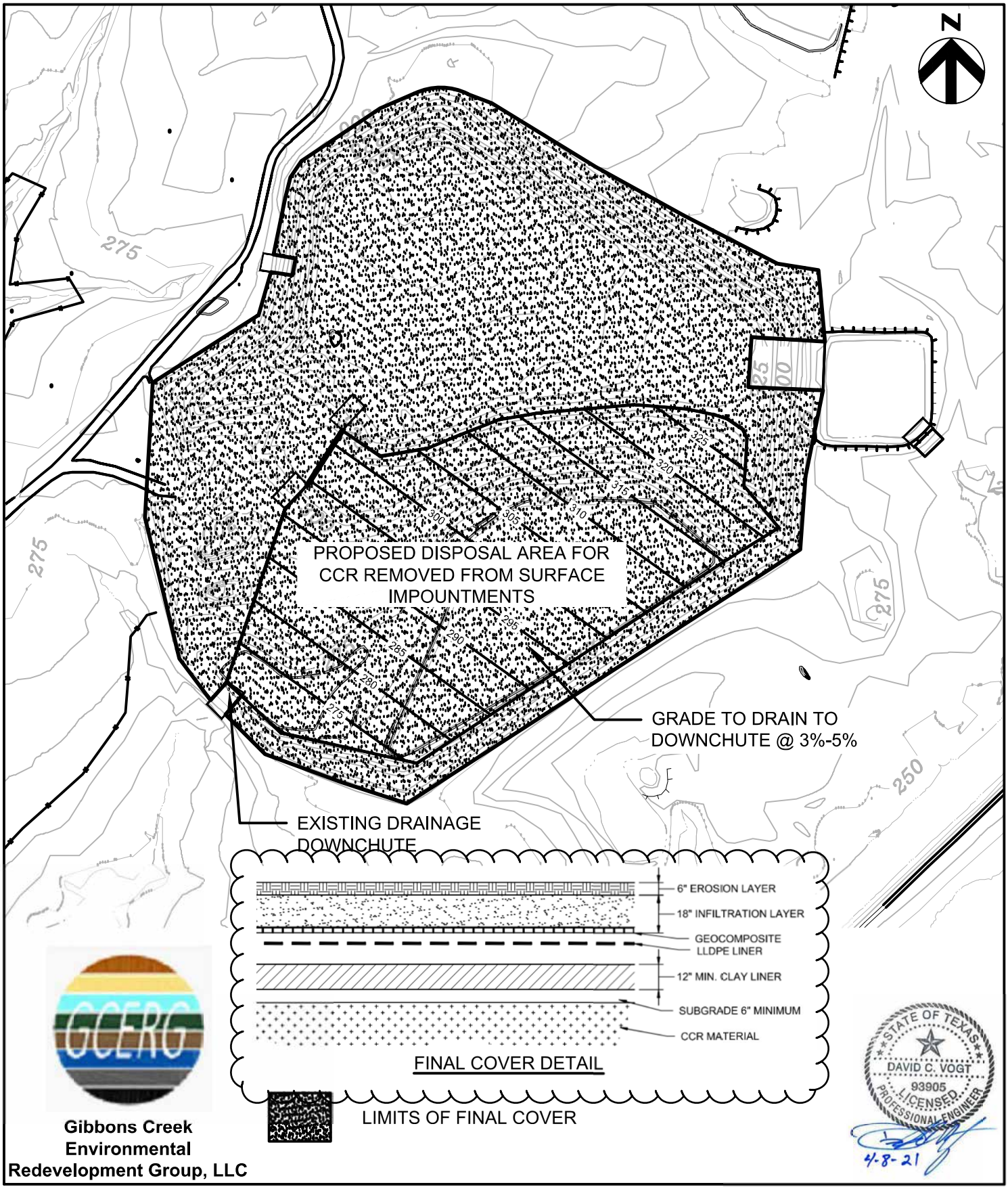
The SFL at the GCSES will be closed by leaving CCR in place (closure in place), the closure will be accomplished in the following steps:

~~TRRP Planning Deliverables: GCERG will prepare, submit to the TCEQ, and obtain TCEQ approval of an Affected Property Assessment Report (APAR) and Response Action Plan (RAP) for closure of the SFL in accordance with Remedy Standard B and related rules in 30 TAC §350.~~

RESPONSE ITEM 26

ATTACHMENT

REVISED LANDFILL CAP DETAIL



GCERG

Gibbons Creek Environmental Redevelopment Group, LLC

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
4-8-21

HDR

Gibbons Creek Electric Station

SITE "F" LANDFILL

DATE
04/2021

FIGURE
2

RESPONSE ITEM 27

ATTACHMENT

ESC PLAN

Gibbons Creek Environmental Redevelopment Group, LLC

Erosion and Sediment Control Plan

For Compliance with the Coal Combustion Residuals Rule
(40 CFR Part 257.102)

Gibbons Creek Steam Electric Station

Anderson, Texas

June 28, 2021

6/28/2021

Calculation Cover Sheet

Client:	Charah Solutions		
Project:	**Gibbons Creek Site F Landfill Erosion and Sediment Control**		
Project No:	10290148	Rev:	0
Title:	Modified Site F Cap Erosion and Sediment Control	Page:	1 of 6
Purpose:	Site F landfill has been conceptually regraded to allow for the disposal of CCR from impoundments elsewhere on the site. The revised landfill cap and its existing outfalls require a new hydraulic analysis to determine what improvements, if any, need to be made to the site to facilitate the drainage and stabilization of stormwater from the landfill area.		

Originator:	David C. Vogt, PE and Patrick D. Brownson	Computed:	6/28/2021
Checked by:	Philip A. Westmoreland	Checked:	6/28/2021

Objective

Locate and design the necessary sediment basins to capture stormwater flow across the mine site while observing buffers.

References

Elements of Urban Stormwater Design, Malcom, H. Rooney (1989 & 2003 Supplement), NC State Univ., Raleigh, NC.

TCEQ Regulatory Guidance RG-417: Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill, Texas Commission on Environmental Quality – Waste Permits Division (Rev. May 2018), Austin, TX.

HydroCAD Stormwater Modeling System, Version 10.0, HydroCAD Software Solutions, LLC (2019). Chororua, New Hampshire.

Perica, Sanja, et. al., “NOAA Atlas 14, Volume 11, Version 2, Point Precipitation Frequency Estimates”, NOAA National Weather Service, obtained June 3, 2021.

Assumptions

There are existing concrete downchutes that function as stormwater outfalls from the existing Pond 1 and around the perimeter of the landfill that will be maintained through the regrading of the landfill.

Runoff was conservatively computed assuming there is bare soil in Hydrologic Soil Group D according to the United States Department of Agriculture (USDA) Natural Resources Conservation Service’s (NRCS) Web Soil Survey. These assumptions generated a curve number of 94 for all drainage areas (see Attachment 1). In addition, times of concentration were conservatively modeled using the minimum value of six (6) minutes as specified by the NRCS Technical Release 55 (TR-55).

The analysis is based on the 25 year-24 hour design storm as defined by the NOAA Atlas 14, Volume 11, Version 2 for Anderson, TX. The depth of rainfall for this design storm is 9.02 inches (see Attachment 2).

Analysis

HDR used the following approach to check, and revise if necessary, the designs for each stormwater management device for the revised Site F Landfill Cap:

1. The site was broken up into individual drainage areas by identifying high points, ridge lines, and areas where water would naturally begin to collect. The landfill is designed to have an upper and a lower plateau, with a distinct ridgeline separating the landfill into east and west sections. The east sections drain to the existing sediment basin, Pond 1. The west sections drain out via concrete downchutes to baffled spillways that run off into the wooded areas to the south of the site. Both the discharges from Pond 1 and via overland flow to the south of the site reach the nearby Gibbons Creek Reservoir.
2. With the drainage areas identified, the runoff on each plateau needed to be sent either to the east, to Pond 1, or to the west to the southern outfalls. This was accomplished through diversion berms around the top deck of each plateau and through the installation of perimeter channels around the landfill base. These reaches were designed in HydroCAD by routing the design storm runoff for each drainage area to the channels and checking them for a minimum of one (1) foot of freeboard as well as flow velocities no greater than 5 feet per second, the TCEQ definition of "erosive."
3. Channels, downchutes, and the pond were all determined to have adequate capacity as well as acceptable discharge velocities according to the guidelines set forth in the TCEQ's *Regulatory Guidance RG-417: Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill.*

Calculations

All calculations were performed using HydroCAD software. The model and outputs are included in Attachment 3.

Conclusions

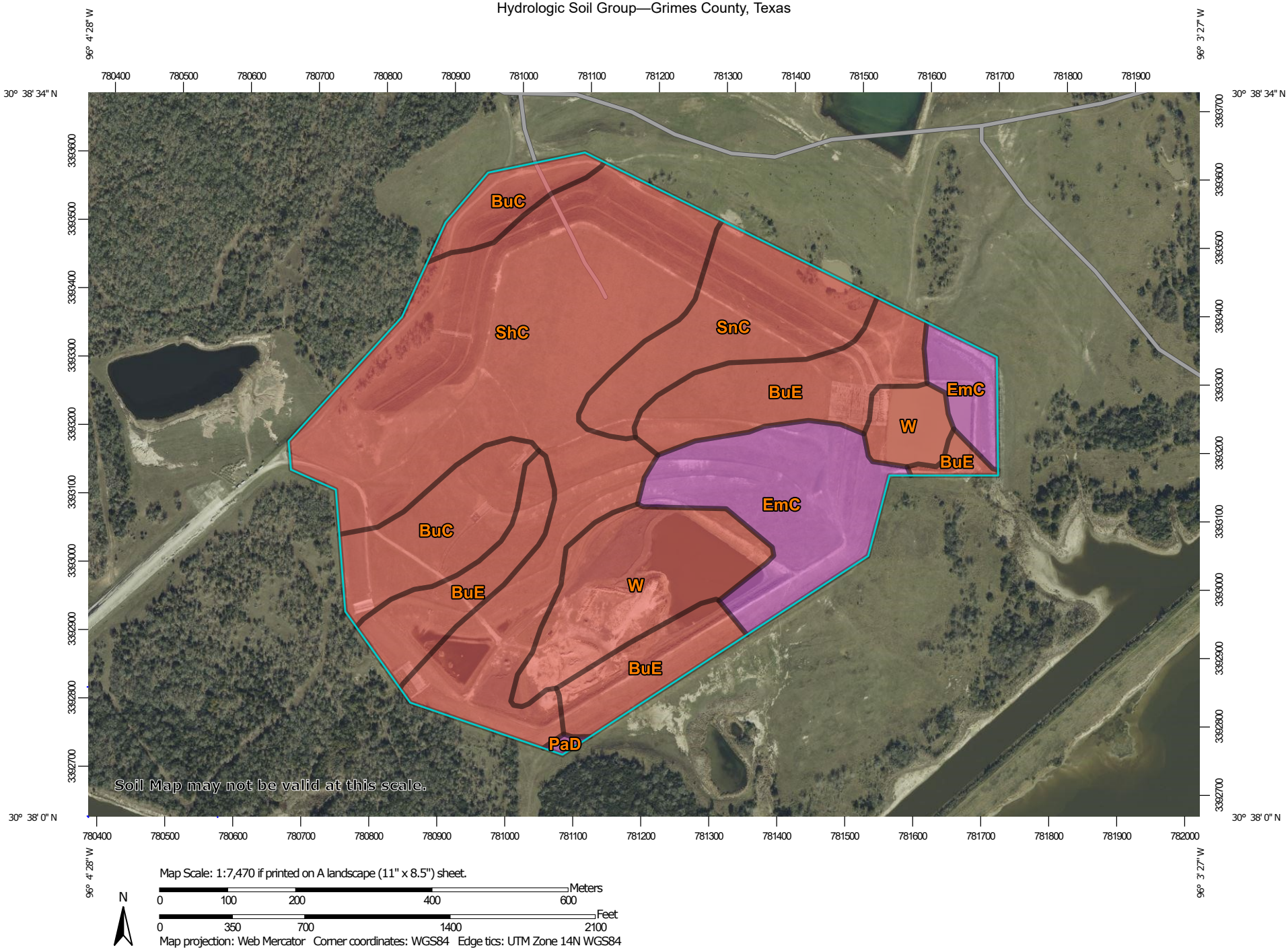
The combination of the perimeter channels, diversion berms, concrete downchutes, and sediment basin at the site effectively capture, direct, detain, stabilize, and carefully discharge stormwater flows at the site, controlling sediment and preventing erosion.

Attachments

- Attachment 1: NRCS Web Soil Survey
- Attachment 2: NOAA Precipitation Frequency Data
- Attachment 3: HydroCAD Report

Attachment 1: NRCS Web Soil Survey

Hydrologic Soil Group—Grimes County, Texas



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 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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: Grimes County, Texas
Survey Area Data: Version 16, Jun 11, 2020

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

Date(s) aerial images were photographed: Dec 14, 2019—Dec 18, 2019

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
BuC	Burlewash fine sandy loam, 1 to 5 percent slopes	D	13.0	9.3%
BuE	Burlewash fine sandy loam, 5 to 12 percent slopes	D	23.8	17.2%
EmC	Elmina loamy fine sand, 1 to 5 percent slopes	A	18.7	13.5%
PaD	Padina loamy fine sand, 1 to 8 percent slopes	A	0.2	0.2%
ShC	Shiro loamy fine sand, 1 to 5 percent slopes	D	53.1	38.3%
SnC	Singleton fine sandy loam, 1 to 5 percent slopes	D	13.1	9.5%
W	Water	D	16.7	12.0%
Totals for Area of Interest			**138.6**	**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 2: NOAA Precipitation Frequency Data

hdrinc.com 440 S Church Street, Suite 1000, Charlotte, NC 28202-2075
704.338.6700

NOAA Atlas 14, Volume 11, Version 2
Location name: Anderson, Texas, USA*
Latitude: 30.6215°, Longitude: -96.0845°
Elevation: 283.2 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

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	0.462 (0.350-0.610)	0.534 (0.409-0.702)	0.655 (0.500-0.862)	0.753 (0.565-1.00)	0.886 (0.642-1.21)	0.984 (0.696-1.39)	1.08 (0.747-1.57)	1.19 (0.799-1.77)	1.33 (0.864-2.05)	1.44 (0.912-2.27)
10-min	0.735 (0.556-0.971)	0.851 (0.652-1.12)	1.05 (0.797-1.38)	1.20 (0.903-1.60)	1.42 (1.03-1.95)	1.58 (1.12-2.23)	1.74 (1.20-2.52)	1.90 (1.27-2.82)	2.10 (1.37-3.23)	2.25 (1.43-3.56)
15-min	0.928 (0.703-1.23)	1.07 (0.821-1.41)	1.31 (0.998-1.72)	1.50 (1.13-2.00)	1.76 (1.28-2.41)	1.96 (1.38-2.75)	2.15 (1.48-3.11)	2.35 (1.58-3.50)	2.63 (1.71-4.04)	2.84 (1.80-4.48)
30-min	1.32 (0.995-1.74)	1.51 (1.16-1.99)	1.84 (1.40-2.42)	2.10 (1.58-2.80)	2.46 (1.78-3.36)	2.71 (1.92-3.82)	2.98 (2.05-4.31)	3.27 (2.20-4.86)	3.67 (2.39-5.66)	4.00 (2.53-6.31)
60-min	1.72 (1.30-2.27)	1.99 (1.52-2.61)	2.43 (1.86-3.20)	2.80 (2.10-3.73)	3.29 (2.38-4.49)	3.65 (2.57-5.13)	4.02 (2.78-5.83)	4.45 (2.99-6.62)	5.06 (3.29-7.80)	5.57 (3.52-8.78)
2-hr	2.08 (1.58-2.73)	2.47 (1.89-3.20)	3.10 (2.38-4.04)	3.64 (2.75-4.81)	4.38 (3.19-5.96)	4.96 (3.52-6.93)	5.58 (3.86-8.01)	6.29 (4.25-9.28)	7.33 (4.78-11.2)	8.21 (5.21-12.8)
3-hr	2.28 (1.74-2.98)	2.76 (2.11-3.54)	3.52 (2.70-4.57)	4.18 (3.17-5.51)	5.13 (3.75-6.95)	5.88 (4.19-8.19)	6.70 (4.66-9.58)	7.65 (5.18-11.2)	9.05 (5.91-13.7)	10.2 (6.51-15.9)
6-hr	2.63 (2.02-3.41)	3.27 (2.50-4.12)	4.25 (3.27-5.46)	5.13 (3.91-6.72)	6.43 (4.74-8.66)	7.50 (5.38-10.4)	8.70 (6.07-12.3)	10.1 (6.84-14.6)	12.1 (7.95-18.2)	13.8 (8.85-21.3)
12-hr	2.99 (2.31-3.85)	3.79 (2.88-4.69)	4.95 (3.83-6.31)	6.04 (4.64-7.87)	7.70 (5.73-10.3)	9.12 (6.59-12.6)	10.7 (7.53-15.1)	12.6 (8.59-18.1)	15.4 (10.1-22.9)	17.7 (11.4-27.0)
24-hr	3.38 (2.63-4.33)	4.34 (3.30-5.30)	5.70 (4.44-7.21)	7.01 (5.41-9.06)	9.02 (6.77-12.0)	10.8 (7.86-14.8)	12.8 (9.03-17.9)	15.1 (10.3-21.5)	18.5 (12.2-27.3)	21.4 (13.8-32.3)
2-day	3.83 (3.00-4.88)	4.96 (3.79-6.00)	6.54 (5.12-8.22)	8.07 (6.27-10.4)	10.4 (7.90-13.9)	12.6 (9.21-17.1)	14.9 (10.6-20.6)	17.5 (12.0-24.7)	21.2 (14.0-30.9)	24.2 (15.6-36.1)
3-day	4.17 (3.28-5.29)	5.38 (4.14-6.50)	7.09 (5.58-8.89)	8.74 (6.81-11.2)	11.3 (8.54-14.9)	13.5 (9.92-18.3)	16.0 (11.3-22.0)	18.6 (12.8-26.1)	22.4 (14.9-32.4)	25.4 (16.5-37.7)
4-day	4.46 (3.52-5.65)	5.70 (4.42-6.92)	7.49 (5.92-9.37)	9.18 (7.18-11.7)	11.7 (8.92-15.5)	14.0 (10.3-18.8)	16.4 (11.7-22.5)	19.1 (13.2-26.8)	23.0 (15.3-33.1)	26.1 (16.9-38.5)
7-day	5.16 (4.09-6.50)	6.44 (5.06-7.85)	8.33 (6.62-10.4)	10.1 (7.91-12.8)	12.6 (9.61-16.5)	14.8 (10.9-19.7)	17.2 (12.3-23.4)	19.9 (13.8-27.6)	23.8 (15.9-34.1)	27.1 (17.6-39.6)
10-day	5.74 (4.57-7.21)	7.05 (5.59-8.63)	9.04 (7.22-11.3)	10.8 (8.52-13.7)	13.4 (10.2-17.4)	15.5 (11.5-20.6)	17.9 (12.8-24.2)	20.5 (14.3-28.5)	24.5 (16.4-35.0)	27.9 (18.1-40.6)
20-day	7.52 (6.02-9.38)	8.98 (7.23-11.0)	11.3 (9.10-14.0)	13.3 (10.5-16.7)	16.1 (12.3-20.7)	18.3 (13.5-24.0)	20.6 (14.9-27.7)	23.2 (16.3-31.9)	27.0 (18.2-38.1)	30.1 (19.7-43.3)
30-day	9.03 (7.27-11.2)	10.6 (8.63-13.1)	13.2 (10.7-16.3)	15.4 (12.2-19.2)	18.3 (14.1-23.4)	20.6 (15.3-26.9)	23.0 (16.6-30.7)	25.5 (17.9-34.8)	29.0 (19.6-40.7)	31.7 (20.8-45.4)
45-day	11.3 (9.14-14.0)	13.1 (10.7-16.1)	16.0 (13.0-19.7)	18.3 (14.7-22.8)	21.5 (16.5-27.3)	23.8 (17.7-30.9)	26.1 (18.9-34.7)	28.5 (20.0-38.6)	31.6 (21.4-44.1)	34.0 (22.3-48.3)
60-day	13.4 (10.9-16.6)	15.3 (12.6-18.9)	18.5 (15.1-22.8)	21.0 (16.8-26.1)	24.3 (18.7-30.8)	26.6 (19.9-34.5)	28.9 (20.9-38.2)	31.0 (21.9-42.0)	33.9 (23.0-47.0)	35.9 (23.6-50.8)

[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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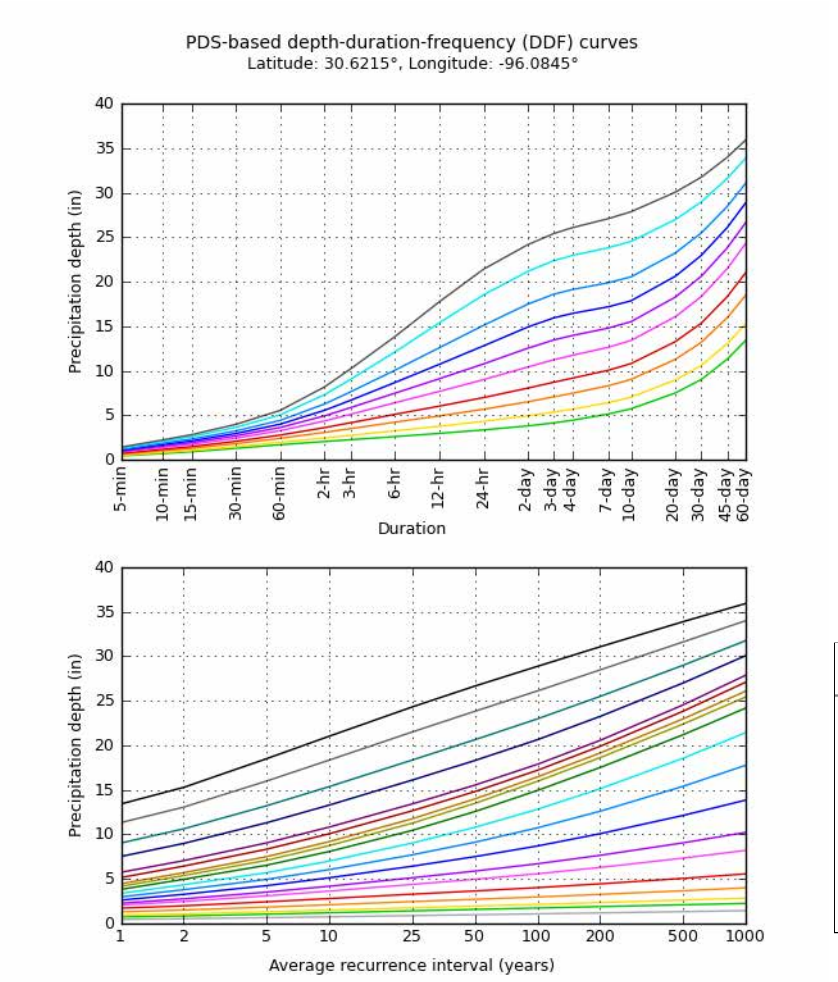
PF graphical



NOAA Atlas 14, Volume 11, Version 2

Created (GMT): Thu Jun 3 12:34:38 2021

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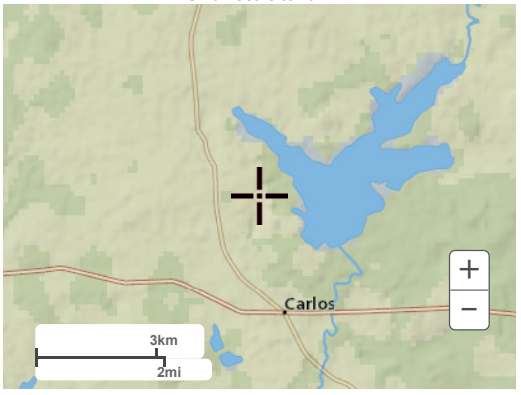
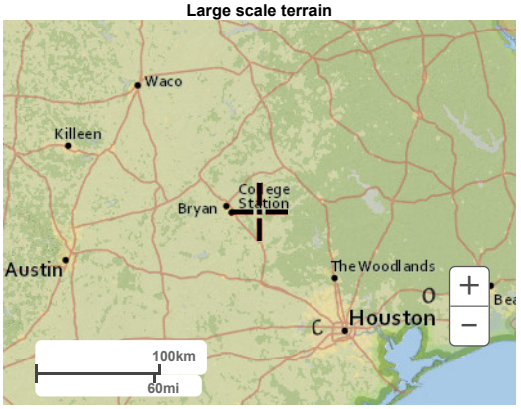
Maps & aerials

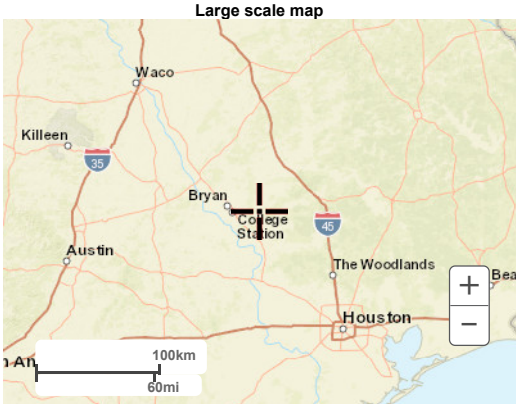
Small scale terrain



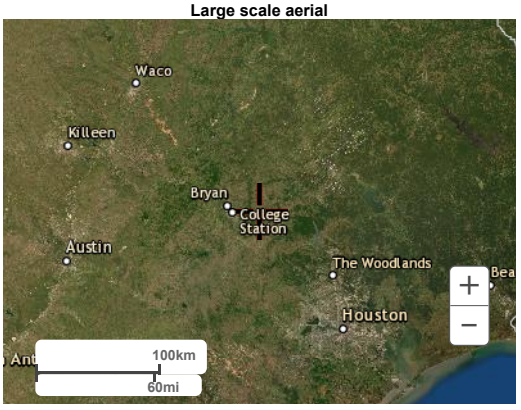
Large scale terrain



Large scale map



Large scale aerial



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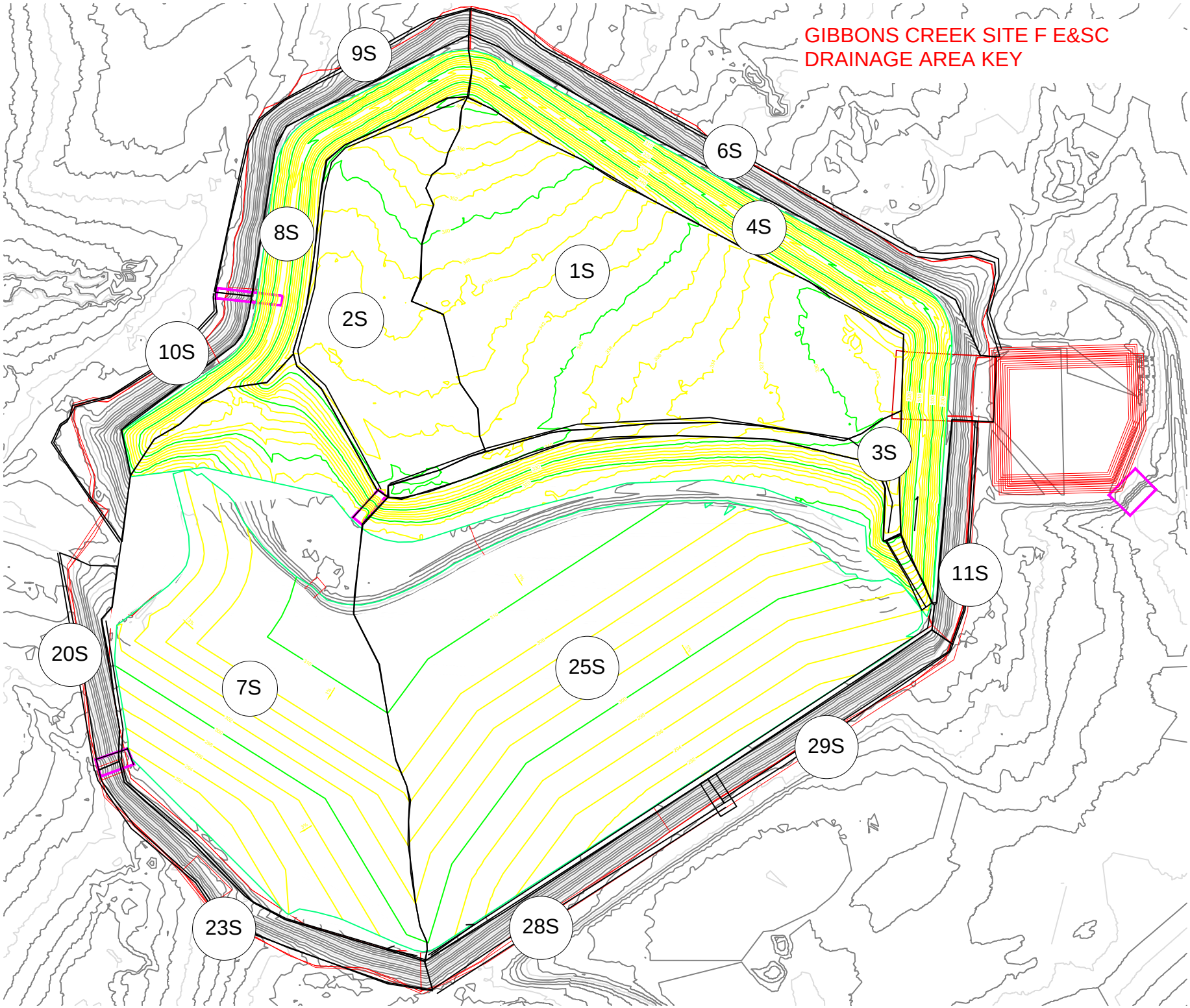
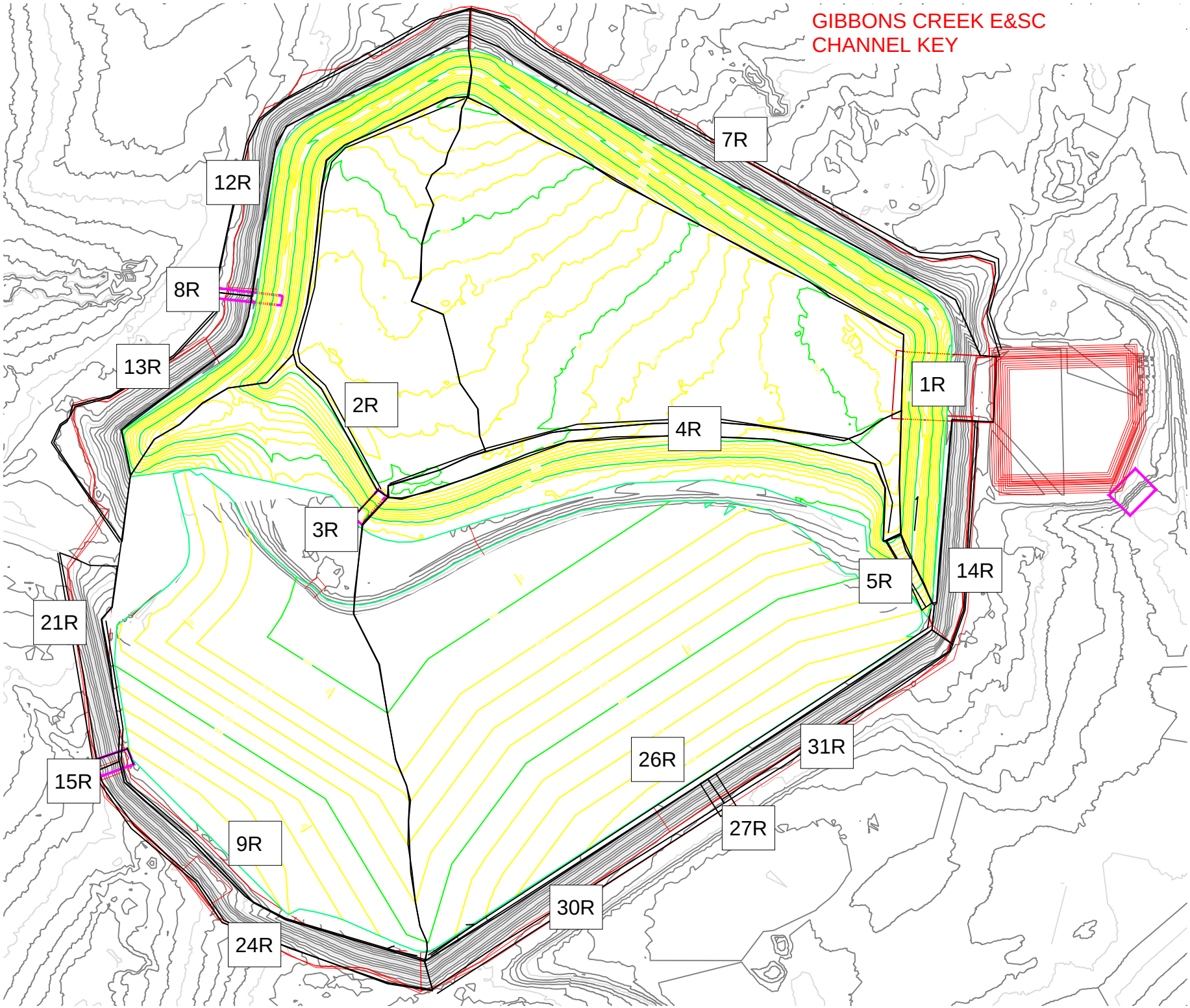
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

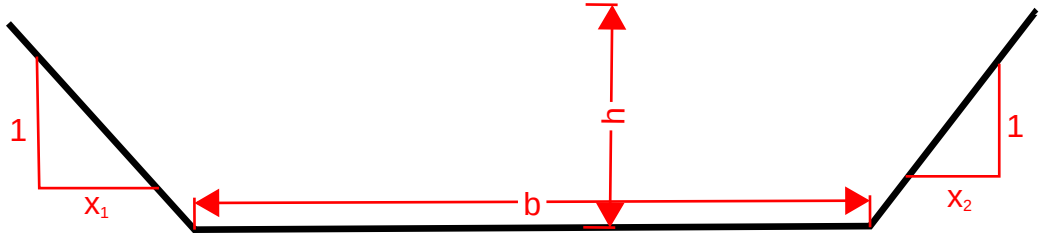
Attachment 3: HydroCAD Report

hdrinc.com 440 S Church Street, Suite 1000, Charlotte, NC 28202-2075
704.338.6700

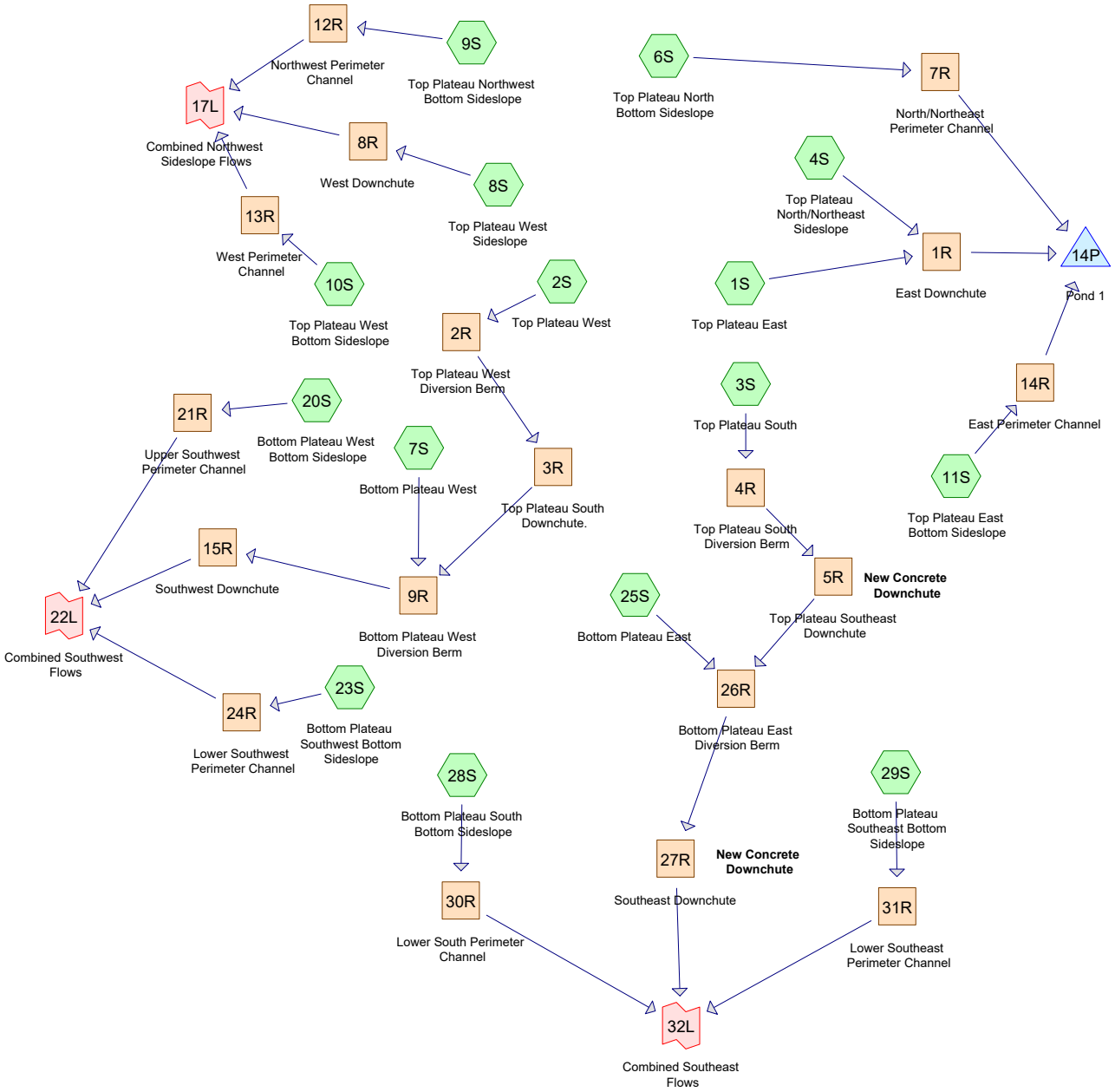

GIBBONS CREEK SITE F E&SC
DRAINAGE AREA KEY
9S
6S
8S
4S
1S
2S
10S
3S
11S
20S
25S
7S
29S
23S
28S


GIBBONS CREEK E&SC
CHANNEL KEY
7R
12R
8R
13R
2R
4R
1R
3R
5R
14R
21R
15R
26R
31R
27R
9R
30R
24R

CHANNEL SCHEDULE



Channel ID	Channel Type	b (ft)	h (ft)	x_1 (ft)	x_2 (ft)	Slope (%)	Channel Lining
1R	Downchute	200	1.5	3	3	20	Concrete
2R	Top Plateau Diversion Berm	0	3.5	3	2	1.5	ECB
3R	Downchute	25	1.5	3	3	15	Concrete
4R	Top Plateau Diversion Berm	0	3.5	3	2	1.5	ECB
5R	Downchute	40	1.5	3	3	12	Concrete
7R	Perimeter Channel	0	3	3	3	1	ECB
8R	Downchute	25	1.5	3	3	24	Concrete
9R	Bttm. Plateau Diversion Berm	0	7	3	2	1	ECB
12R	Perimeter Channel	0	3	3	3	1	ECB
13R	Perimeter Channel	0	3	3	3	1	ECB
14R	Perimeter Channel	0	3	3	3	1	ECB
15R	Downchute	50	1.5	3	3	26	Concrete
21R	Perimeter Channel	0	3	3	3	3	ECB
24R	Perimeter Channel	0	3	3	3	1	ECB
26R	Bttm. Plateau Diversion Berm	0	7	3	2	1	ECB
27R	Downchute	50	1.5	3	3	20	Concrete
30R	Perimeter Channel	0	3	3	3	1	ECB
31R	Perimeter Channel	0	3	3	3	1	ECB



Routing Diagram for Charah Gibbons Creek Site F ESC REGRADED
Prepared by HDR, Inc, Printed 6/25/2021

Project Notes

Rainfall events imported from "Charah Gibbons Creek Site F ESC.hcp"

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
114.204	94	Fallow, bare soil, HSG D (1S, 2S, 3S, 4S, 6S, 7S, 8S, 9S, 10S, 11S, 20S, 23S, 25S, 28S, 29S)
114.204	**94**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
114.204	HSG D	1S, 2S, 3S, 4S, 6S, 7S, 8S, 9S, 10S, 11S, 20S, 23S, 25S, 28S, 29S
0.000	Other	
114.204		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	114.204	0.000	114.204	Fallow, bare soil	1S, 2S, 3S, 4S, 6S, 7S, 8S, 9S, 10S, 11S, 20S, 23S, 25S, 28S, 29S
0.000	**0.000**	**0.000**	**114.204**	**0.000**	**114.204**	**TOTAL AREA**	

Time span=0.00-96.00 hrs, dt=0.01 hrs, 9601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Top Plateau East Runoff Area=808,760 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=236.14 cfs 12.837 af

Subcatchment2S: Top Plateau West Runoff Area=355,269 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=103.73 cfs 5.639 af

Subcatchment3S: Top Plateau South Runoff Area=79,119 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=23.10 cfs 1.256 af

Subcatchment4S: Top Plateau Runoff Area=357,237 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=104.30 cfs 5.670 af

Subcatchment6S: Top Plateau North Runoff Area=127,070 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=37.10 cfs 2.017 af

Subcatchment7S: Bottom Plateau West Runoff Area=1,022,944 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=298.67 cfs 16.237 af

Subcatchment8S: Top Plateau West Runoff Area=208,646 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=60.92 cfs 3.312 af

Subcatchment9S: Top Plateau Northwest Runoff Area=89,298 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=26.07 cfs 1.417 af

Subcatchment10S: Top Plateau West Runoff Area=92,560 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=27.02 cfs 1.469 af

Subcatchment11S: Top Plateau East Runoff Area=48,135 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=14.05 cfs 0.764 af

Subcatchment20S: Bottom Plateau West Runoff Area=53,199 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=15.53 cfs 0.844 af

Subcatchment23S: Bottom Plateau Runoff Area=84,299 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=24.61 cfs 1.338 af

Subcatchment25S: Bottom Plateau East Runoff Area=1,507,374 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=440.11 cfs 23.926 af

Subcatchment28S: Bottom Plateau South Runoff Area=75,491 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=22.04 cfs 1.198 af

Subcatchment29S: Bottom Plateau Runoff Area=65,341 sf 0.00% Impervious Runoff Depth=8.30"
Tc=6.0 min CN=94 Runoff=19.08 cfs 1.037 af

Reach 1R: East Downchute Avg. Flow Depth=0.15' Max Vel=11.08 fps Inflow=340.44 cfs 18.507 af
n=0.017 L=300.0' S=0.1967 '/' Capacity=15,333.40 cfs Outflow=339.33 cfs 18.507 af

Reach 2R: Top Plateau West Avg. Flow Depth=2.17' Max Vel=8.21 fps Inflow=103.73 cfs 5.639 af
n=0.022 L=1,430.0' S=0.0147 '/' Capacity=345.90 cfs Outflow=96.77 cfs 5.639 af

Reach 3R: Top Plateau South Avg. Flow Depth=0.27' Max Vel=13.97 fps Inflow=96.77 cfs 5.639 af
n=0.017 L=110.0' S=0.1545 '/' Capacity=1,795.50 cfs Outflow=96.65 cfs 5.639 af

Reach 4R: Top Plateau South Avg. Flow Depth=1.26' Max Vel=4.92 fps Inflow=23.10 cfs 1.256 af
n=0.022 L=1,649.0' S=0.0109 '/' Capacity=298.22 cfs Outflow=19.44 cfs 1.256 af

Reach 5R: Top Plateau Southeast Avg. Flow Depth=0.08' Max Vel=5.75 fps Inflow=19.44 cfs 1.256 af
n=0.017 L=220.0' S=0.1182 '/' Capacity=2,448.71 cfs Outflow=19.39 cfs 1.256 af

Reach 7R: North/Northeast Perimeter Avg. Flow Depth=1.29' Max Vel=6.35 fps Inflow=37.10 cfs 2.017 af
n=0.022 L=1,947.0' S=0.0169 '/' Capacity=300.38 cfs Outflow=31.81 cfs 2.017 af

Reach 8R: West Downchute Avg. Flow Depth=0.18' Max Vel=13.37 fps Inflow=60.92 cfs 3.312 af
n=0.017 L=200.0' S=0.2400 '/' Capacity=2,237.50 cfs Outflow=60.75 cfs 3.312 af

Reach 9R: Bottom Plateau West Avg. Flow Depth=3.74' Max Vel=10.14 fps Inflow=371.13 cfs 21.875 af
n=0.022 L=1,475.0' S=0.0108 '/' Capacity=1,887.62 cfs Outflow=354.24 cfs 21.875 af

Reach 12R: Northwest Perimeter Avg. Flow Depth=1.14' Max Vel=6.11 fps Inflow=26.07 cfs 1.417 af
n=0.022 L=1,190.0' S=0.0185 '/' Capacity=313.72 cfs Outflow=24.01 cfs 1.417 af

Reach 13R: West Perimeter Channel Avg. Flow Depth=1.51' Max Vel=3.40 fps Inflow=27.02 cfs 1.469 af
n=0.022 L=1,015.0' S=0.0039 '/' Capacity=144.84 cfs Outflow=23.30 cfs 1.469 af

Reach 14R: East Perimeter Channel Avg. Flow Depth=1.11' Max Vel=3.50 fps Inflow=14.05 cfs 0.764 af
n=0.022 L=635.0' S=0.0063 '/' Capacity=183.12 cfs Outflow=13.07 cfs 0.764 af

Reach 15R: Southwest Downchute Avg. Flow Depth=0.33' Max Vel=21.01 fps Inflow=354.24 cfs 21.875 af
n=0.017 L=100.0' S=0.2600 '/' Capacity=4,503.90 cfs Outflow=353.99 cfs 21.875 af

Reach 21R: Upper Southwest Avg. Flow Depth=0.89' Max Vel=6.43 fps Inflow=15.53 cfs 0.844 af
n=0.022 L=625.0' S=0.0288 '/' Capacity=391.56 cfs Outflow=15.10 cfs 0.844 af

Reach 24R: Lower Southwest Avg. Flow Depth=1.28' Max Vel=4.41 fps Inflow=24.61 cfs 1.338 af
n=0.022 L=1,200.0' S=0.0083 '/' Capacity=210.63 cfs Outflow=21.59 cfs 1.338 af

Reach 26R: Bottom Plateau East Avg. Flow Depth=5.34' Max Vel=5.99 fps Inflow=449.09 cfs 25.181 af
n=0.022 L=850.0' S=0.0024 '/' Capacity=879.14 cfs Outflow=427.27 cfs 25.181 af

Reach 27R: Southeast Downchute Avg. Flow Depth=0.40' Max Vel=20.86 fps Inflow=427.27 cfs 25.181 af
n=0.017 L=100.0' S=0.2000 '/' Capacity=3,950.18 cfs Outflow=426.89 cfs 25.181 af

Reach 30R: Lower South Perimeter Avg. Flow Depth=1.19' Max Vel=4.74 fps Inflow=22.04 cfs 1.198 af
n=0.022 L=950.0' S=0.0105 '/' Capacity=236.72 cfs Outflow=20.22 cfs 1.198 af

Reach 31R: Lower Southeast Avg. Flow Depth=1.20' Max Vel=4.07 fps Inflow=19.08 cfs 1.037 af
n=0.022 L=780.0' S=0.0077 '/' Capacity=202.36 cfs Outflow=17.60 cfs 1.037 af

Pond 14P: Pond 1 Peak Elev=263.17' Storage=927,301 cf Inflow=368.86 cfs 21.288 af
Outflow=0.00 cfs 0.000 af

Link 17L: Combined Northwest Sideslope Flows Inflow=94.25 cfs 6.198 af
Primary=94.25 cfs 6.198 af

Link 22L: Combined Southwest Flows Inflow=387.91 cfs 24.058 af
Primary=387.91 cfs 24.058 af

Link 32L: Combined Southeast Flows Inflow=463.98 cfs 27.417 af
Primary=463.98 cfs 27.417 af

Total Runoff Area = 114.204 ac Runoff Volume = 78.961 af Average Runoff Depth = 8.30"
100.00% Pervious = 114.204 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Top Plateau East

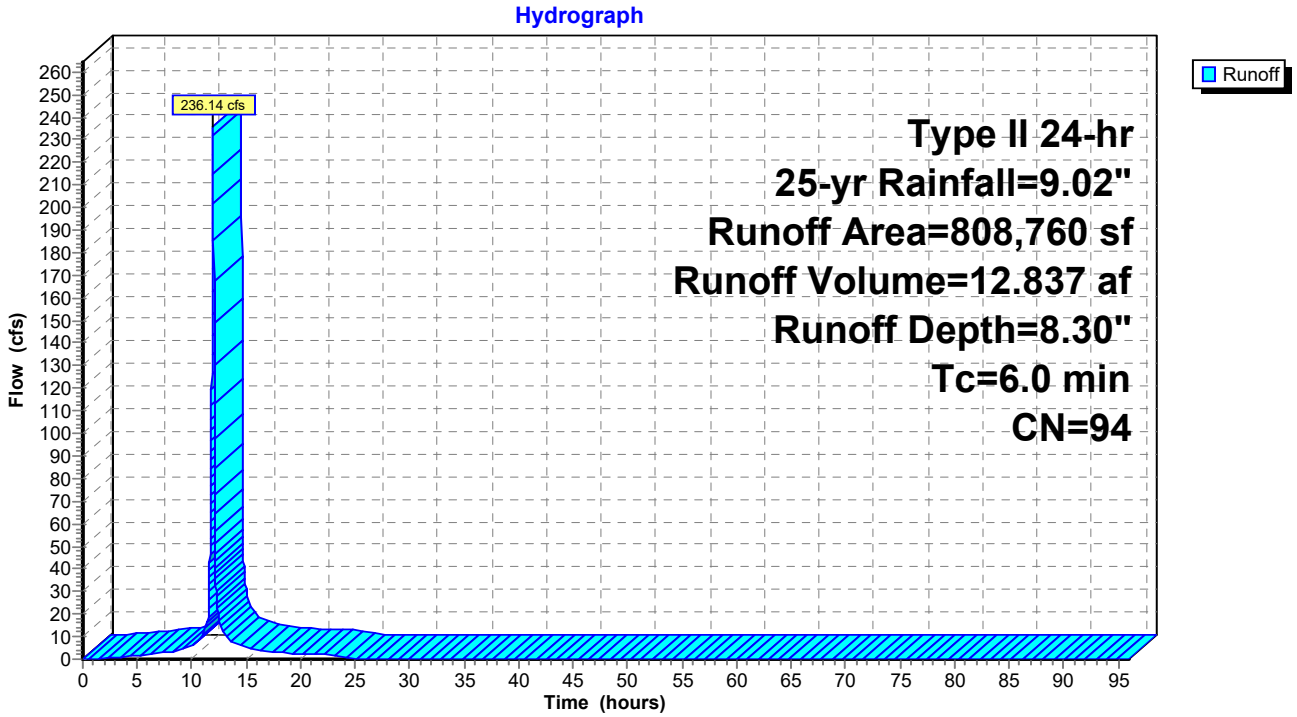
Runoff = 236.14 cfs @ 11.97 hrs, Volume= 12.837 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
808,760	94	Fallow, bare soil, HSG D
808,760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: Top Plateau East



Summary for Subcatchment 2S: Top Plateau West

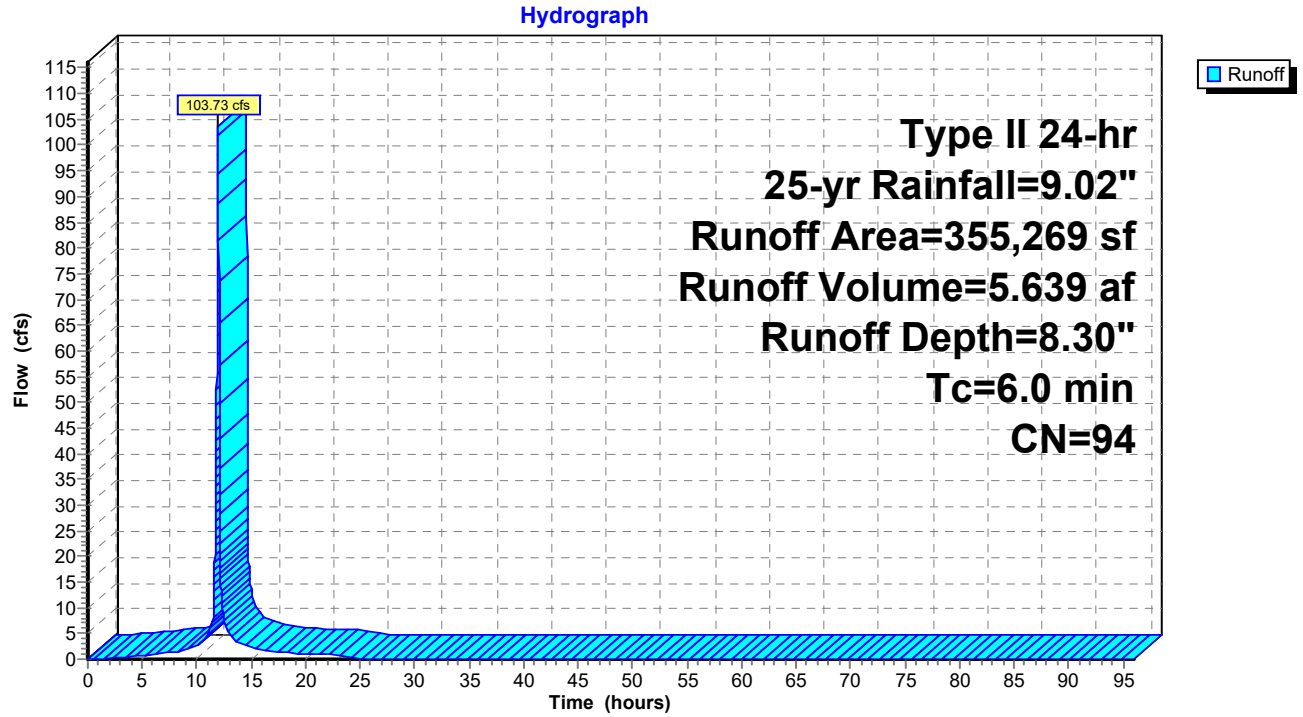
Runoff = 103.73 cfs @ 11.97 hrs, Volume= 5.639 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
355,269	94	Fallow, bare soil, HSG D
355,269		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 2S: Top Plateau West



Summary for Subcatchment 3S: Top Plateau South

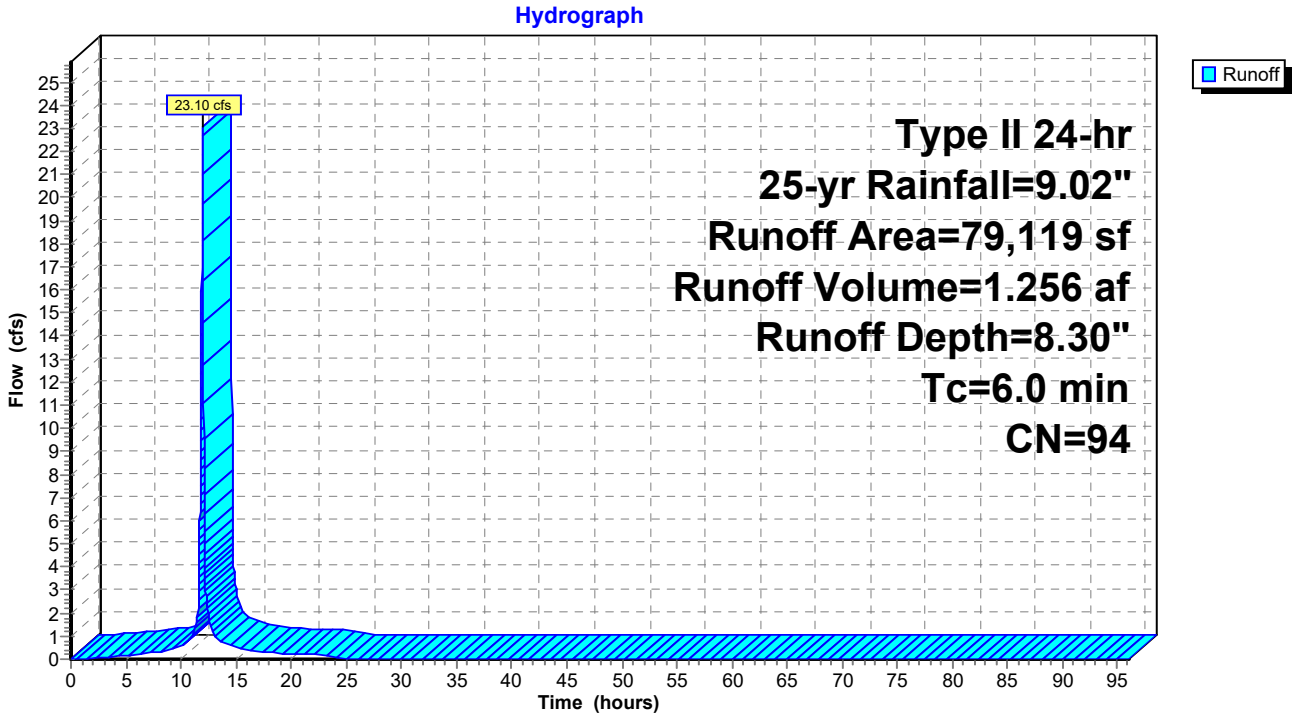
Runoff = 23.10 cfs @ 11.97 hrs, Volume= 1.256 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
79,119	94	Fallow, bare soil, HSG D
79,119		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 3S: Top Plateau South



Summary for Subcatchment 4S: Top Plateau North/Northeast Sideslope

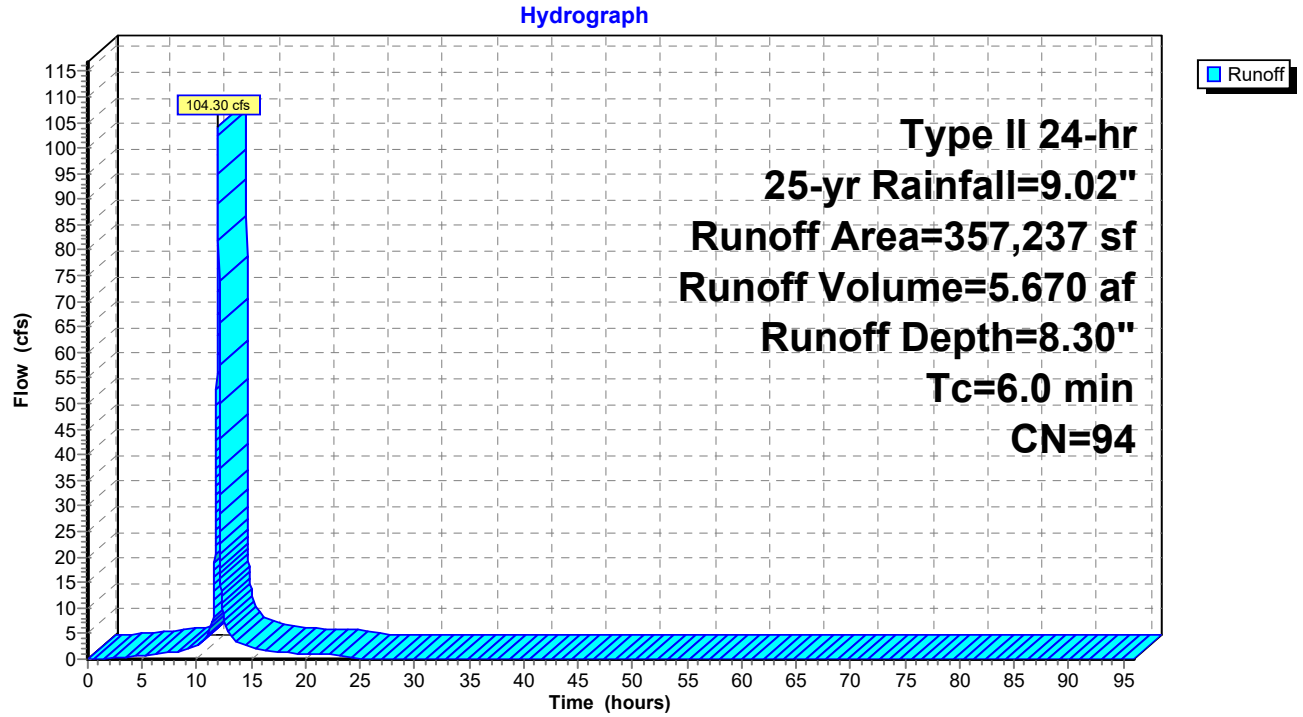
Runoff = 104.30 cfs @ 11.97 hrs, Volume= 5.670 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
357,237	94	Fallow, bare soil, HSG D
357,237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: Top Plateau North/Northeast Sideslope



Summary for Subcatchment 6S: Top Plateau North Bottom Sideslope

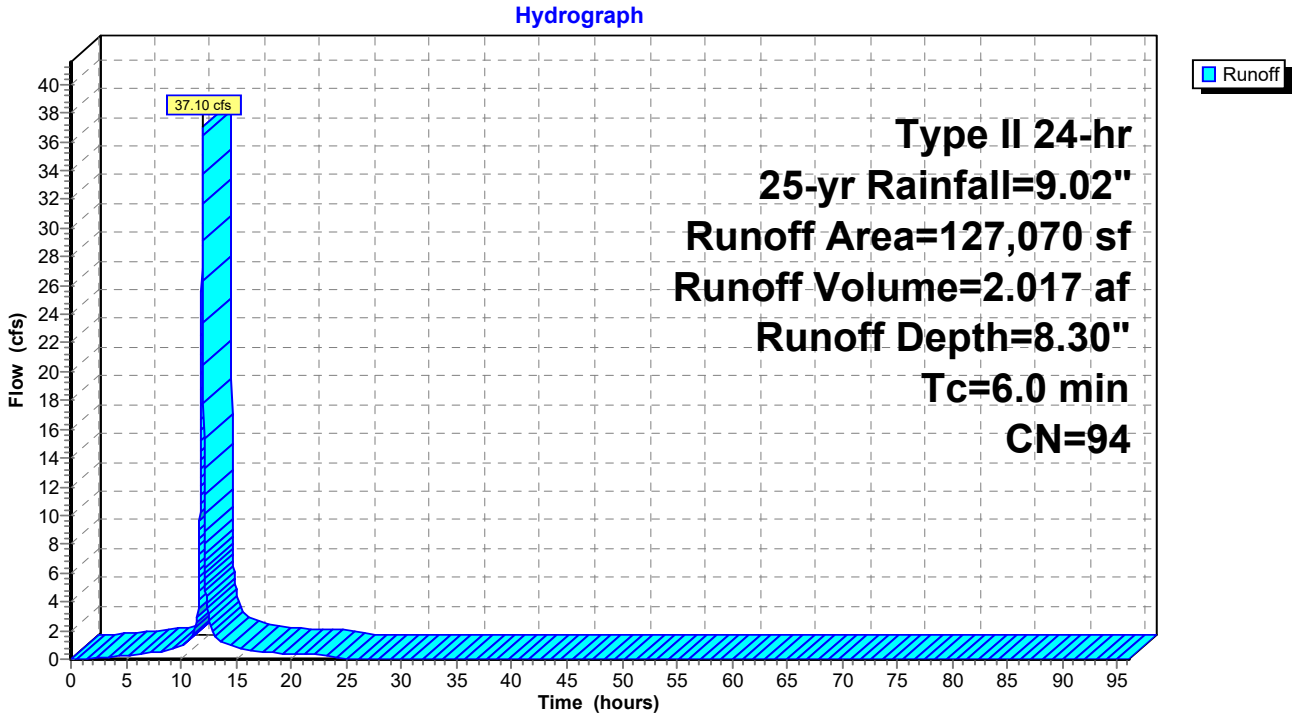
Runoff = 37.10 cfs @ 11.97 hrs, Volume= 2.017 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
127,070	94	Fallow, bare soil, HSG D
127,070		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: Top Plateau North Bottom Sideslope



Summary for Subcatchment 7S: Bottom Plateau West

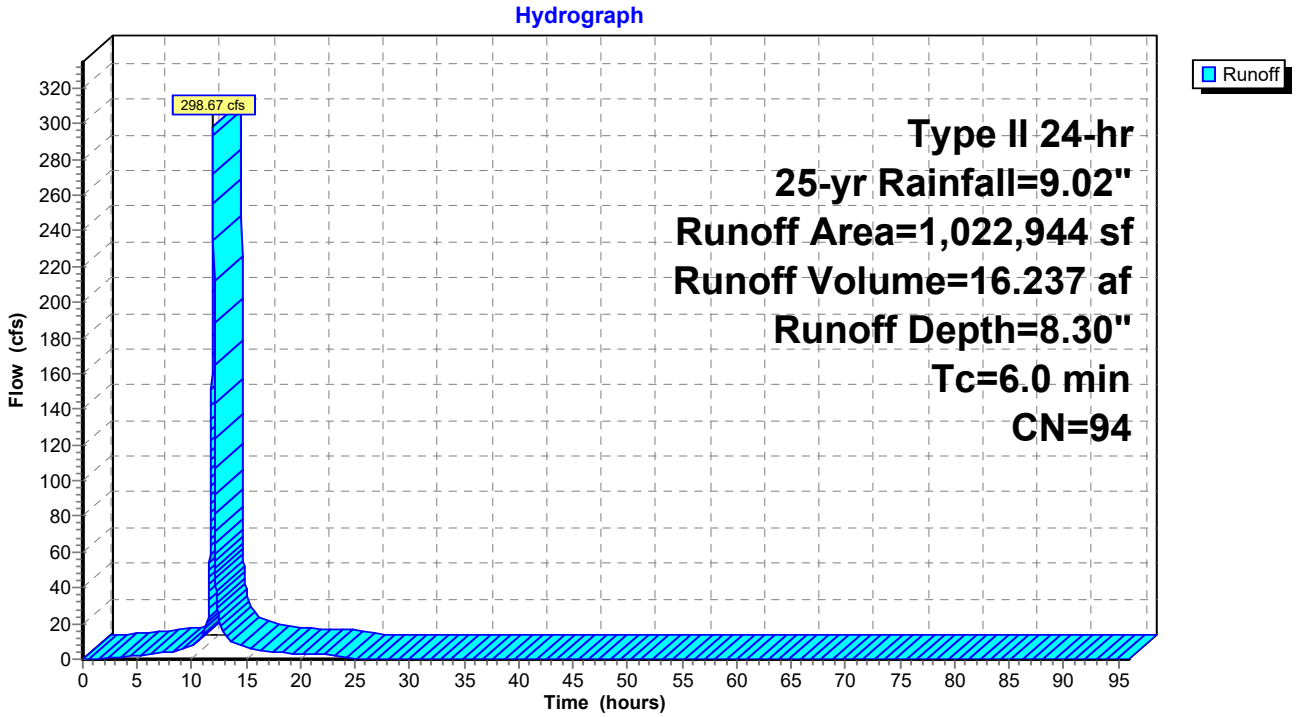
Runoff = 298.67 cfs @ 11.97 hrs, Volume= 16.237 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
1,022,944	94	Fallow, bare soil, HSG D
1,022,944		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 7S: Bottom Plateau West



Summary for Subcatchment 8S: Top Plateau West Sideslope

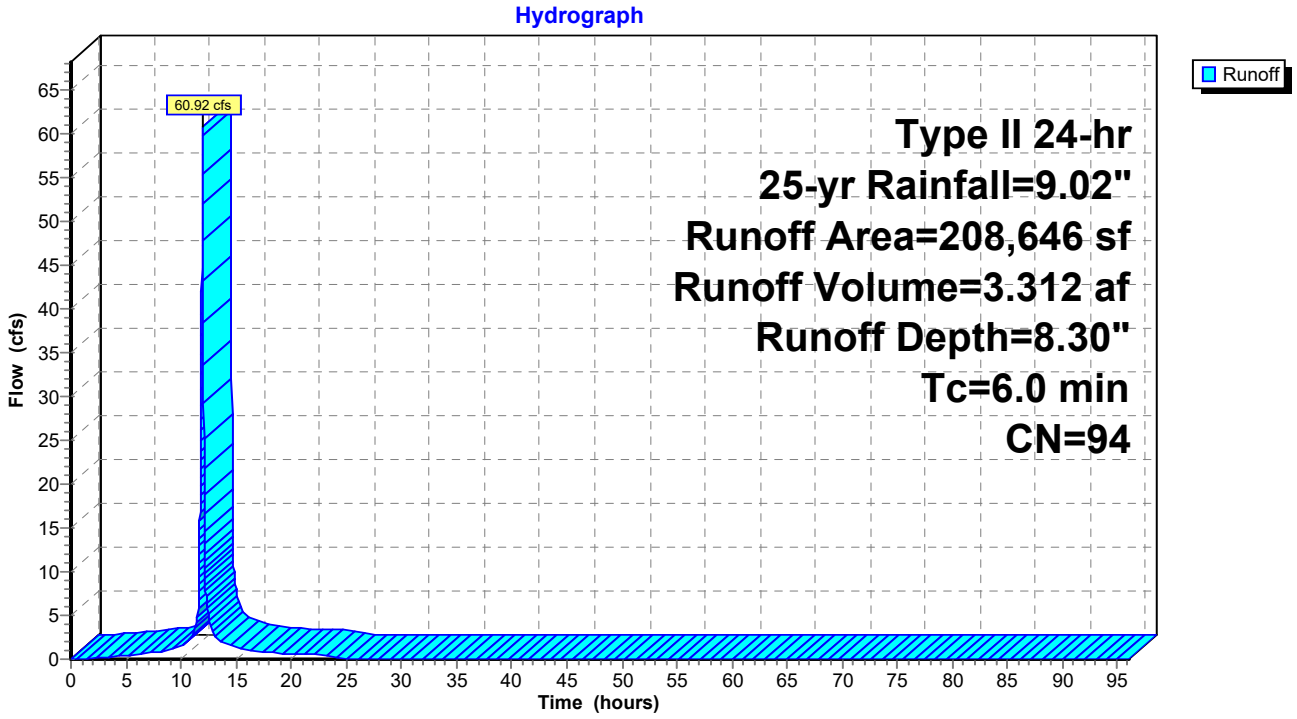
Runoff = 60.92 cfs @ 11.97 hrs, Volume= 3.312 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
208,646	94	Fallow, bare soil, HSG D
208,646		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 8S: Top Plateau West Sideslope



Summary for Subcatchment 9S: Top Plateau Northwest Bottom Sideslope

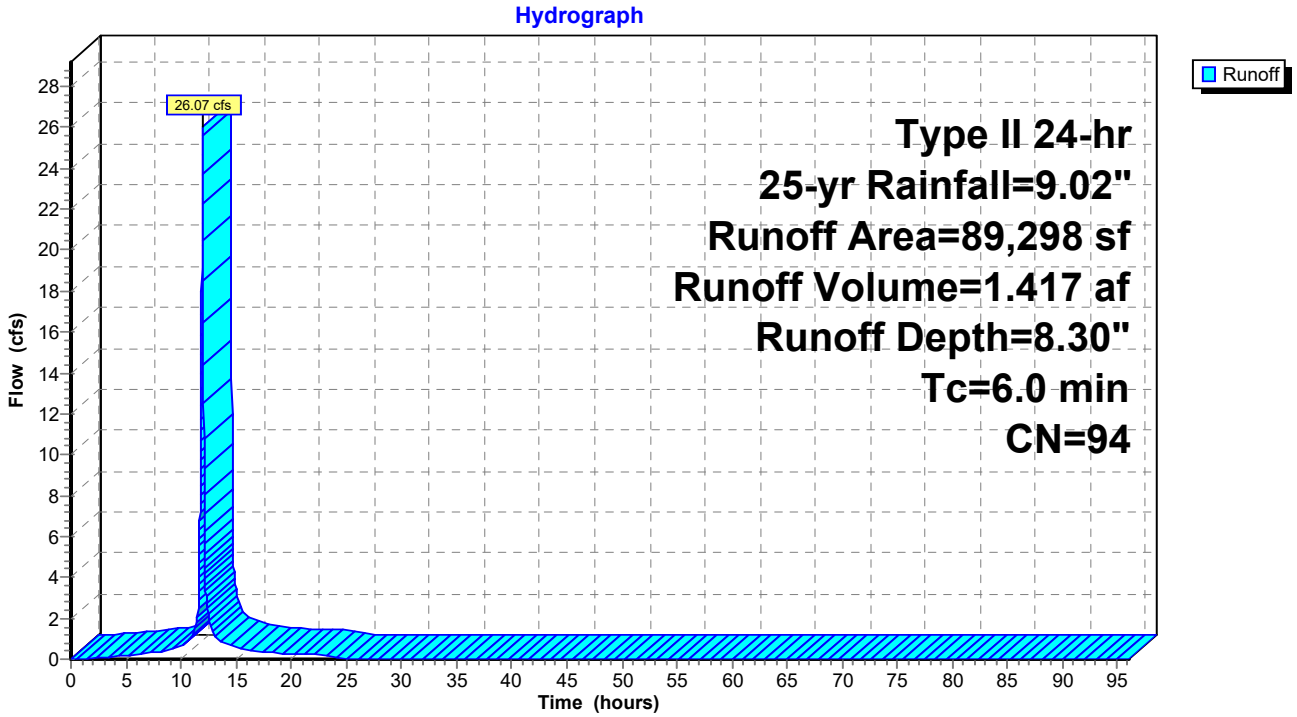
Runoff = 26.07 cfs @ 11.97 hrs, Volume= 1.417 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
89,298	94	Fallow, bare soil, HSG D
89,298		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 9S: Top Plateau Northwest Bottom Sideslope



Summary for Subcatchment 10S: Top Plateau West Bottom Sideslope

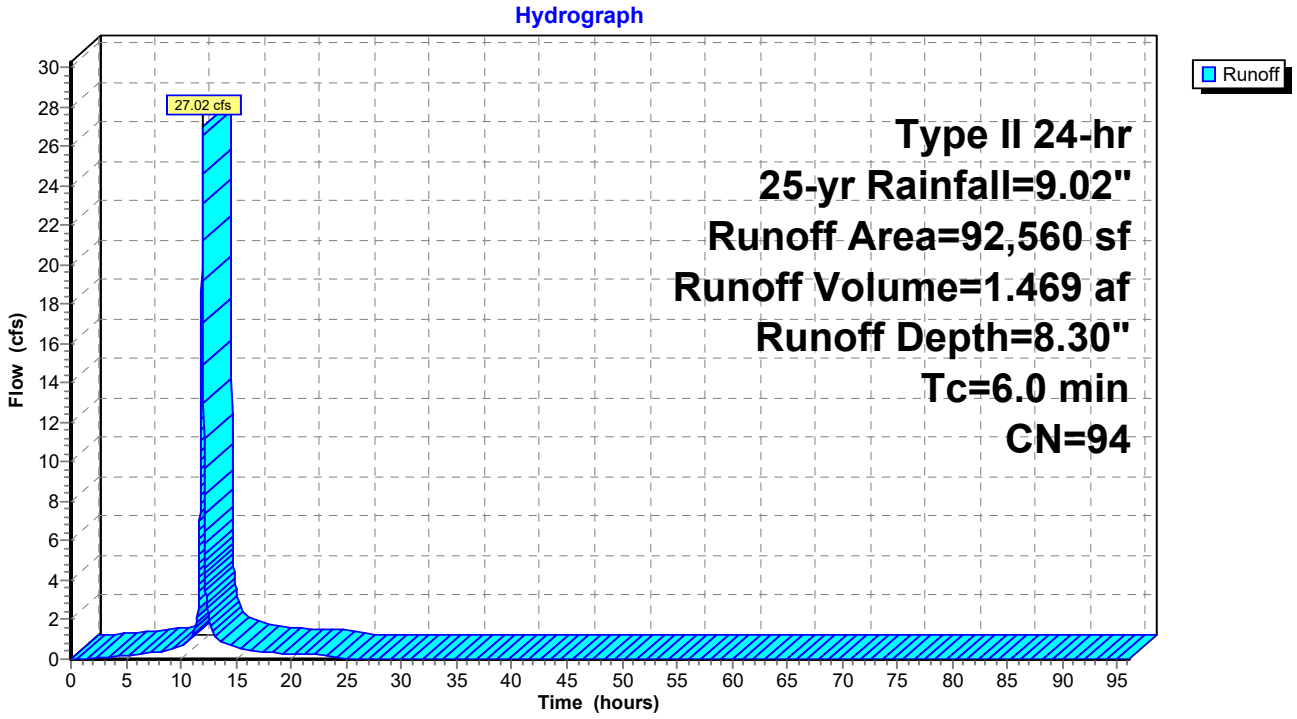
Runoff = 27.02 cfs @ 11.97 hrs, Volume= 1.469 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
92,560	94	Fallow, bare soil, HSG D
92,560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 10S: Top Plateau West Bottom Sideslope



Summary for Subcatchment 11S: Top Plateau East Bottom Sideslope

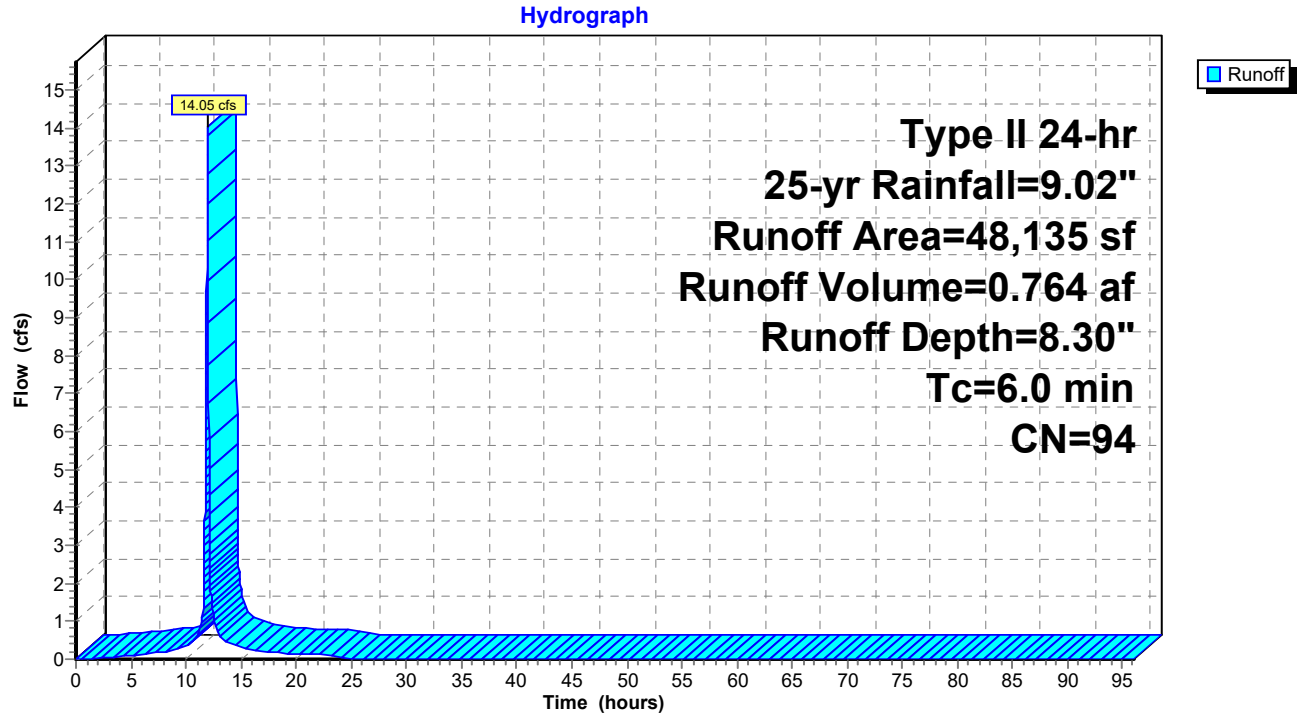
Runoff = 14.05 cfs @ 11.97 hrs, Volume= 0.764 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
48,135	94	Fallow, bare soil, HSG D
48,135		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 11S: Top Plateau East Bottom Sideslope



Summary for Subcatchment 20S: Bottom Plateau West Bottom Sideslope

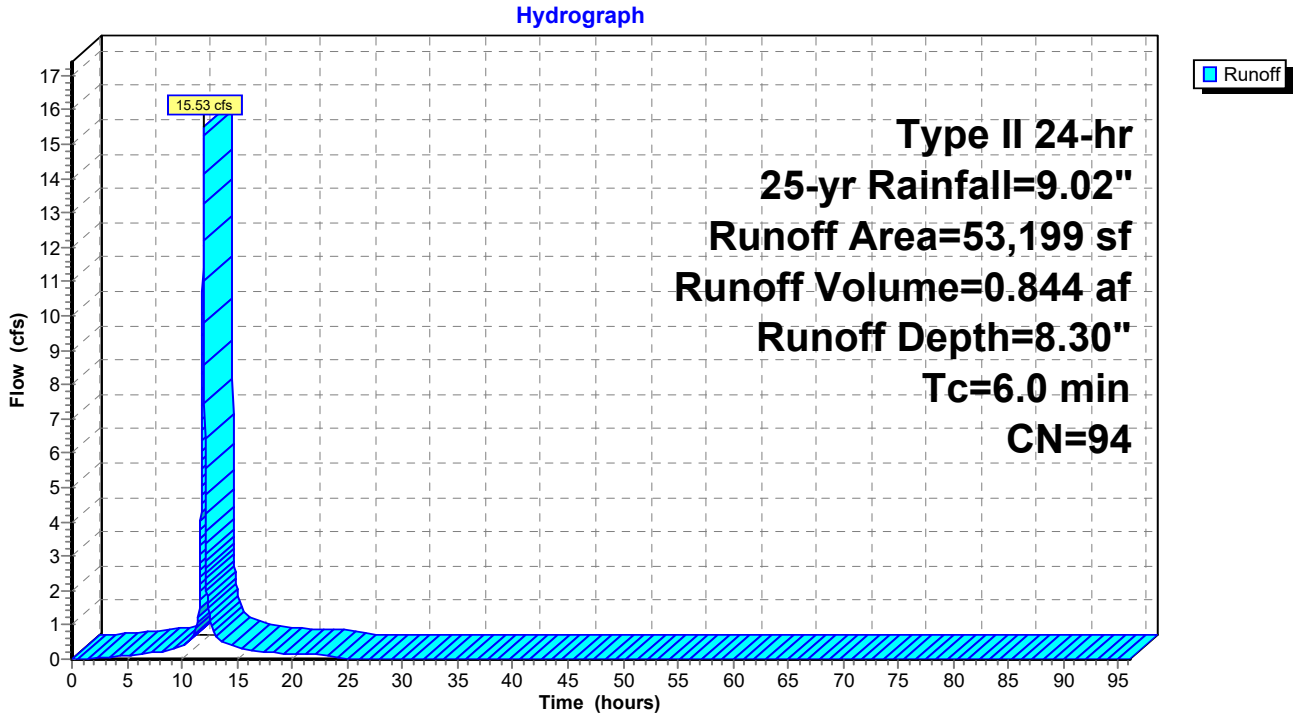
Runoff = 15.53 cfs @ 11.97 hrs, Volume= 0.844 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
53,199	94	Fallow, bare soil, HSG D
53,199		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 20S: Bottom Plateau West Bottom Sideslope



Summary for Subcatchment 23S: Bottom Plateau Southwest Bottom Sideslope

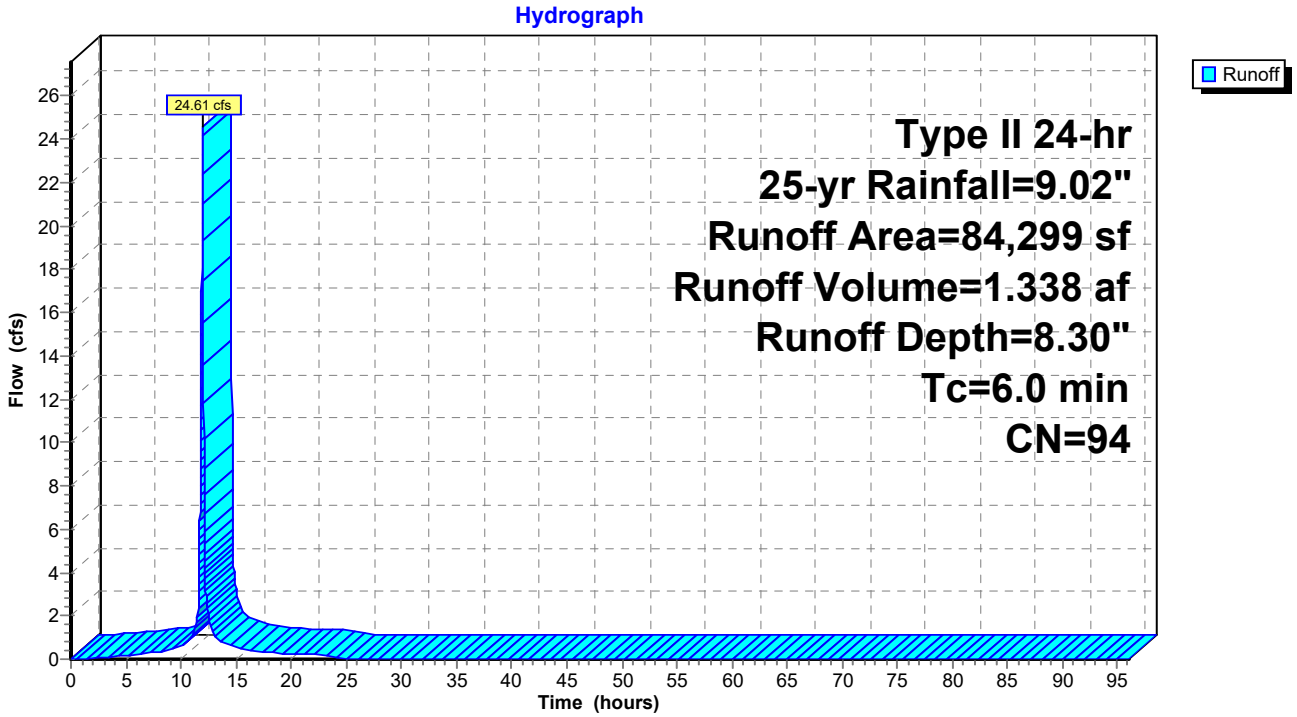
Runoff = 24.61 cfs @ 11.97 hrs, Volume= 1.338 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
84,299	94	Fallow, bare soil, HSG D
84,299		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 23S: Bottom Plateau Southwest Bottom Sideslope



Summary for Subcatchment 25S: Bottom Plateau East

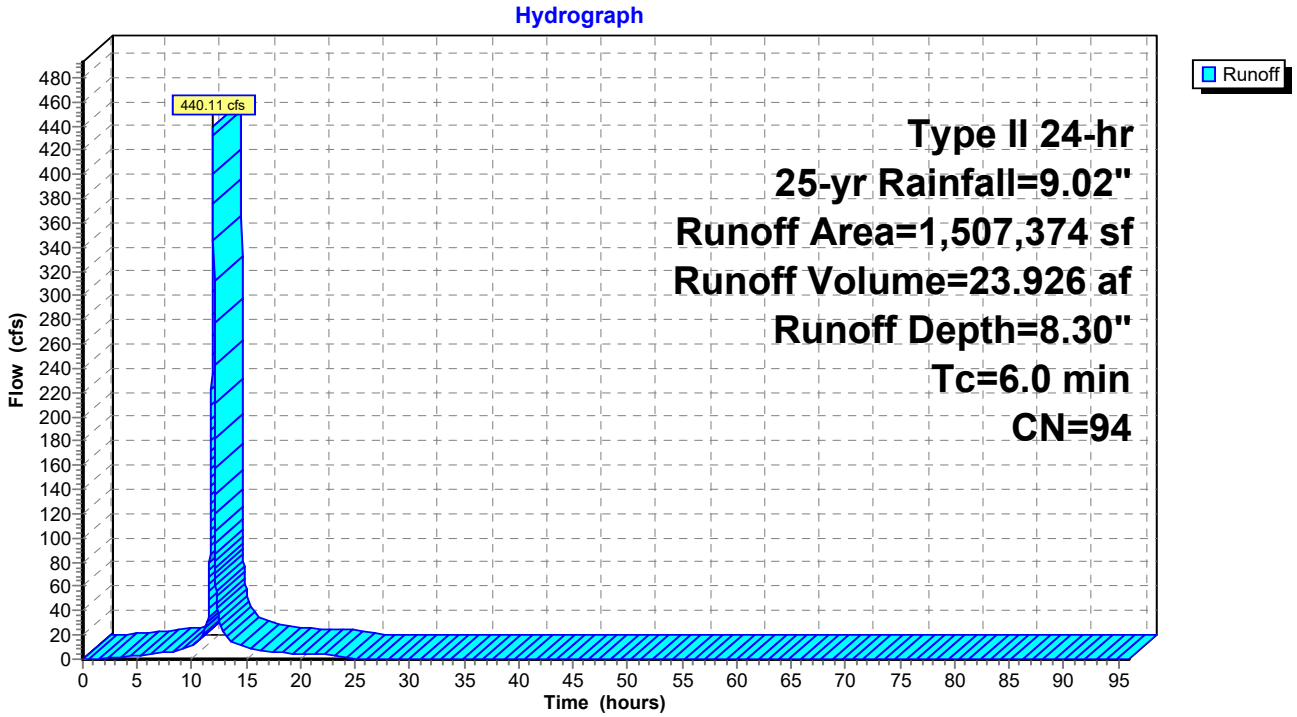
Runoff = 440.11 cfs @ 11.97 hrs, Volume= 23.926 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
1,507,374	94	Fallow, bare soil, HSG D
1,507,374		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 25S: Bottom Plateau East



Summary for Subcatchment 28S: Bottom Plateau South Bottom Sideslope

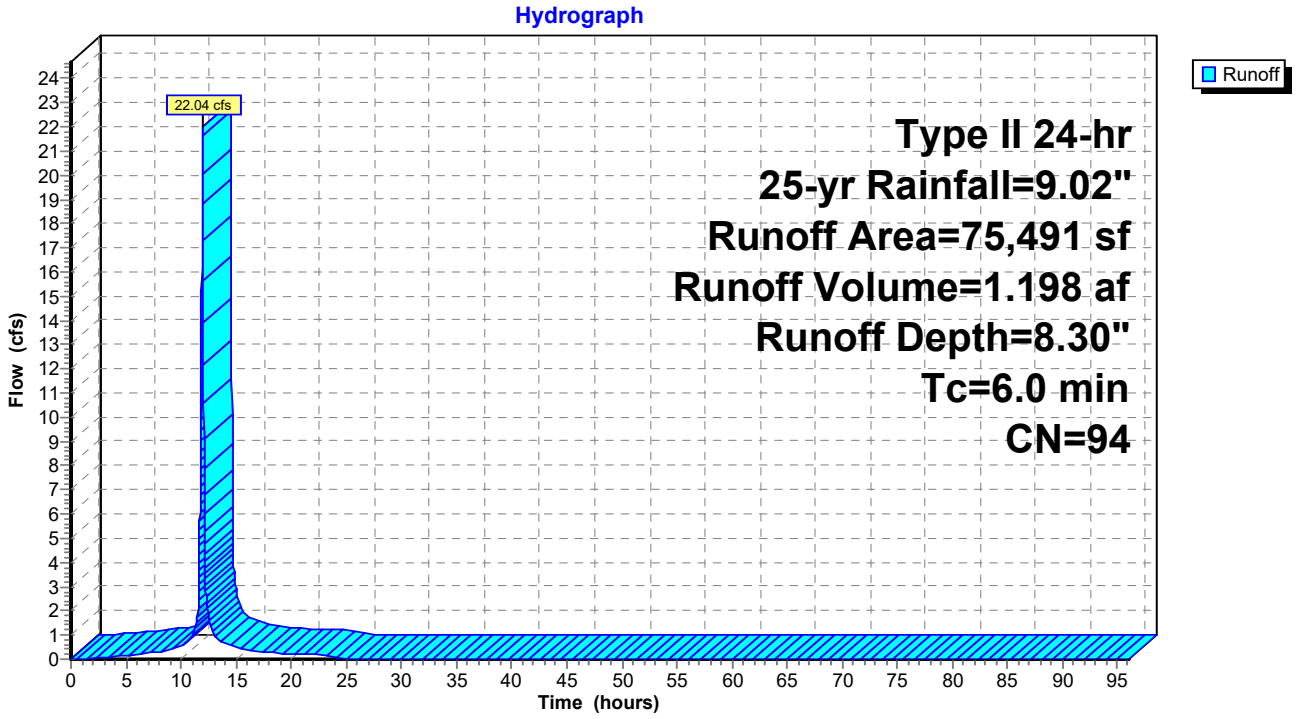
Runoff = 22.04 cfs @ 11.97 hrs, Volume= 1.198 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
75,491	94	Fallow, bare soil, HSG D
75,491		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 28S: Bottom Plateau South Bottom Sideslope



Summary for Subcatchment 29S: Bottom Plateau Southeast Bottom Sideslope

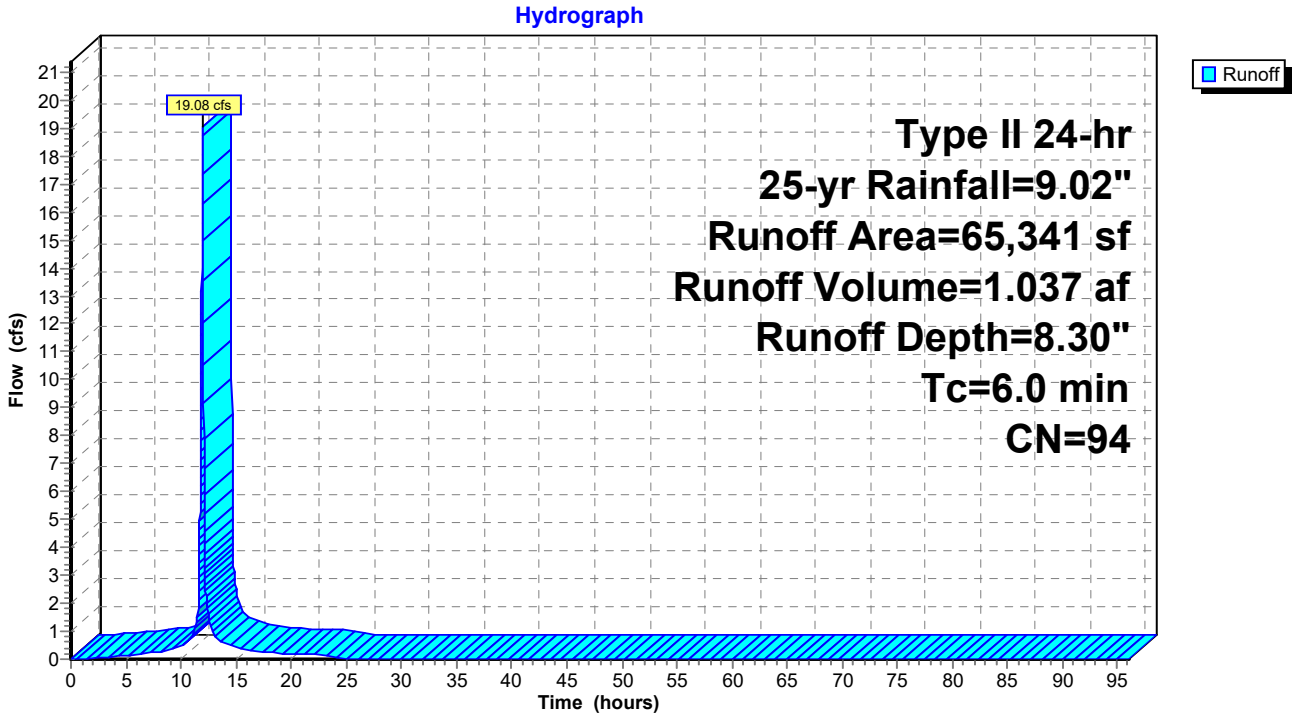
Runoff = 19.08 cfs @ 11.97 hrs, Volume= 1.037 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=9.02"

Area (sf)	CN	Description
65,341	94	Fallow, bare soil, HSG D
65,341		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 29S: Bottom Plateau Southeast Bottom Sideslope



Summary for Reach 1R: East Downchute

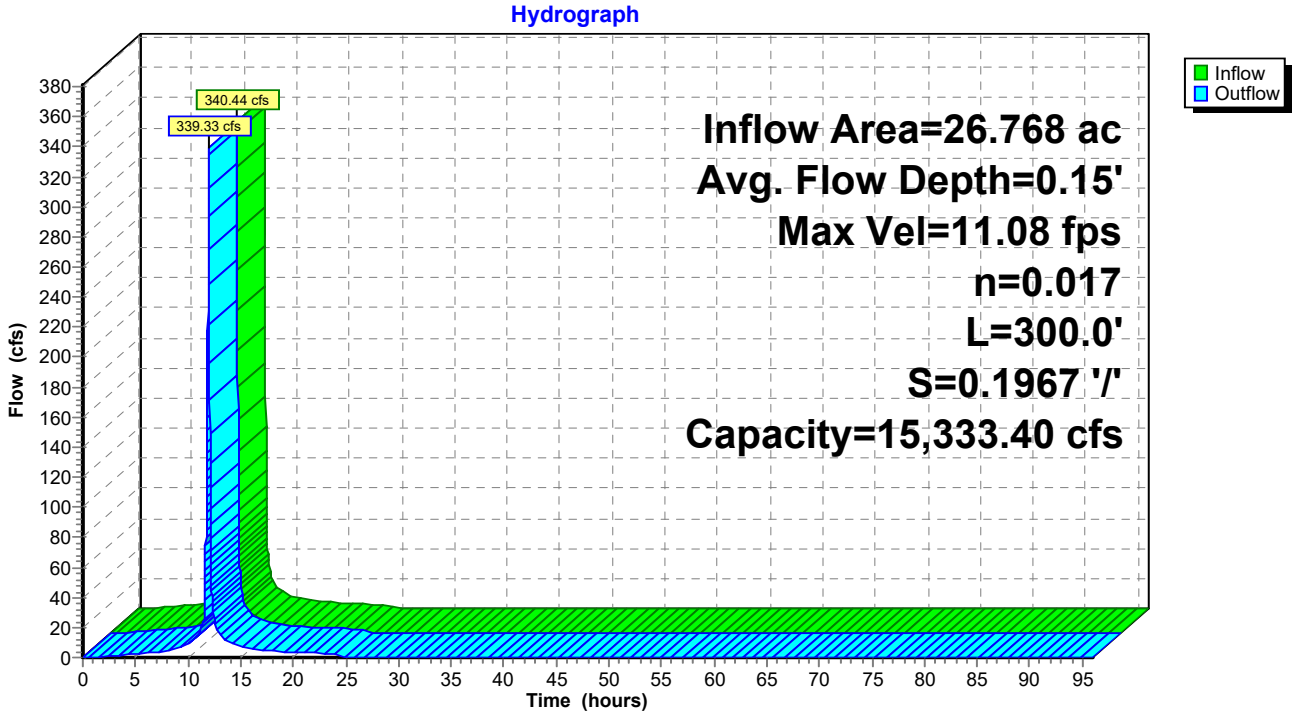
Inflow Area = 26.768 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 340.44 cfs @ 11.97 hrs, Volume= 18.507 af
Outflow = 339.33 cfs @ 11.98 hrs, Volume= 18.507 af, Atten= 0%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.08 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 2.65 fps, Avg. Travel Time= 1.9 min

Peak Storage= 9,201 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 1.50' Flow Area= 306.8 sf, Capacity= 15,333.40 cfs

200.00' x 1.50' deep channel, n= 0.017 Concrete, unfinished
Side Slope Z-value= 3.0 '/' Top Width= 209.00'
Length= 300.0' Slope= 0.1967 '/'
Inlet Invert= 325.00', Outlet Invert= 266.00'

Reach 1R: East Downchute



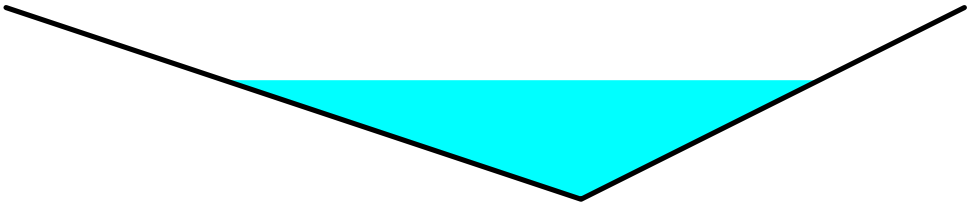
Summary for Reach 2R: Top Plateau West Diversion Berm

Inflow Area = 8.156 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 103.73 cfs @ 11.97 hrs, Volume= 5.639 af
Outflow = 96.77 cfs @ 12.04 hrs, Volume= 5.639 af, Atten= 7%, Lag= 4.6 min

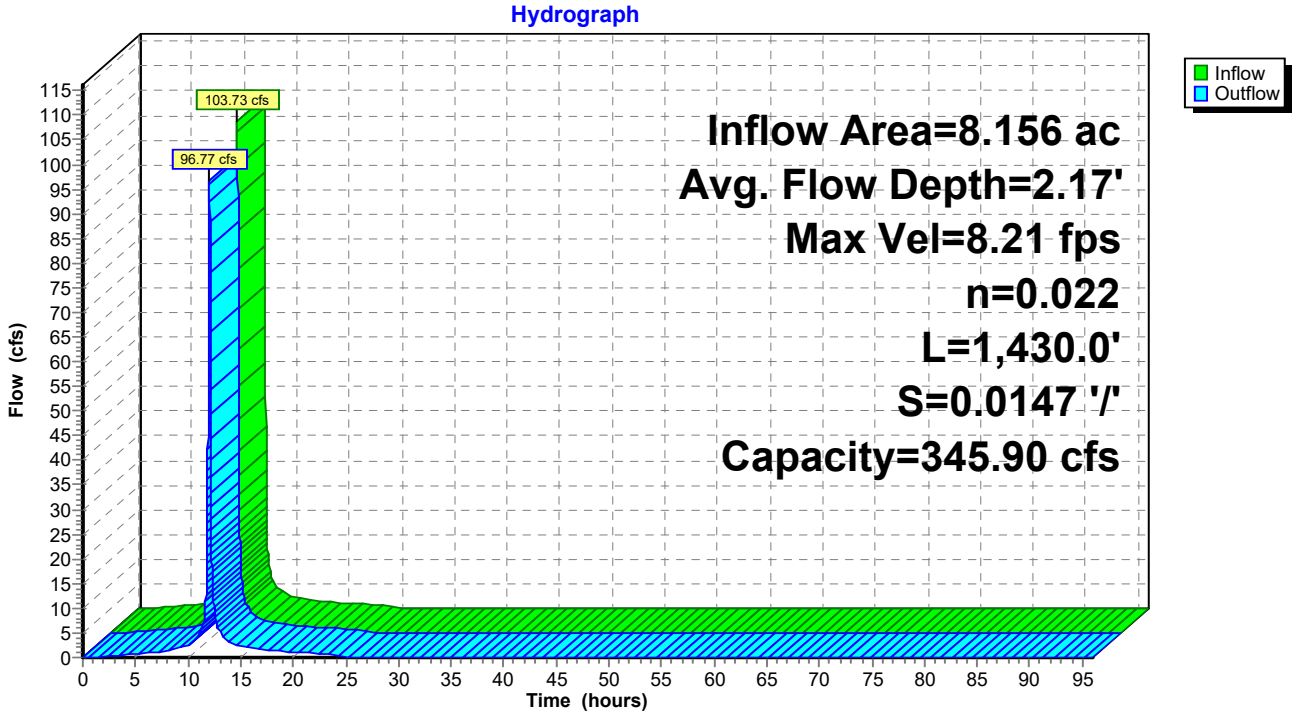
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.21 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 2.57 fps, Avg. Travel Time= 9.3 min

Peak Storage= 16,858 cf @ 12.00 hrs
Average Depth at Peak Storage= 2.17'
Bank-Full Depth= 3.50' Flow Area= 30.6 sf, Capacity= 345.90 cfs

0.00' x 3.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 2.0 '/' Top Width= 17.50'
Length= 1,430.0' Slope= 0.0147 '/'
Inlet Invert= 359.00', Outlet Invert= 338.00'



Reach 2R: Top Plateau West Diversion Berm



Summary for Reach 3R: Top Plateau South Downchute.

Inflow Area = 8.156 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 96.77 cfs @ 12.04 hrs, Volume= 5.639 af
Outflow = 96.65 cfs @ 12.05 hrs, Volume= 5.639 af, Atten= 0%, Lag= 0.2 min

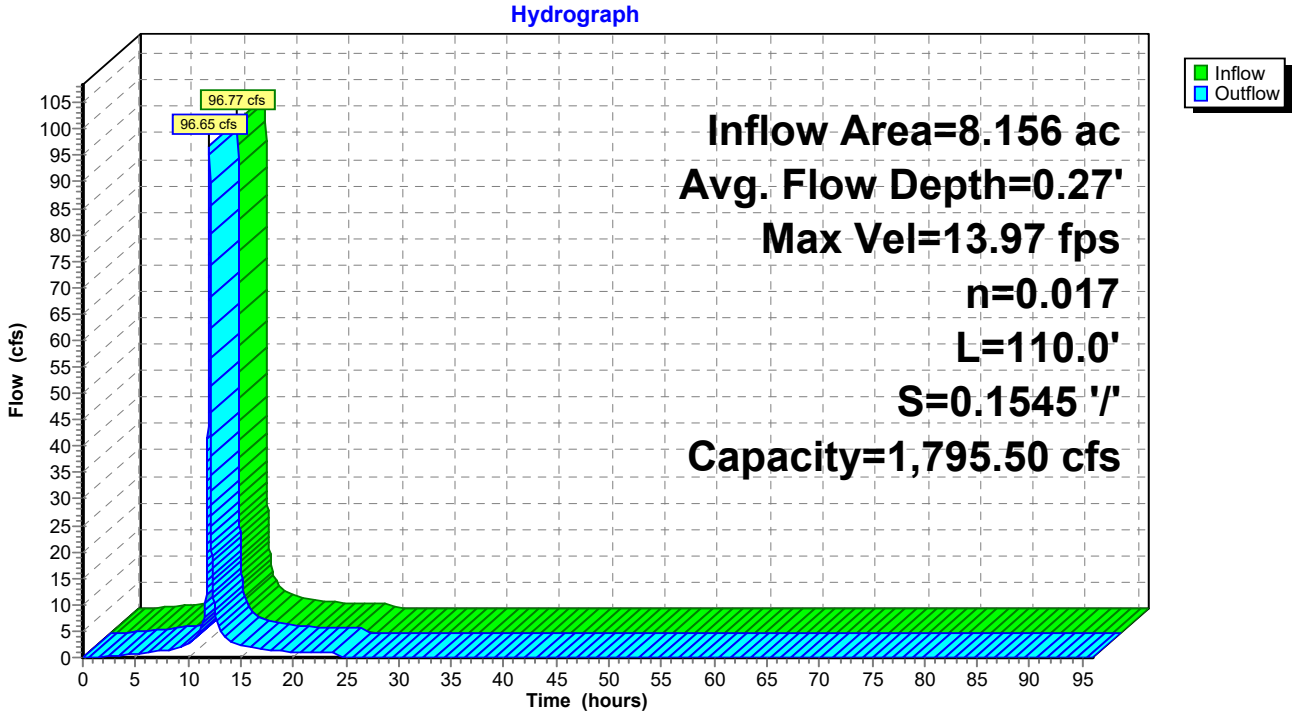
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.97 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.88 fps, Avg. Travel Time= 0.6 min

Peak Storage= 762 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.50' Flow Area= 44.3 sf, Capacity= 1,795.50 cfs

25.00' x 1.50' deep channel, n= 0.017 Concrete, unfinished
Side Slope Z-value= 3.0 '/' Top Width= 34.00'
Length= 110.0' Slope= 0.1545 '/'
Inlet Invert= 335.00', Outlet Invert= 318.00'

‡

Reach 3R: Top Plateau South Downchute.



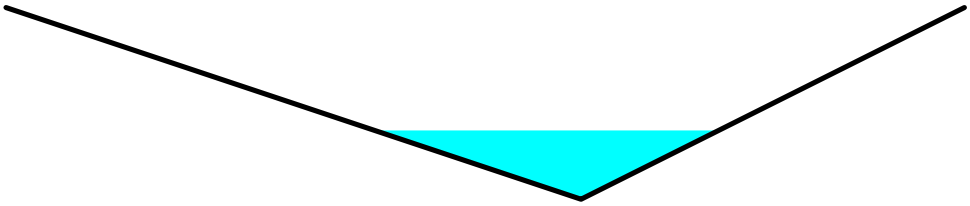
Summary for Reach 4R: Top Plateau South Diversion Berm

Inflow Area = 1.816 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 23.10 cfs @ 11.97 hrs, Volume= 1.256 af
Outflow = 19.44 cfs @ 12.10 hrs, Volume= 1.256 af, Atten= 16%, Lag= 8.2 min

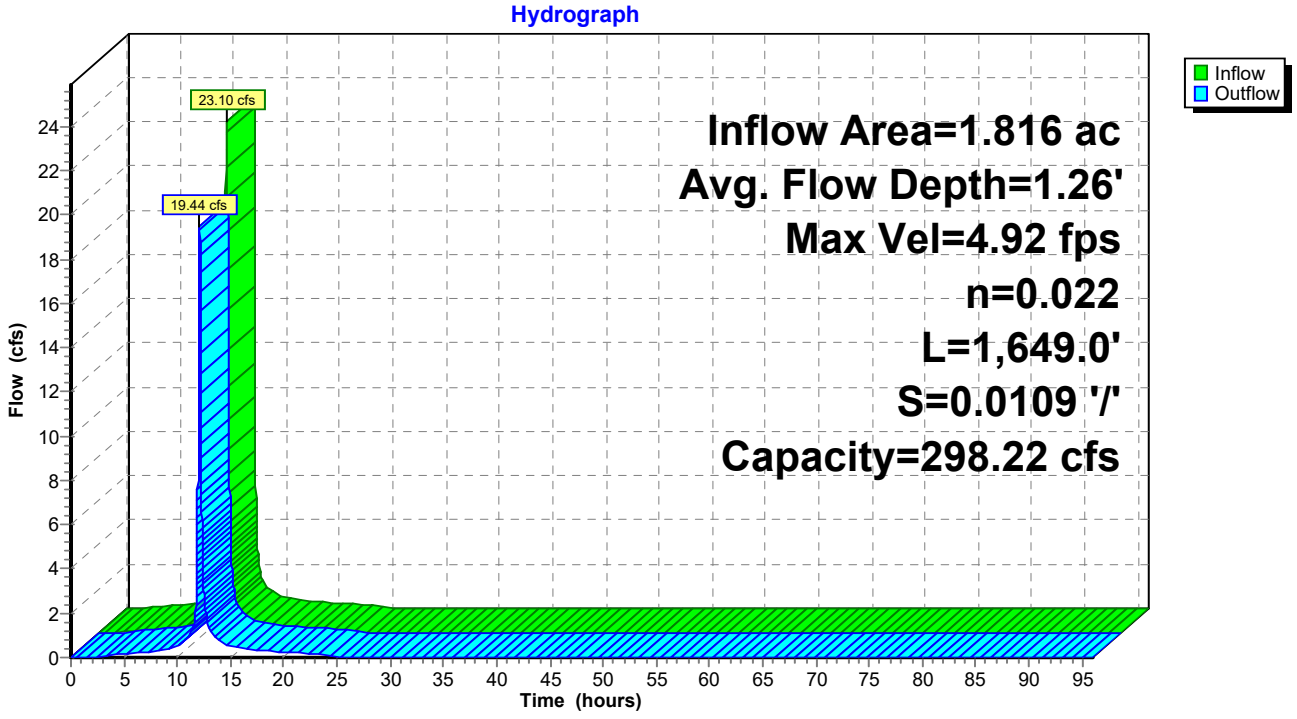
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.92 fps, Min. Travel Time= 5.6 min
Avg. Velocity = 1.56 fps, Avg. Travel Time= 17.6 min

Peak Storage= 6,522 cf @ 12.01 hrs
Average Depth at Peak Storage= 1.26'
Bank-Full Depth= 3.50' Flow Area= 30.6 sf, Capacity= 298.22 cfs

0.00' x 3.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 2.0 '/' Top Width= 17.50'
Length= 1,649.0' Slope= 0.0109 '/'
Inlet Invert= 340.00', Outlet Invert= 322.00'



Reach 4R: Top Plateau South Diversion Berm



Summary for Reach 5R: Top Plateau Southeast Downchute

Inflow Area = 1.816 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 19.44 cfs @ 12.10 hrs, Volume= 1.256 af
Outflow = 19.39 cfs @ 12.12 hrs, Volume= 1.256 af, Atten= 0%, Lag= 1.0 min

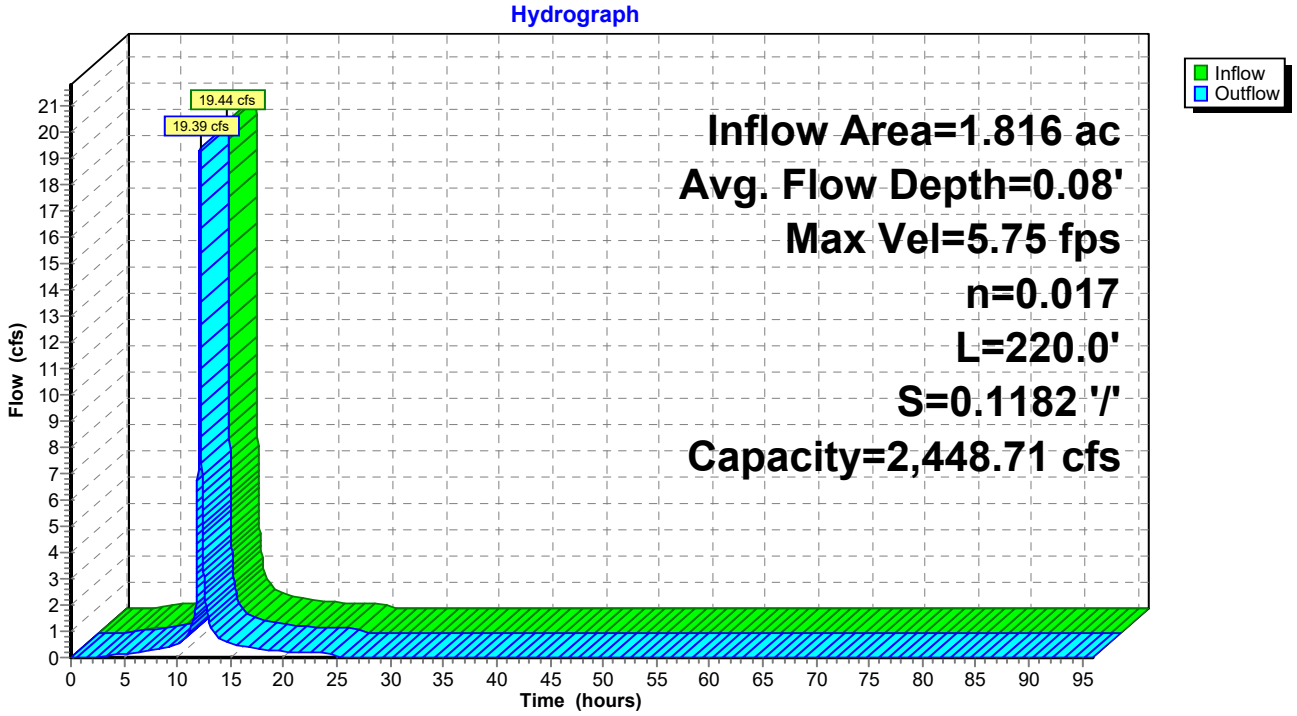
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.75 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.90 fps, Avg. Travel Time= 1.9 min

Peak Storage= 742 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.50' Flow Area= 66.8 sf, Capacity= 2,448.71 cfs

40.00' x 1.50' deep channel, n= 0.017 Concrete, unfinished
Side Slope Z-value= 3.0 '/' Top Width= 49.00'
Length= 220.0' Slope= 0.1182 '/'
Inlet Invert= 318.00', Outlet Invert= 292.00'

‡

Reach 5R: Top Plateau Southeast Downchute



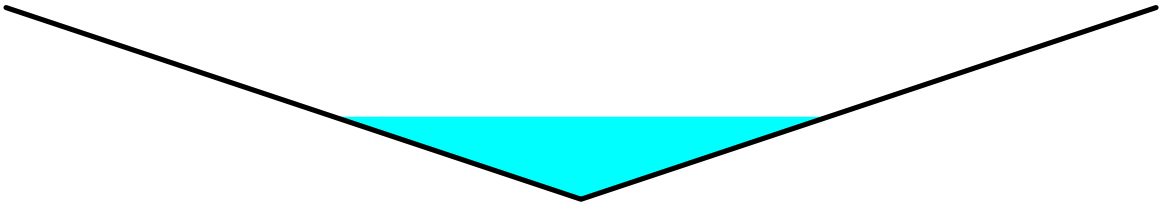
Summary for Reach 7R: North/Northeast Perimeter Channel

Inflow Area = 2.917 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 37.10 cfs @ 11.97 hrs, Volume= 2.017 af
Outflow = 31.81 cfs @ 12.09 hrs, Volume= 2.017 af, Atten= 14%, Lag= 7.6 min

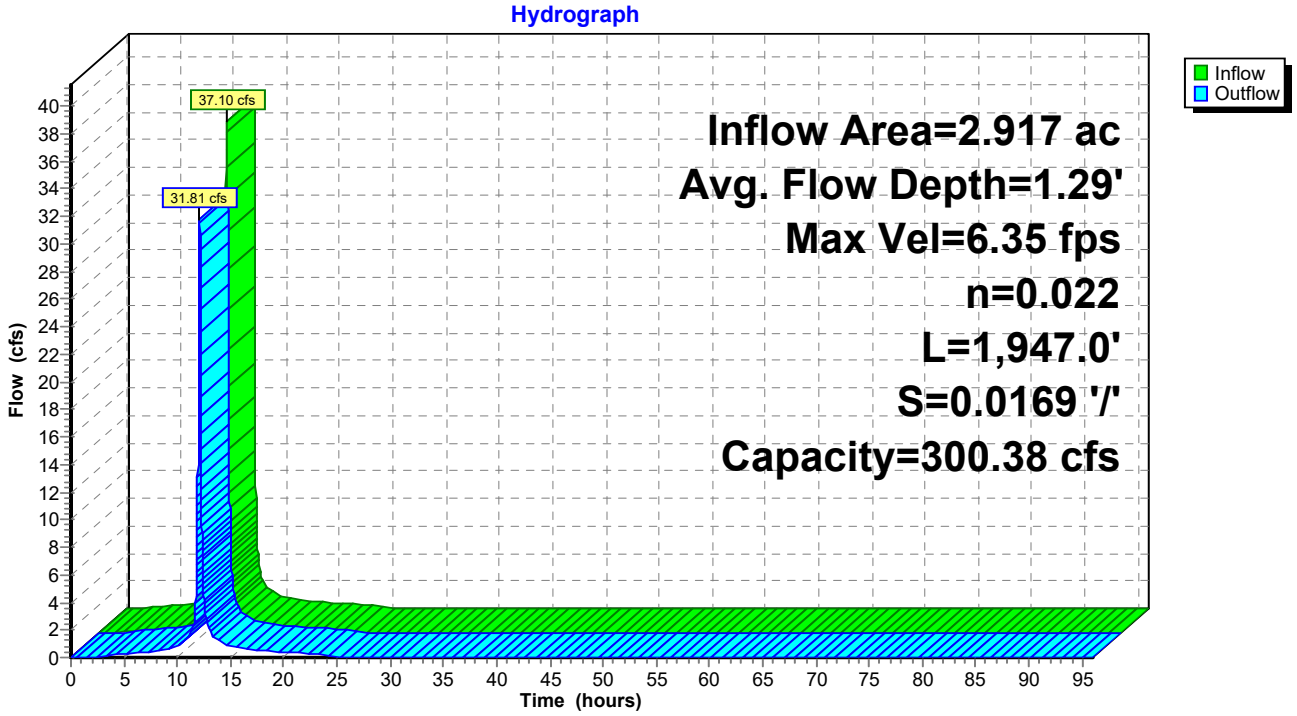
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.35 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 1.98 fps, Avg. Travel Time= 16.4 min

Peak Storage= 9,768 cf @ 12.01 hrs
Average Depth at Peak Storage= 1.29'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 300.38 cfs

0.00' x 3.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 1,947.0' Slope= 0.0169 '/'
Inlet Invert= 299.00', Outlet Invert= 266.00'



Reach 7R: North/Northeast Perimeter Channel



Summary for Reach 8R: West Downchute

Inflow Area = 4.790 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 60.92 cfs @ 11.97 hrs, Volume= 3.312 af
Outflow = 60.75 cfs @ 11.97 hrs, Volume= 3.312 af, Atten= 0%, Lag= 0.4 min

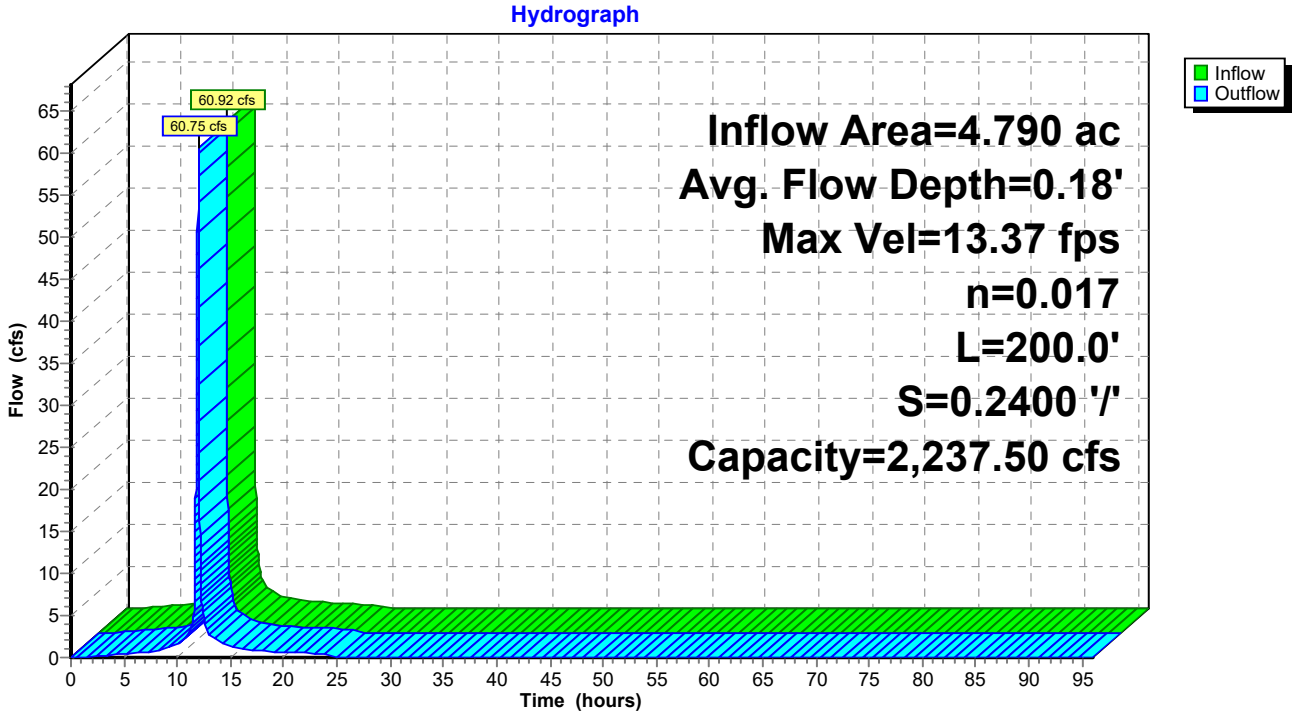
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.37 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.05 fps, Avg. Travel Time= 1.1 min

Peak Storage= 911 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.50' Flow Area= 44.3 sf, Capacity= 2,237.50 cfs

25.00' x 1.50' deep channel, n= 0.017 Concrete, unfinished
Side Slope Z-value= 3.0 '/' Top Width= 34.00'
Length= 200.0' Slope= 0.2400 '/'
Inlet Invert= 328.00', Outlet Invert= 280.00'

‡

Reach 8R: West Downchute



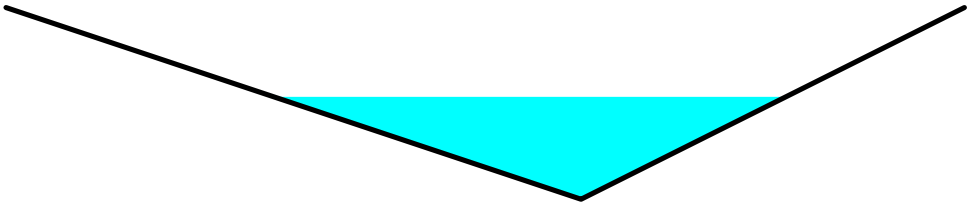
Summary for Reach 9R: Bottom Plateau West Diversion Berm

Inflow Area = 31.639 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 371.13 cfs @ 11.98 hrs, Volume= 21.875 af
Outflow = 354.24 cfs @ 12.04 hrs, Volume= 21.875 af, Atten= 5%, Lag= 4.0 min

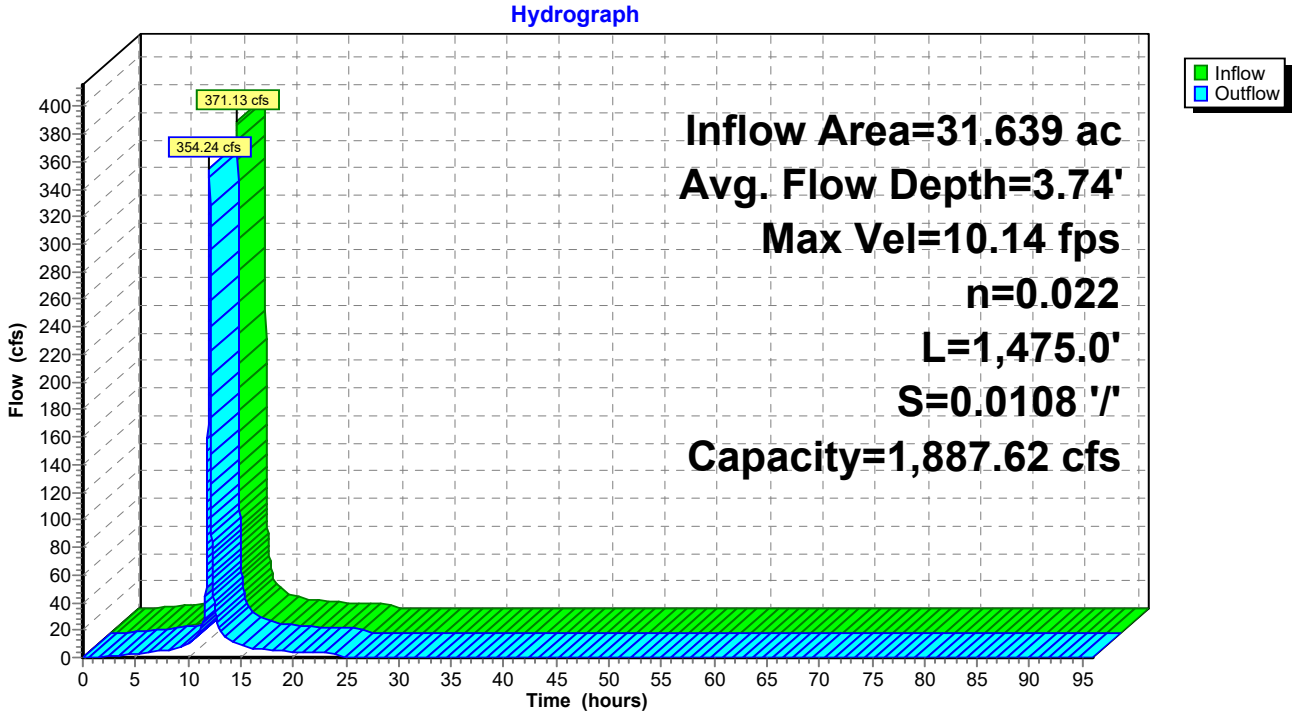
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.14 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 3.15 fps, Avg. Travel Time= 7.8 min

Peak Storage= 51,524 cf @ 12.00 hrs
Average Depth at Peak Storage= 3.74'
Bank-Full Depth= 7.00' Flow Area= 122.5 sf, Capacity= 1,887.62 cfs

0.00' x 7.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 2.0 '/' Top Width= 35.00'
Length= 1,475.0' Slope= 0.0108 '/'
Inlet Invert= 300.00', Outlet Invert= 284.00'



Reach 9R: Bottom Plateau West Diversion Berm



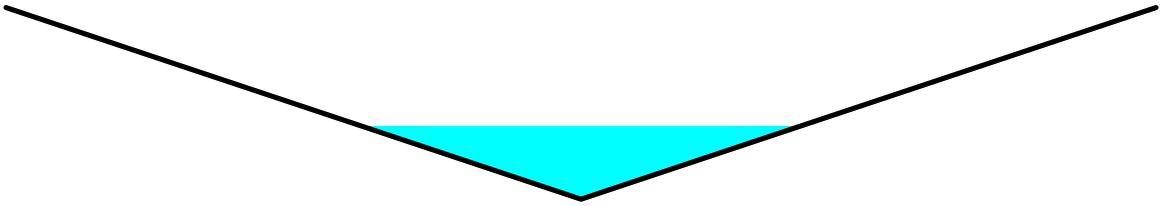
Summary for Reach 12R: Northwest Perimeter Channel

Inflow Area = 2.050 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 26.07 cfs @ 11.97 hrs, Volume= 1.417 af
Outflow = 24.01 cfs @ 12.05 hrs, Volume= 1.417 af, Atten= 8%, Lag= 5.1 min

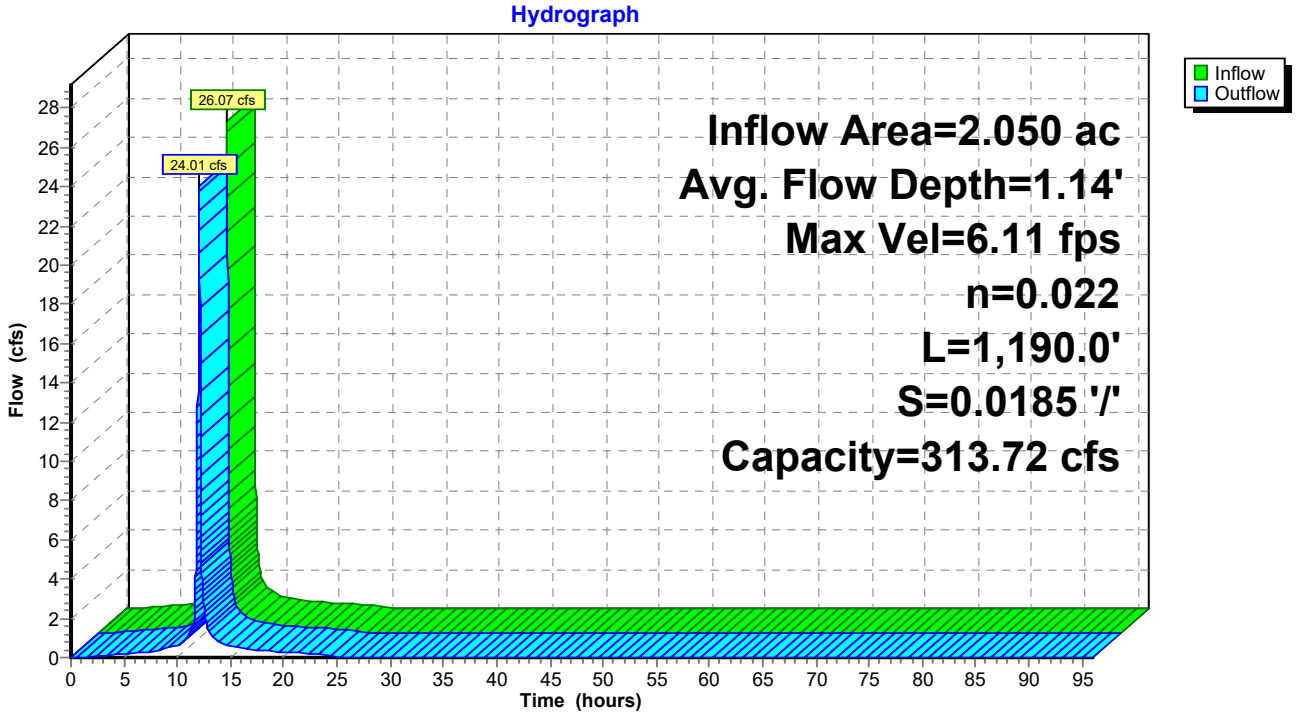
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.11 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 2.00 fps, Avg. Travel Time= 9.9 min

Peak Storage= 4,680 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.14'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 313.72 cfs

0.00' x 3.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 1,190.0' Slope= 0.0185 '/'
Inlet Invert= 302.00', Outlet Invert= 280.00'



Reach 12R: Northwest Perimeter Channel



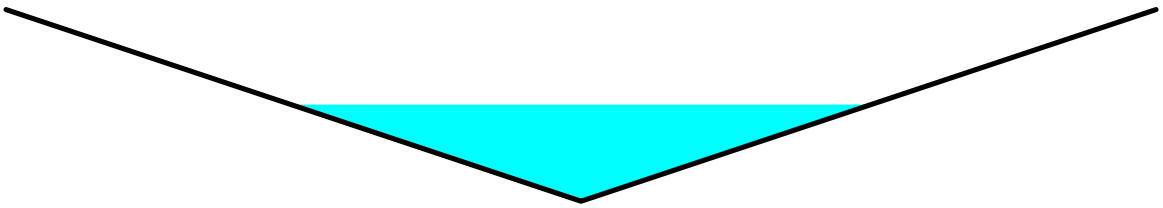
Summary for Reach 13R: West Perimeter Channel

Inflow Area = 2.125 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 27.02 cfs @ 11.97 hrs, Volume= 1.469 af
Outflow = 23.30 cfs @ 12.09 hrs, Volume= 1.469 af, Atten= 14%, Lag= 7.4 min

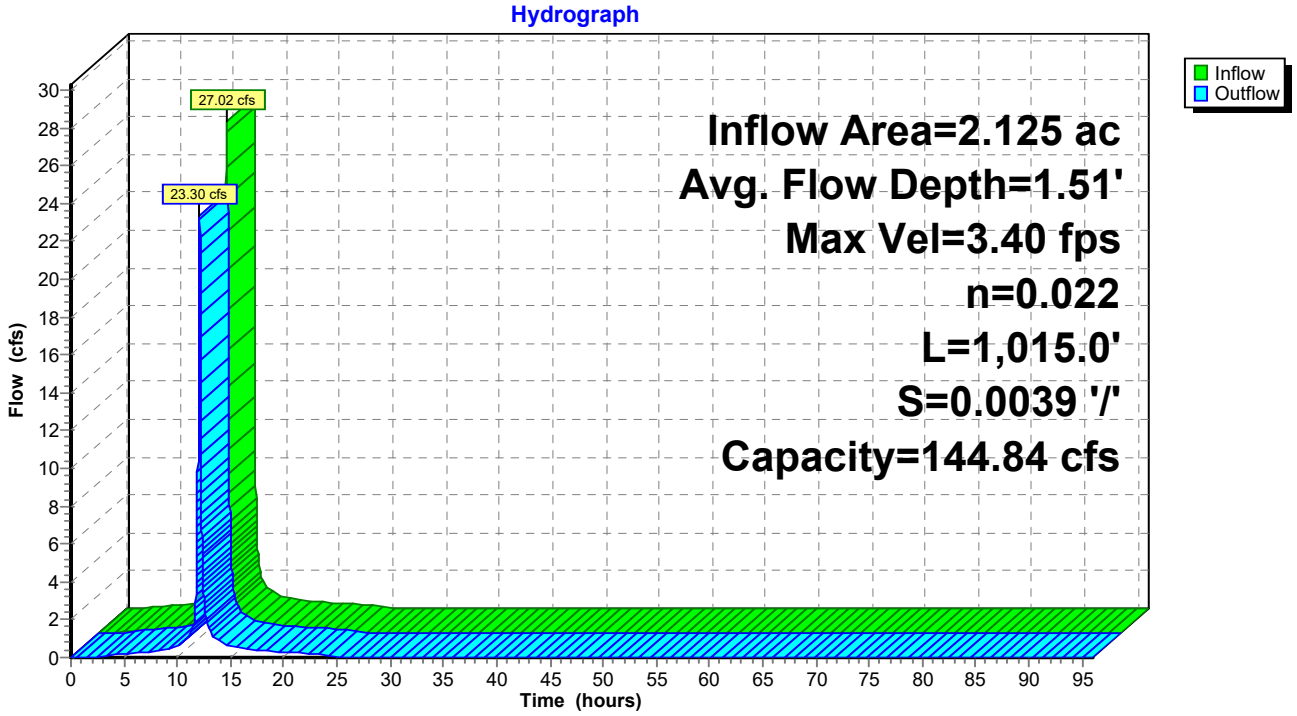
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.40 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 1.04 fps, Avg. Travel Time= 16.3 min

Peak Storage= 6,966 cf @ 12.01 hrs
Average Depth at Peak Storage= 1.51'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 144.84 cfs

0.00' x 3.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 1,015.0' Slope= 0.0039 '/'
Inlet Invert= 284.00', Outlet Invert= 280.00'



Reach 13R: West Perimeter Channel



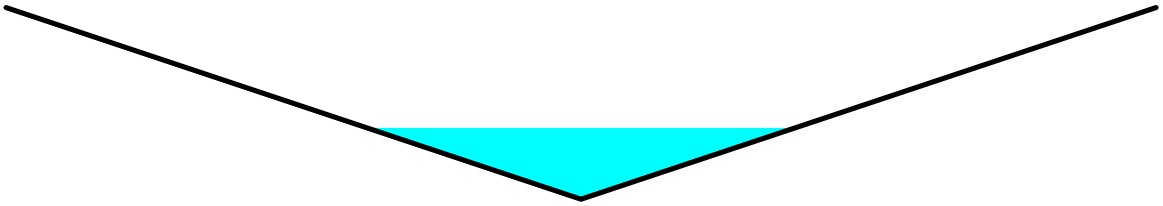
Summary for Reach 14R: East Perimeter Channel

Inflow Area = 1.105 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 14.05 cfs @ 11.97 hrs, Volume= 0.764 af
Outflow = 13.07 cfs @ 12.05 hrs, Volume= 0.764 af, Atten= 7%, Lag= 4.8 min

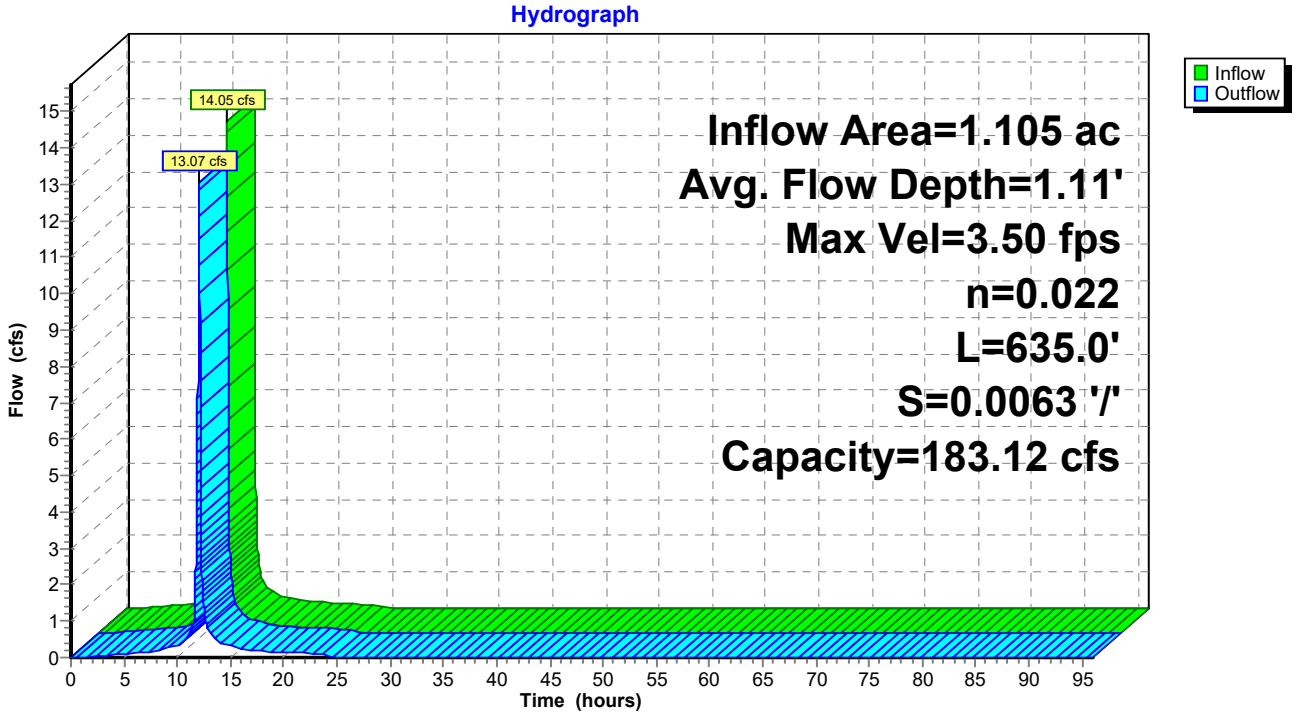
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.50 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 1.15 fps, Avg. Travel Time= 9.2 min

Peak Storage= 2,367 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.11'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 183.12 cfs

0.00' x 3.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 635.0' Slope= 0.0063 '/'
Inlet Invert= 270.00', Outlet Invert= 266.00'



Reach 14R: East Perimeter Channel



Summary for Reach 15R: Southwest Downchute

[62] Hint: Exceeded Reach 9R OUTLET depth by 4.00' @ 0.00 hrs

Inflow Area = 31.639 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 354.24 cfs @ 12.04 hrs, Volume= 21.875 af
Outflow = 353.99 cfs @ 12.04 hrs, Volume= 21.875 af, Atten= 0%, Lag= 0.1 min

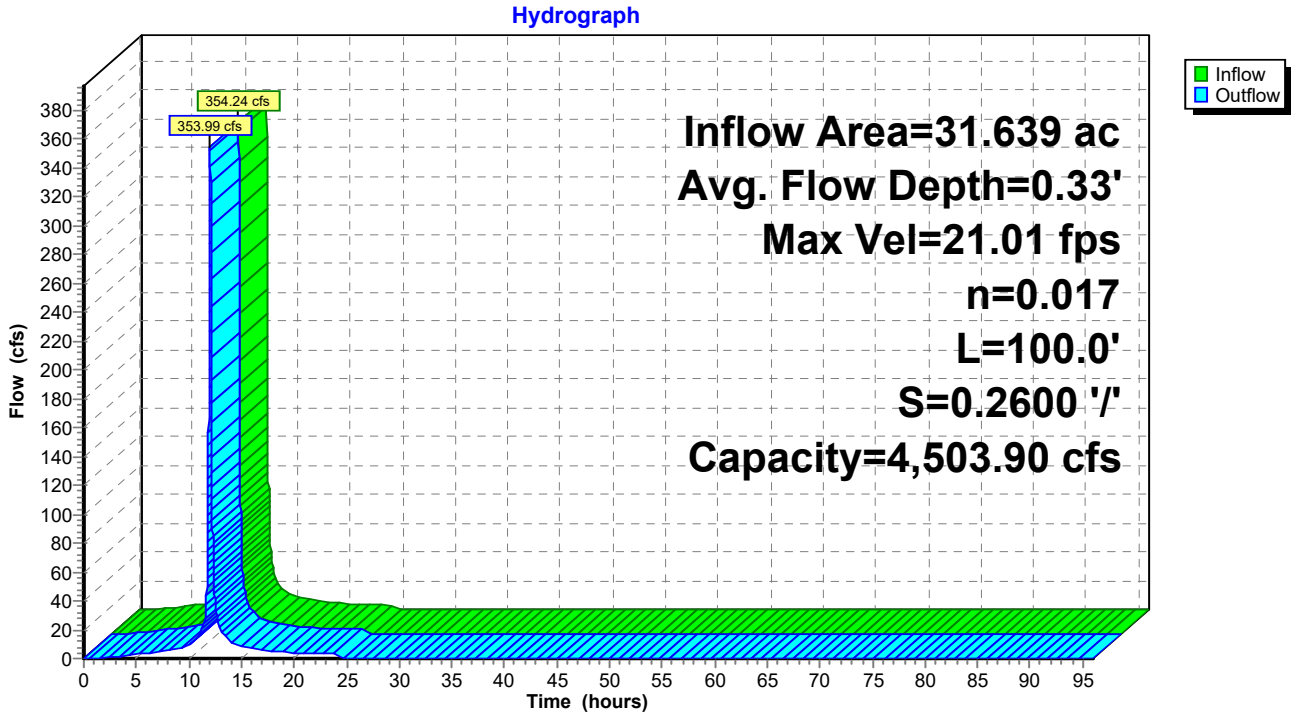
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 21.01 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.23 fps, Avg. Travel Time= 0.4 min

Peak Storage= 1,686 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.50' Flow Area= 81.8 sf, Capacity= 4,503.90 cfs

50.00' x 1.50' deep channel, n= 0.017 Concrete, unfinished
Side Slope Z-value= 3.0 '/' Top Width= 59.00'
Length= 100.0' Slope= 0.2600 '/'
Inlet Invert= 288.00', Outlet Invert= 262.00'

‡

Reach 15R: Southwest Downchute



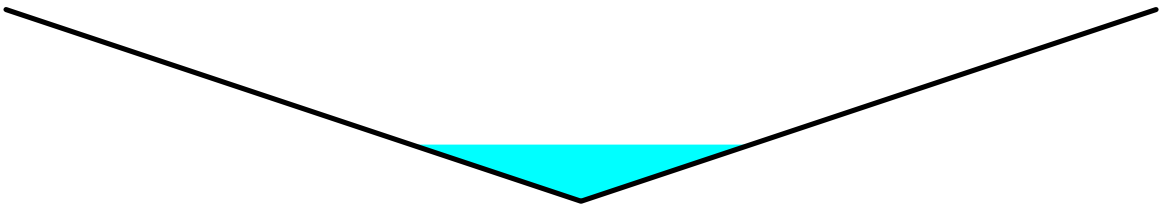
Summary for Reach 21R: Upper Southwest Perimeter Channel

Inflow Area = 1.221 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 15.53 cfs @ 11.97 hrs, Volume= 0.844 af
Outflow = 15.10 cfs @ 12.01 hrs, Volume= 0.844 af, Atten= 3%, Lag= 2.7 min

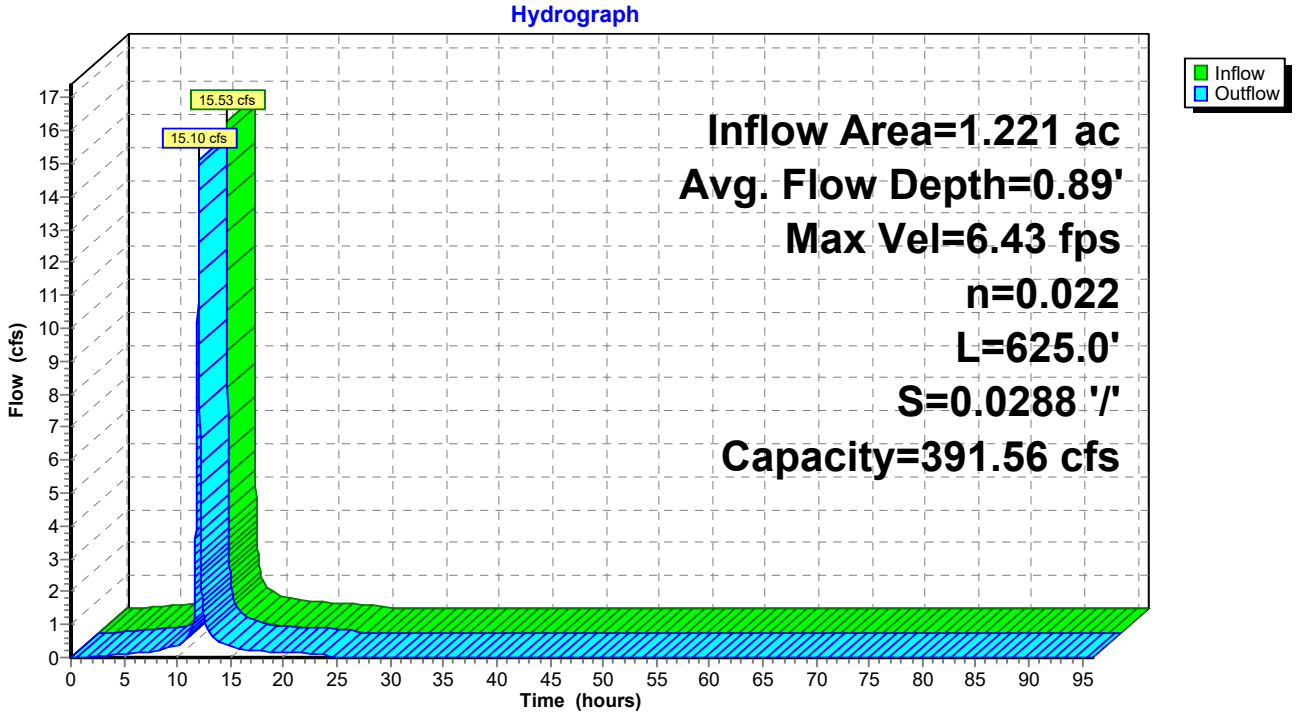
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.43 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 2.19 fps, Avg. Travel Time= 4.8 min

Peak Storage= 1,470 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.89'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 391.56 cfs

0.00' x 3.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 625.0' Slope= 0.0288 '/'
Inlet Invert= 280.00', Outlet Invert= 262.00'



Reach 21R: Upper Southwest Perimeter Channel



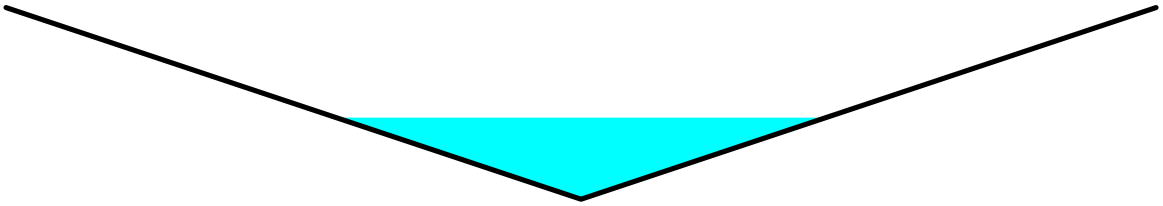
Summary for Reach 24R: Lower Southwest Perimeter Channel

Inflow Area = 1.935 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 24.61 cfs @ 11.97 hrs, Volume= 1.338 af
Outflow = 21.59 cfs @ 12.08 hrs, Volume= 1.338 af, Atten= 12%, Lag= 6.8 min

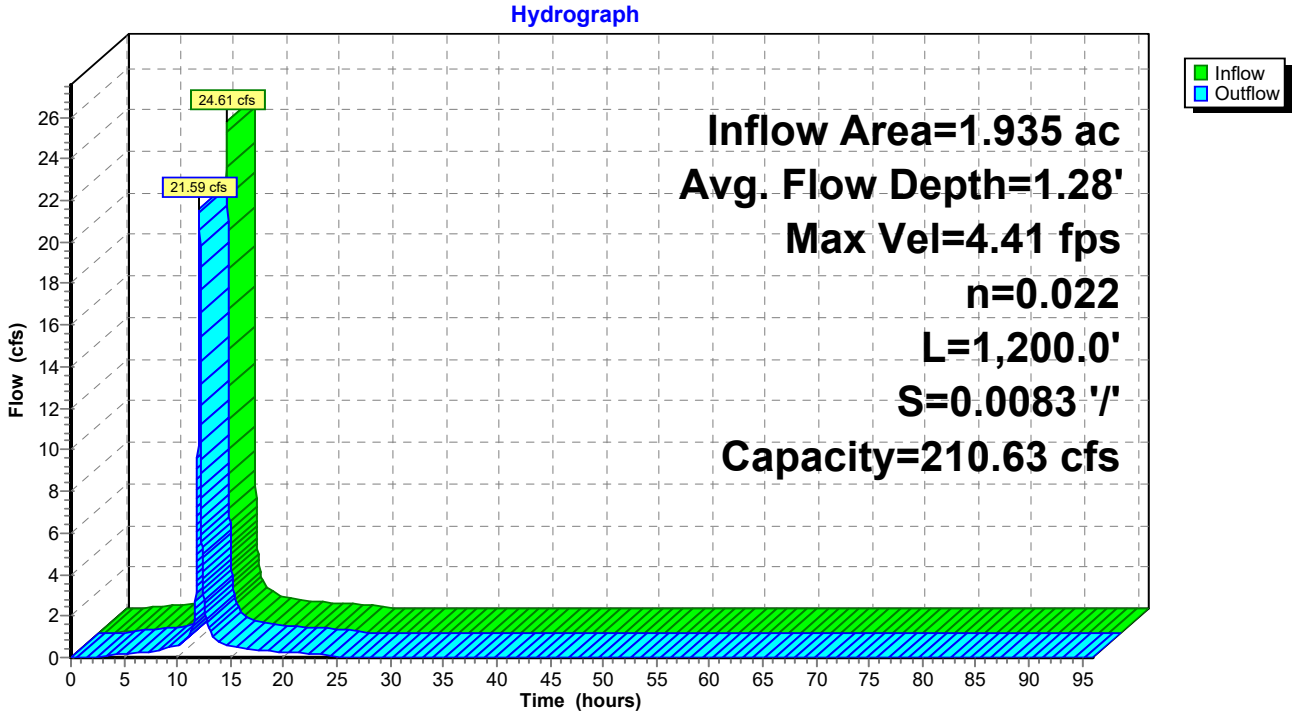
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.41 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.39 fps, Avg. Travel Time= 14.3 min

Peak Storage= 5,875 cf @ 12.01 hrs
Average Depth at Peak Storage= 1.28'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 210.63 cfs

0.00' x 3.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 1,200.0' Slope= 0.0083 '/'
Inlet Invert= 272.00', Outlet Invert= 262.00'



Reach 24R: Lower Southwest Perimeter Channel



Summary for Reach 26R: Bottom Plateau East Diversion Berm

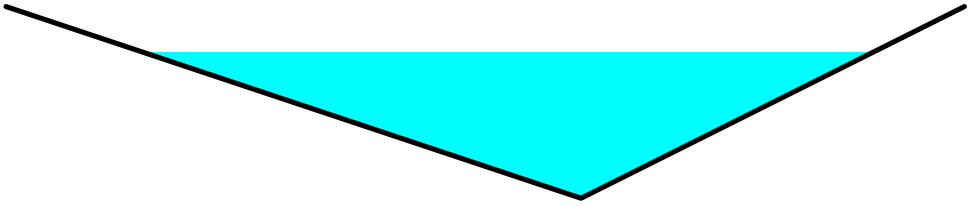
[62] Hint: Exceeded Reach 5R OUTLET depth by 1.28' @ 11.99 hrs

Inflow Area = 36.421 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 449.09 cfs @ 11.97 hrs, Volume= 25.181 af
Outflow = 427.27 cfs @ 12.03 hrs, Volume= 25.181 af, Atten= 5%, Lag= 3.8 min

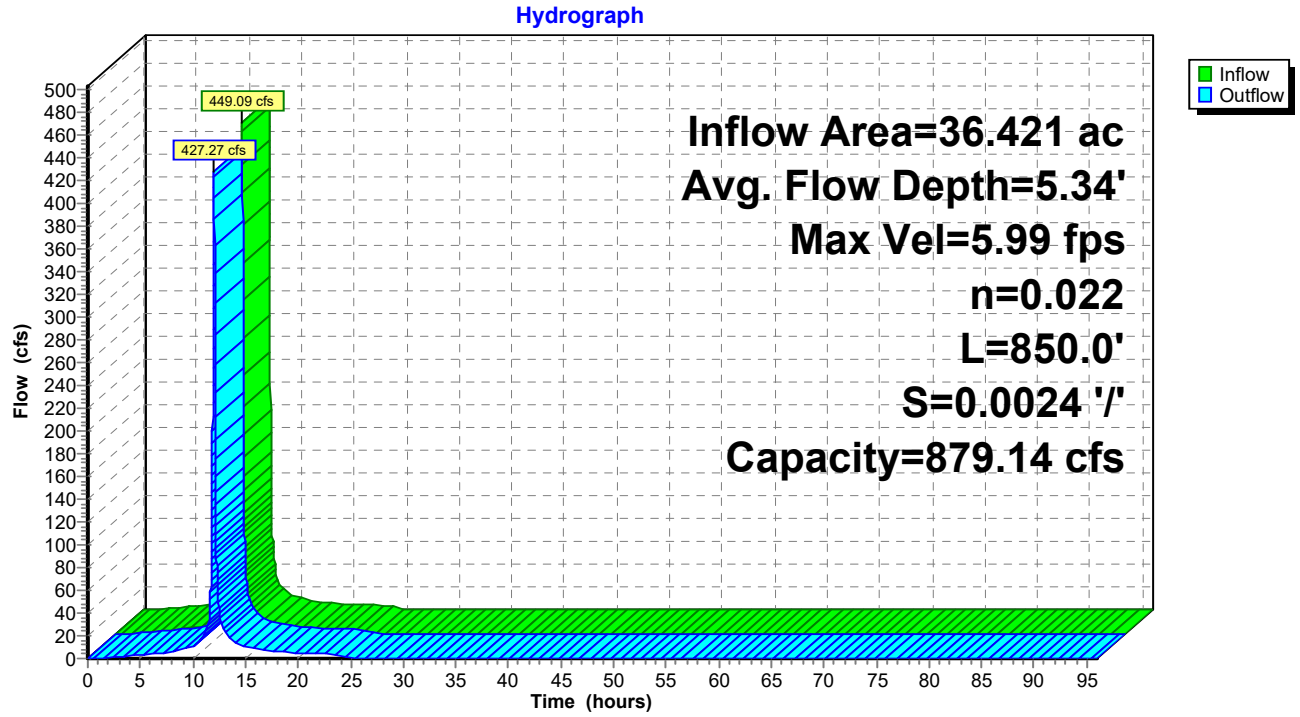
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.99 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 8.2 min

Peak Storage= 60,626 cf @ 11.99 hrs
Average Depth at Peak Storage= 5.34'
Bank-Full Depth= 7.00' Flow Area= 122.5 sf, Capacity= 879.14 cfs

0.00' x 7.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 2.0 '/' Top Width= 35.00'
Length= 850.0' Slope= 0.0024 '/'
Inlet Invert= 288.00', Outlet Invert= 286.00'



Reach 26R: Bottom Plateau East Diversion Berm



Summary for Reach 27R: Southeast Downchute

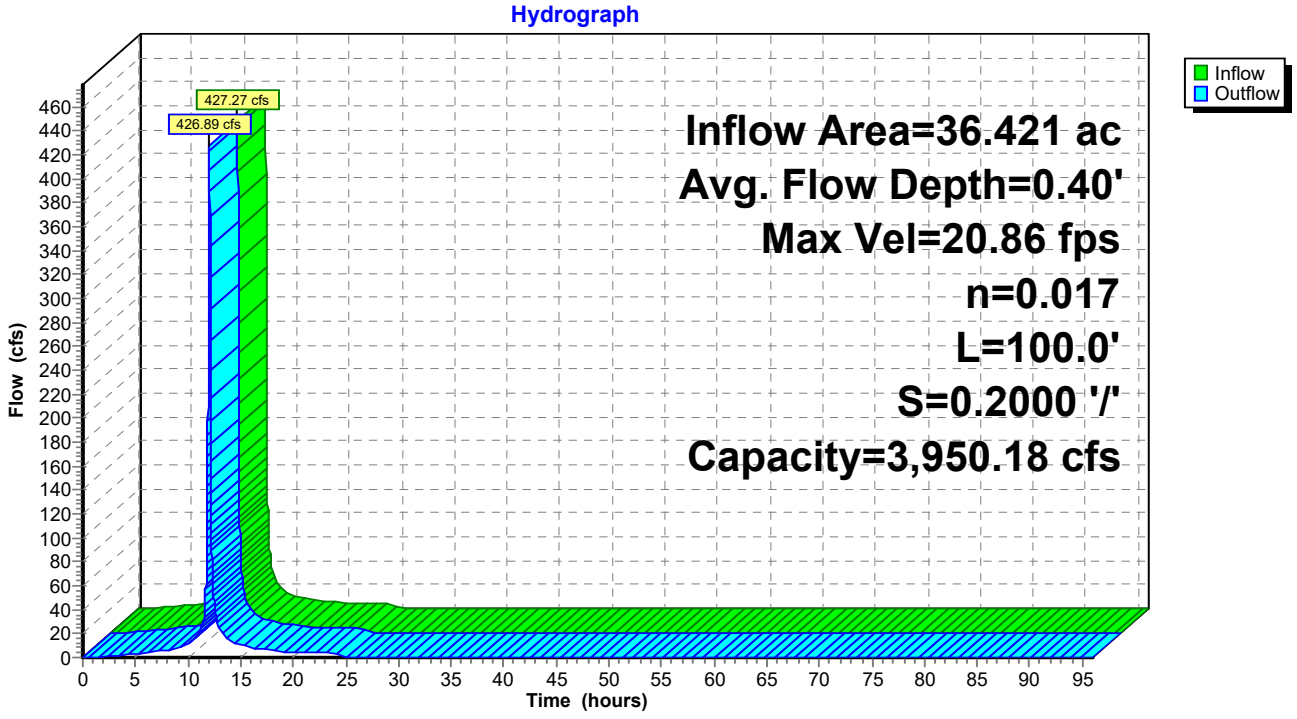
Inflow Area = 36.421 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 427.27 cfs @ 12.03 hrs, Volume= 25.181 af
Outflow = 426.89 cfs @ 12.03 hrs, Volume= 25.181 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.86 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.00 fps, Avg. Travel Time= 0.4 min

Peak Storage= 2,048 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.50' Flow Area= 81.8 sf, Capacity= 3,950.18 cfs

50.00' x 1.50' deep channel, n= 0.017 Concrete, unfinished
Side Slope Z-value= 3.0 '/' Top Width= 59.00'
Length= 100.0' Slope= 0.2000 '/'
Inlet Invert= 282.00', Outlet Invert= 262.00'

Reach 27R: Southeast Downchute



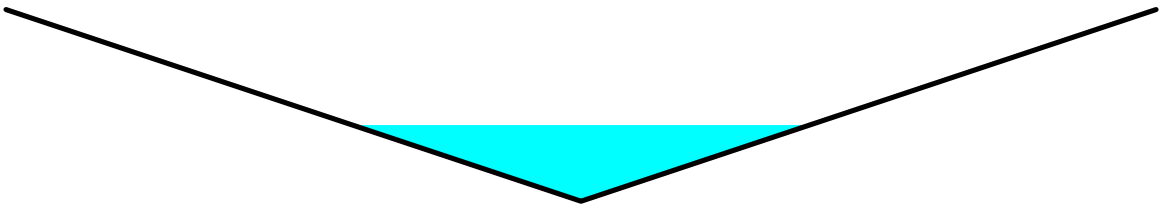
Summary for Reach 30R: Lower South Perimeter Channel

Inflow Area = 1.733 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 22.04 cfs @ 11.97 hrs, Volume= 1.198 af
Outflow = 20.22 cfs @ 12.05 hrs, Volume= 1.198 af, Atten= 8%, Lag= 5.2 min

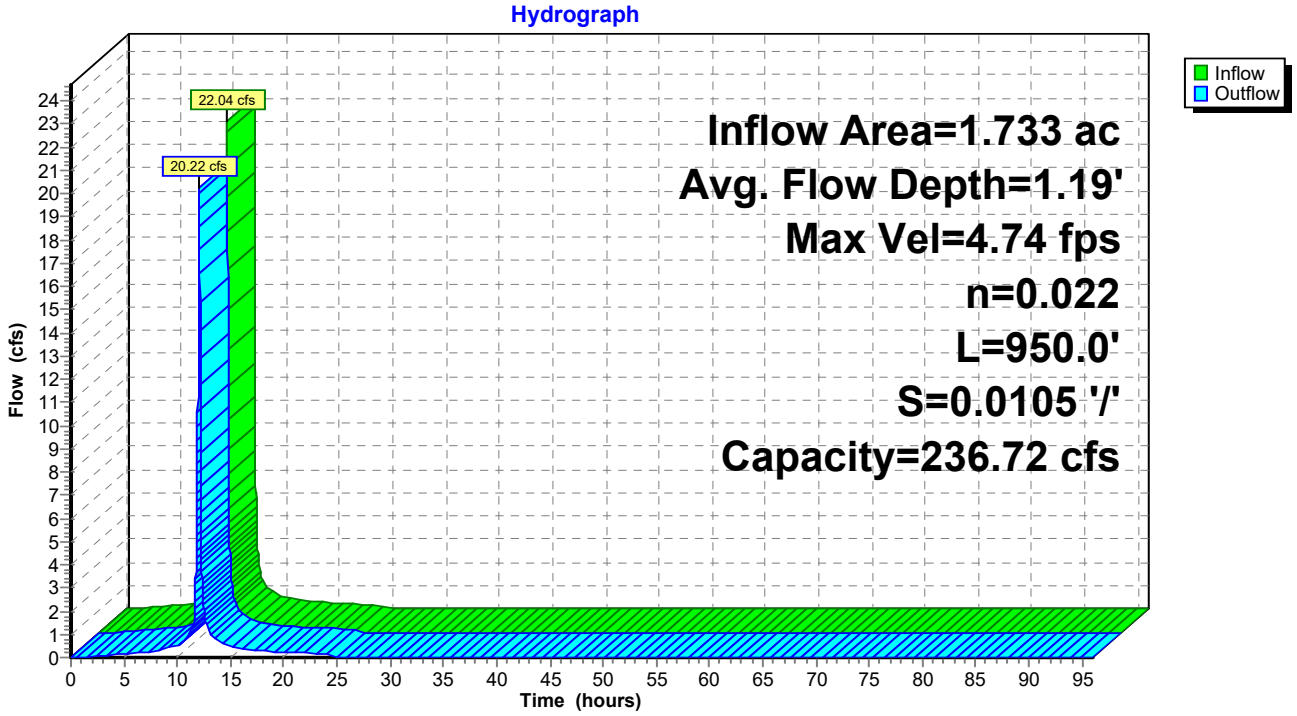
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.74 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 10.3 min

Peak Storage= 4,058 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.19'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 236.72 cfs

0.00' x 3.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 950.0' Slope= 0.0105 '/'
Inlet Invert= 272.00', Outlet Invert= 262.00'



Reach 30R: Lower South Perimeter Channel



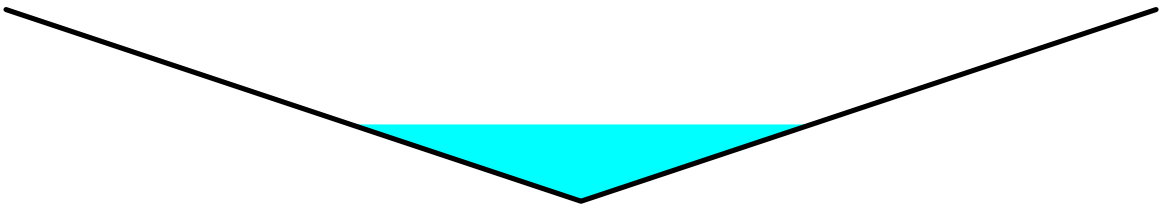
Summary for Reach 31R: Lower Southeast Perimeter Channel

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 19.08 cfs @ 11.97 hrs, Volume= 1.037 af
Outflow = 17.60 cfs @ 12.05 hrs, Volume= 1.037 af, Atten= 8%, Lag= 5.0 min

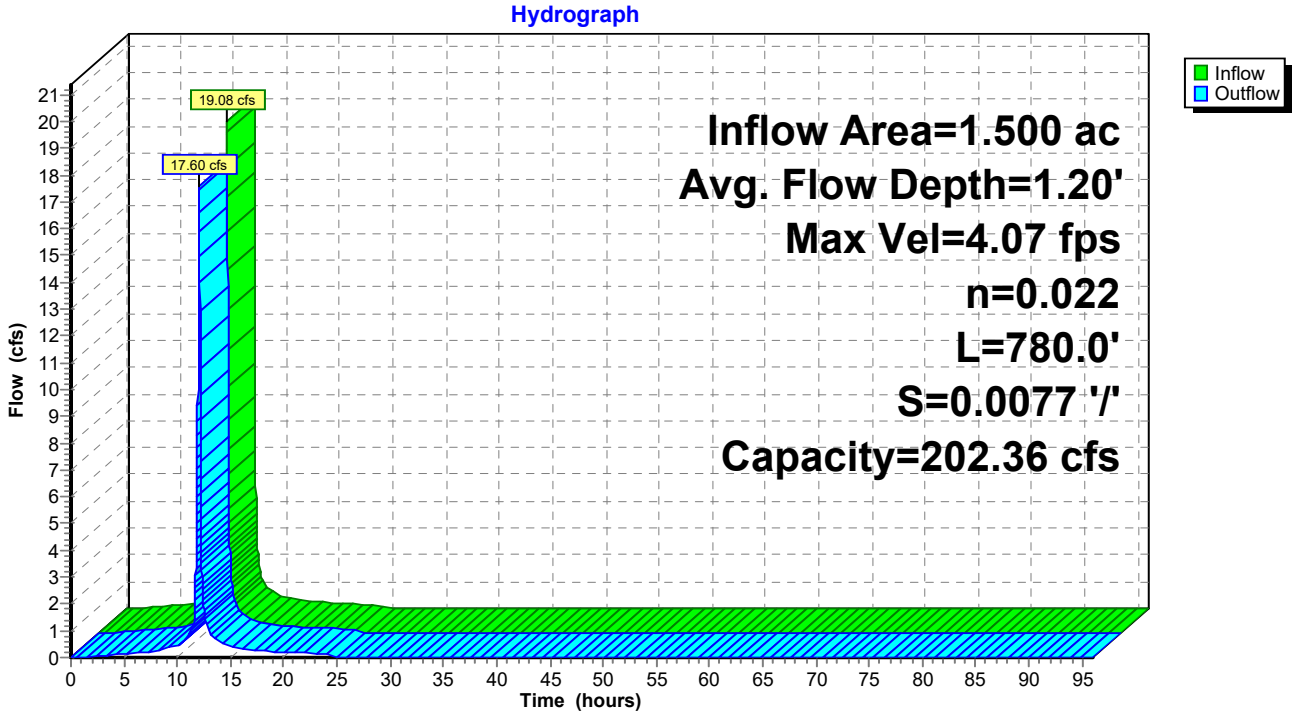
Routing by Stor-Ind+Trans method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.07 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 1.33 fps, Avg. Travel Time= 9.8 min

Peak Storage= 3,377 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.20'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 202.36 cfs

0.00' x 3.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 18.00'
Length= 780.0' Slope= 0.0077 '/'
Inlet Invert= 268.00', Outlet Invert= 262.00'



Reach 31R: Lower Southeast Perimeter Channel



Summary for Pond 14P: Pond 1

Inflow Area = 30.790 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 368.86 cfs @ 11.98 hrs, Volume= 21.288 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 263.17' @ 47.88 hrs Surf.Area= 144,918 sf Storage= 927,301 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

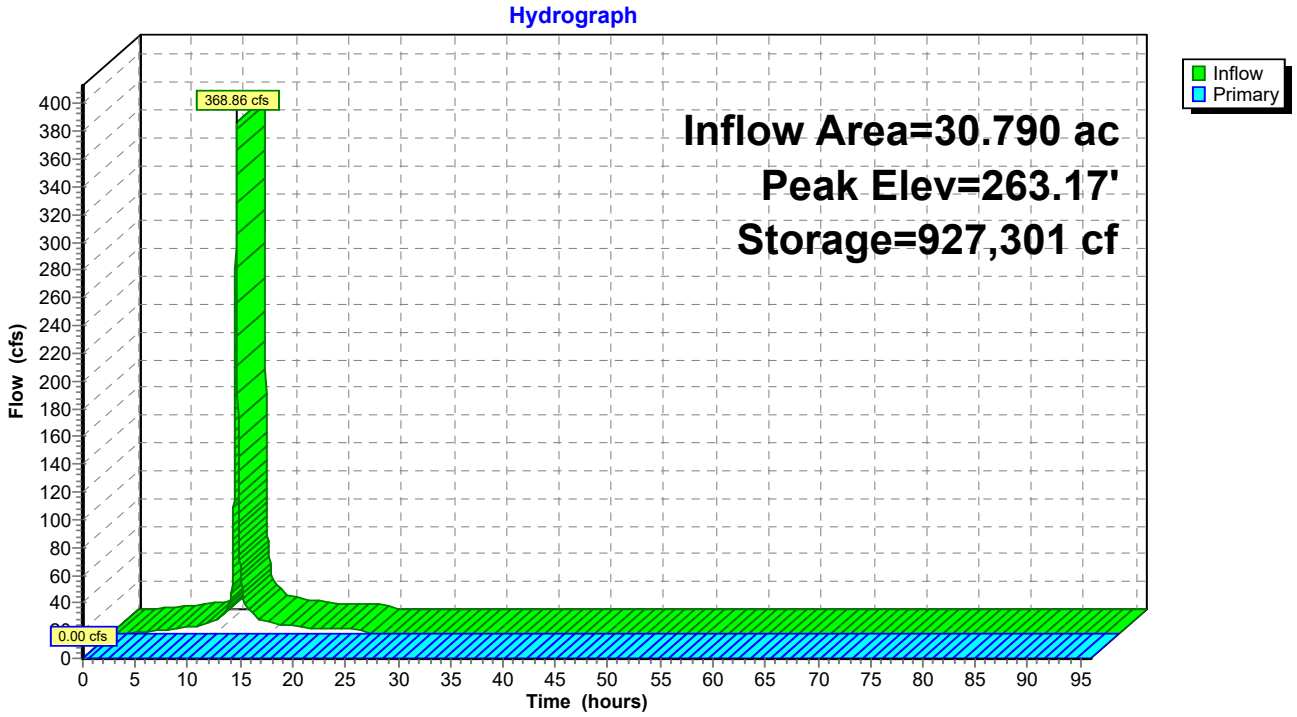
Volume	Invert	Avail.Storage	Storage Description
#1	256.00'	1,356,386 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
256.00	114,495	0	0
258.00	122,621	237,116	237,116
260.00	131,024	253,645	490,761
262.00	139,702	270,726	761,487
264.00	148,656	288,358	1,049,845
266.00	157,885	306,541	1,356,386

Device	Routing	Invert	Outlet Devices
#1	Primary	265.00'	**100.0' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=256.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 14P: Pond 1

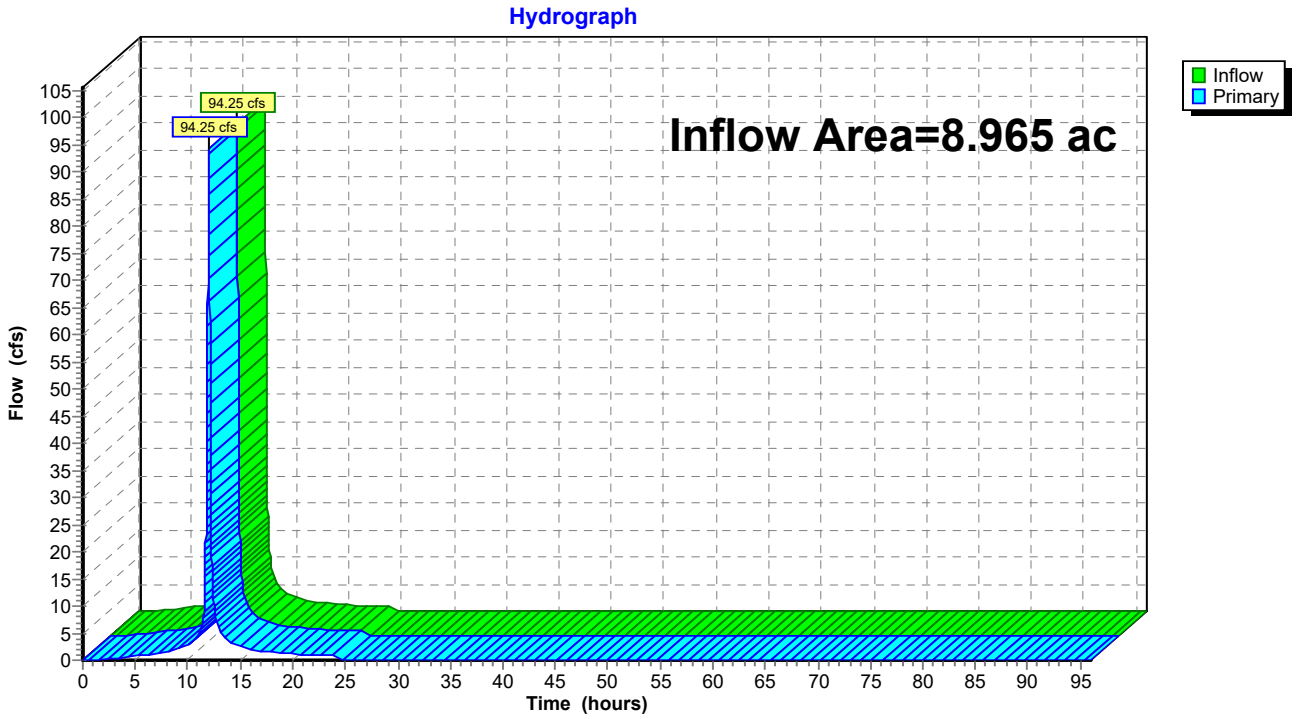


Summary for Link 17L: Combined Northwest Sideslope Flows

Inflow Area = 8.965 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 94.25 cfs @ 11.99 hrs, Volume= 6.198 af
Primary = 94.25 cfs @ 11.99 hrs, Volume= 6.198 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Link 17L: Combined Northwest Sideslope Flows

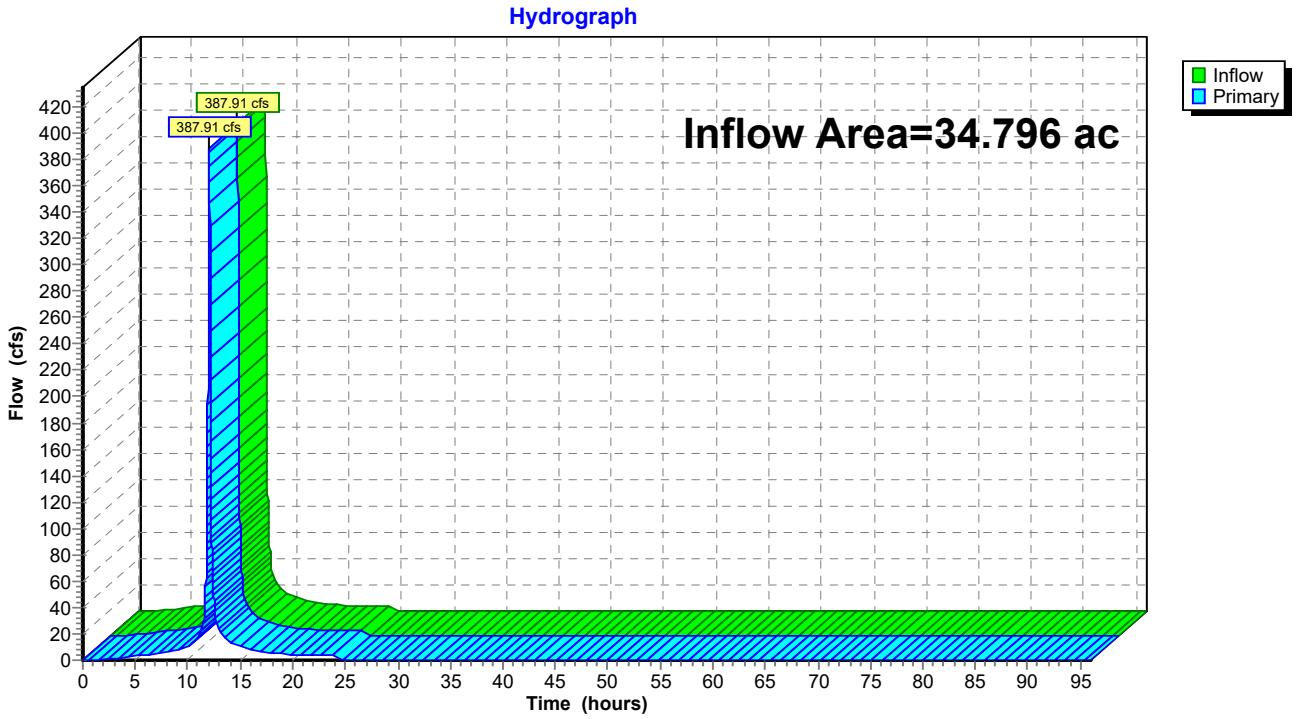


Summary for Link 22L: Combined Southwest Flows

Inflow Area = 34.796 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 387.91 cfs @ 12.04 hrs, Volume= 24.058 af
Primary = 387.91 cfs @ 12.04 hrs, Volume= 24.058 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Link 22L: Combined Southwest Flows

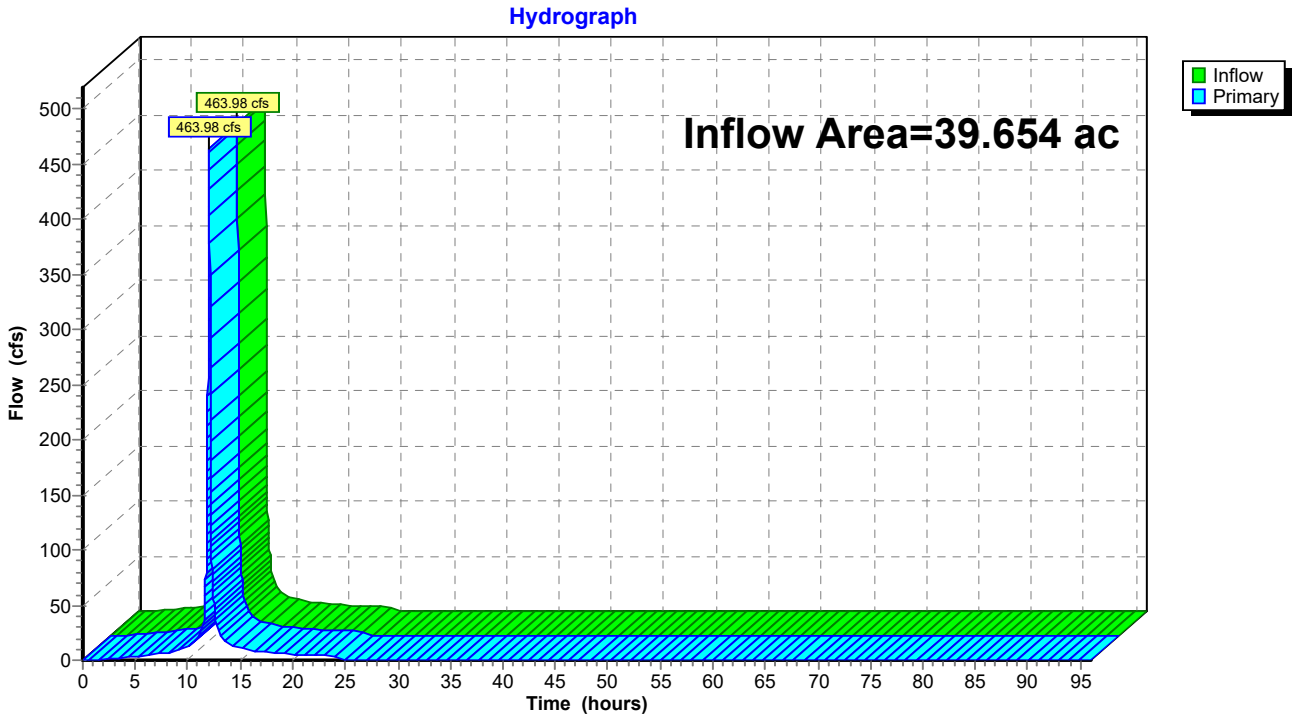


Summary for Link 32L: Combined Southeast Flows

Inflow Area = 39.654 ac, 0.00% Impervious, Inflow Depth = 8.30" for 25-yr event
Inflow = 463.98 cfs @ 12.04 hrs, Volume= 27.417 af
Primary = 463.98 cfs @ 12.04 hrs, Volume= 27.417 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Link 32L: Combined Southeast Flows



RESPONSE ITEM 28

ATTACHMENT

FINANCIAL ASSURANCE STATEMENT

Gibbons Creek Environmental Redevelopment Group, LLC

August 26, 2022

Texas Commission for Environmental Quality ***submitted via email***
Industrial and Hazardous Waste Permits Section MC-130
PO Box 13087
Austin, Texas 78711-3087
Attn.: Brent Wade

RE: Financial Assurance Post Closure Care
Gibbons Creek Reservoir – Solid Waste Registration 32271 (CCR113).

Dear Mr. Wade:

In accordance with 30 TAC §352.1241 and 40 C.F.R. §257.104, the owner or operator of a coal combustion residuals (CCR) unit must prepare a post closure care cost estimate. The post closure care of each CCR unit must continue for at least 30 years after the date of completing closure of the unit and must consist of monitoring and reporting of the groundwater monitoring systems, in addition to the maintenance and monitoring of the CCR unit and continuation of certain security requirements.

As detailed in the Closure and Post-Closure Plan for the Gibbons Creek Steam Electric Station dated April 9, 2021, the Gibbons Creek Environmental Redevelopment Group, LLC (GCERG) intends to close the CCR units at the facility (see gcerg-ccrule.com). Specifically, the GCERG intends to close the Scrubber Sludge Pond (SSP), Ash Ponds (APs), and Site F Landfill (SFL) consistent with the Closure and Post Closure Plan. The SSP and APs will be closed by removing the CCR material in accordance with 40 C.F.R. §257.102(c) and the SFL will be closed by leaving CCR materials in place in accordance with 40 C.F.R. §257.102(d). The closure activities are expected to be completed in 2023.

In accordance with 30 TAC §352.1101, the GCERG will submit a financial assurance mechanism acceptable to the executive director no more than 90 days after the executive director's approval of the registration.

Best regards,
Gibbons Creek Environmental Redevelopment Group, LLC

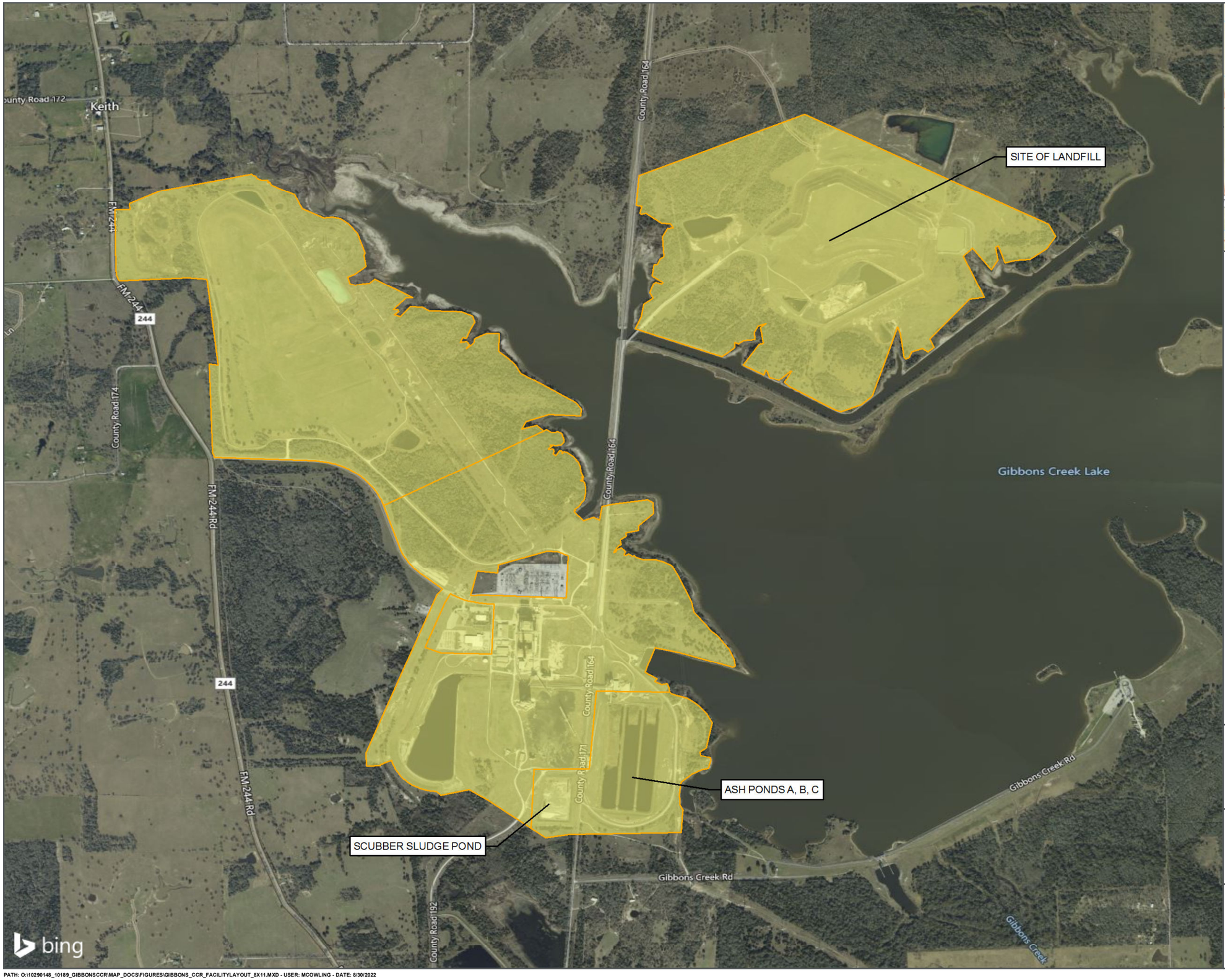
Norman E. Divers, III, VP – Quality, Environment, Health & Safety
/nd

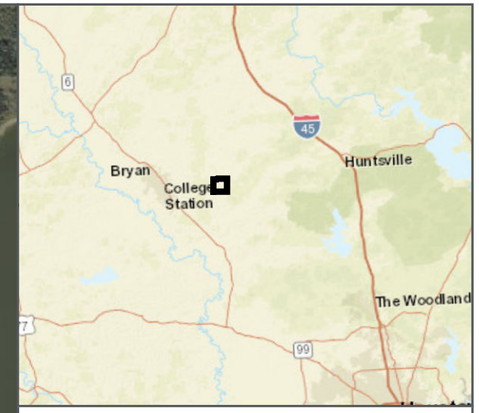
12601 Plantside Drive
Louisville, KY 40299
(502) 245-1353

RESPONSE ITEM 6 (2)

ATTACHMENT

UPDATED REGISTRATION BOUNDARY





LEGEND

GCERG OWNED PARCELS

PARCEL BOUNDARY

FACILITY LAYOUT MAP

GIBBONS CREEK STEAM ELECTRIC STATION

N

0 0.25 0.5

MILES

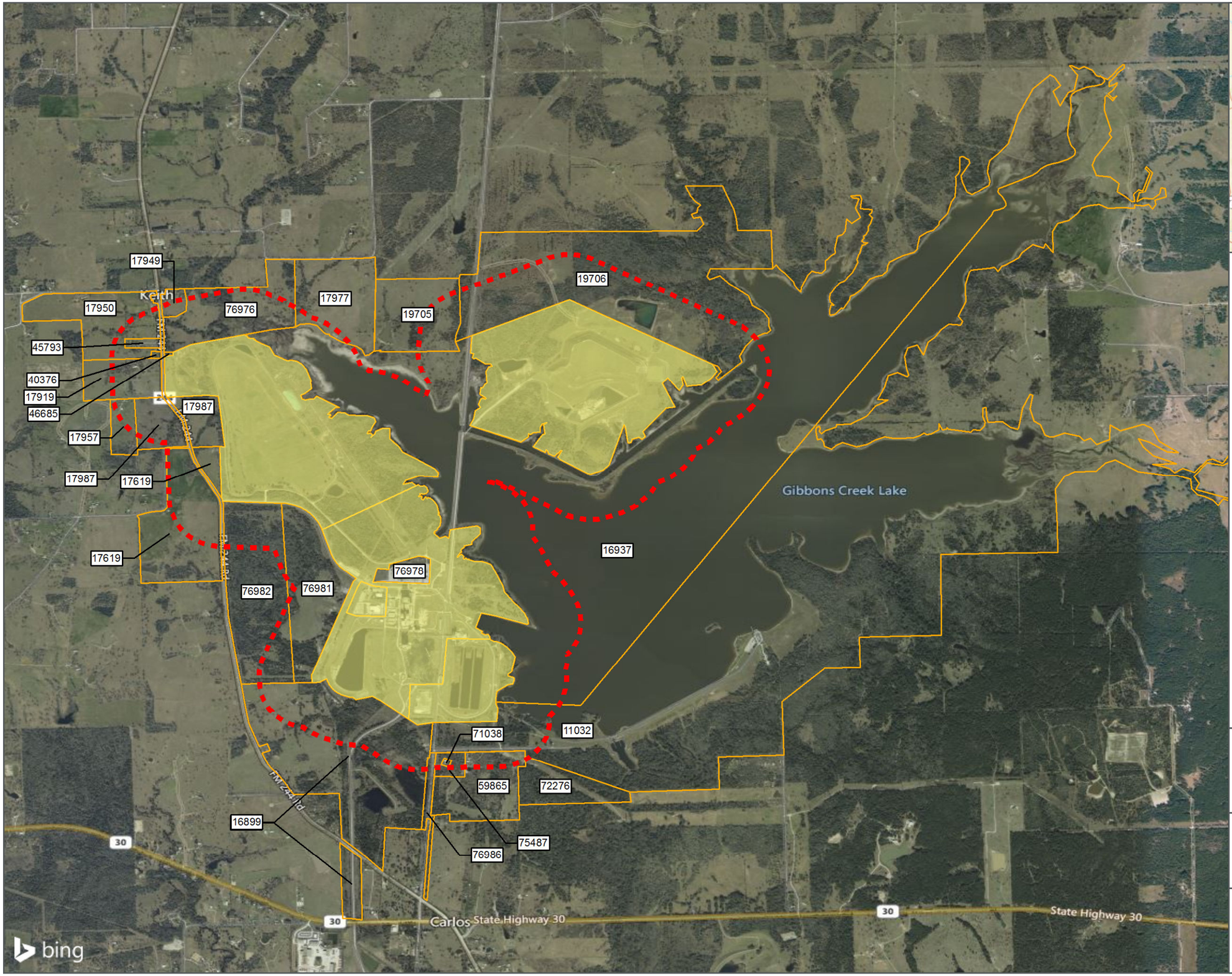
FIGURE 1

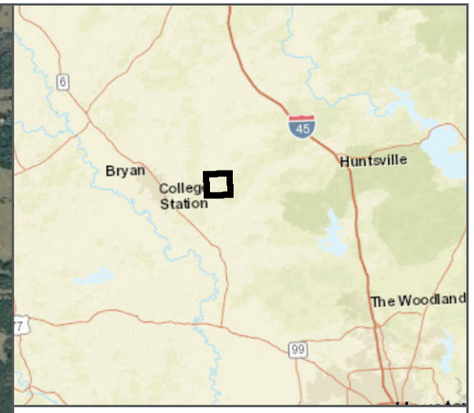
PATH: O:\10290148_10189_GIBBONSCCR\MAP_DOCS\FIGURES\GIBBONS_CCR_FACILITYLAYOUT_8X11.MXD - USER: MCOWLING - DATE: 8/30/2022

RESPONSE ITEM 10 (2)

ATTACHMENT

UPDATED ADJACENT LANDOWNER LIST AND DRAWING





LEGEND

- GCERG OWNED PARCELS
- QUARTER-MILE BUFFER
- PARCEL BOUNDARY

ADJACENT LAND OWNERSHIP MAP

GIBBONS CREEK STEAM ELECTRIC STATION

N

0 0.5 1
MILES

FIGURE 1

PATH: O:\10290148_10189_GIBBONSCCR\MAP_DOCS\FIGURES\GIBBONS_CCR_LANDOWNERS_20220822_8X11.MXD - USER: MCOWLING - DATE: 8/22/2022

ADJACENT PROPERTY OWNERSHIP DATA

Landowners Cross-Referenced to Adjacent Land Ownership Map

The persons identified below would be considered as affected persons.

11032 GIBBONS TRACT 1, LP
11801 PRIVATE RD
NORMANGEE, TX 77871

16899 3S REAL ESTATE INVESTMENTS, LLC
P. O. BOX 433
GARWOOD, TX 77442

16937 GIBBONS TRACT 1, LP
11801 PRIVATE RD
NORMANGEE, TX 77871

17619 SMITH FAMILY PARTNERS L.P.
SMITH PARTNERS
4315 VALENCIA CT
COLLEGE STATION, TX 77845-1934

17919 JONES, JAMES H & CYNTHIA L
13585 FM 244
IOLA, TX 77861

17949 ROYALL, JASON
13998 FM 244
IOLA, TX 77861-3672

17950 TRANT, BOBBY JOE
13769 FM 244
IOLA, TX 77861

17957 LYNDEL BEENE FAMILY PARTNERSHIP LP
BEENE PARTNERSHIP
4315 VELENCIA CT
COLLEGE STATION, TX 77845-1934

17977 TRANT, JAMES RAY & CYNTHIA
17988 FM 244
IOLA, TX 77861-3659

17987 FINLEY, LENA L (ESTATE)
24423 SPLIT ROCK FLS
TOMBALL, TX 77375-5357

17987 FINLEY, LENA L (ESTATE)
24423 SPLIT ROCK FLS
TOMBALL, TX 77375-5357

19705 TRANT, JAMES RAY & CYNTHIA
17988 FM 244
IOLA, TX 77861-3659

19706 GIBBONS TRACT 8, LP
11801 PRIVATE RD
NORMANGEE, TX 77871

40376 TRANT, BOBBY JOE
13769 FM 244
IOLA, TX 77861-3673

45793 TRANT, BOBBY JOE
13769 FM 244
IOLA, TX 77861

46685 FAIRBANKS, LLOYD JR & LUCILLE AVERA
5121 HWY 30
ANDERSON, TX 77830-8907

59865 GILBERT, ROY E & SHERYL J
9028 GIBBONS CREEK RD
ANDERSON, TX 77830-4102

71038 ROEHLING, MELVIN V & CINDY
8952 GIBBONS CREEK RD
ANDERSON, TX 77830

72276 GILBERT, ROY E ET AL
9028 GIBBONS CREEK RD
ANDERSON, TX 77830

75487 ROEHLING, MELVIN V & CINDY
8952 GIBBONS CREEK RD
ANDERSON, TX 77830

76976 GIBBONS TRACT 7, LP
11801 PRIVATE RD
NORMANGEE, TX 77871

76978 T M P A
ATTN: MURPHY HAWKINS
P O BOX 7000
BRYAN, TX 77805-7000

76981 GIBBONS TRACT 9, LP
11801 PRIVATE RD
NORMANGEE, TX 77871

76982 GIBBONS TRACT 10, LP
11801 PRIVATE RD
NORMANGEE, TX 77871

76986 GIBBONS TRACT 12A, LP
11801 PRIVATE RD
NORMANGEE, TX 77871